THE

# STATE AGRICULTURAL COLLEGE

OF THE

## STATE OF COLORADO.

---

THIRD ANNUAL REPORT

OF

# The Agricultural Experiment Station.

1890.

FORT COLLINS, COLO.

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# The Agricultural Experiment Station.

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The Arkansas Valley Station, Rocky Ford, - - - - - - - - - FRANK L. WATROUS, Superintendent

* Resigned July 1, 1890.
† Resigned June 7, 1890.

# TABLE OF CONTENTS.

# Letter of Transmittal.

HON. JOHN L. ROUTT,

*Governor of Colorado:*

SIR—I have the honor to transmit herewith the Third Annual Report of the Agricultural Experiment Station, conducted in connection with the State Agricultural College, as required by law.

Respectfully submitted,

FRANK J. ANNIS,

*Secretary of the State Board of Agriculture.*

THE STATE AGRICULTURAL COLLEGE,

FORT COLLINS, Colorado, January 31, 1891.

# Third Annual Report of the Director.

*To the Executive Committee, State Board of Agriculture:*

SIRS—I present my report as Director to your committee directly, and through you to the whole Board of Control.

No change has taken place in the methods of operation or in the management of the Station. The Council has held meetings during the year as follows:

December 30, 1889, and January 27 and 29; February 17 and 27; March 17 and 31; June 17; October 9th; November 3 and December 1, 1890, a total of eleven meetings. At these meetings the order of business is:

1. Roll call.
2. Reading of minutes and approval.
3. Reports of heads of sections.
4. Reports of committees.
5. Unfinished business.
6. New business.
7. Adjournment.

The reports of heads of sections have been, as a rule, full and comprehensive, and by a perusal of these one may obtain a very good idea of the diversified work of the Station.

The Council during this year has not taken cognizance of the work of sub-stations in its meetings or reports, except incidentally in the work of the particular sections.

During the month of January, high winds injured some of the instruments used in meteorology. This was the storm which damaged the building in process of erec-

tion, and the veterinary laboratory which, just previous to this, had been transformed into a building for use in horticulture.

The completion of the laboratory for botany and horticulture has been of great importance to us in the Station. It relieved rooms in the main building which have since been occupied by the Department of Physics and Engineering, to their great convenience and advantage.

The time of the Council has been largely taken up in the discussion of lines of work for the year first, and in consideration of the subject matter prepared for bulletins by the sections. Some of this material was referred back once or twice before ready to recommend to your committee for final adoption and issue. The bulletins prepared and printed are:

No. 10—"Tobacco," by the Sections of Horticulture and Chemistry.

No. 11—"Sugar Beets," by the Chemical Section, with an introduction by the Director.

No. 12—"Some Colorado Grasses and Their Chemical Analysis," by the Sections of Botany and Chemistry.

No. 13—"The Measurement and Division of Water," by the Section of Irrigation Engineering.

On account of the promised extra call for Nos. 12 and 13, the larger editions ordered by your committee seem fully justified, 5,000 of No. 12 and 3,000 of No. 13 being issued.

The subjects chosen seem to have been fortunate, as the public have been very much interested in the results of our work as published. The bulletin on sugar beets was very opportune and has been one means of arousing a deep interest in the subject of sugar production in our State. The bulletin on grasses has been more extensively

called for by all classes of people than any other yet issued. The one on alfalfa (No. 8) had the greatest run among the farmers. No. 13 is eagerly sought by all farmers residing in the arid region where irrigation is practiced. The vexing question of water supply and division have but to be mentioned when an eager interest is at once evinced.

Since July 1st the Director, according to order, has assumed supervision of the Agricultural Section, the limited area east of the railroad, divided into plats. As plans were already adopted and in operation, the chief thing was to supervise the carrying forward of the work to completion. This has been done, and Mr. R. H. McDowell has written the report for the section, he having been in immediate charge.

He has shown a faithfulness and attention to detail which has kept things moving properly and given us good results. This section has prepared exhibits for St. Louis Exposition, Larimer County Fair and the Pueblo State Fair. These exhibits were as fine as any ever sent from the College, though not so large as two years ago.

Specimens of flax grown at the Station have been sent to the Boyce Flax & Fibre Company, of New York, for examination, they to report upon fibre and seed; also to Hon. S. E. Locke, of Omaha, Nebraska. Samples of grain have been sent to many.

The Horticultural Section made another collection of grass seeds of twenty-five species, being absent from August 29 to September 12 to accomplish it. They have raised several varieties of sugar beets, nine in all, for analysis, and specimens were sent to Grand Island, Nebraska, to the Oxnard Beet Sugar Company for analysis. Their report showed returns from six of these to be as follows:

| | Per cent. sucrose. | Per cent. purity. |
|---|---|---|
| Bulteau Deprez | 14.4 | 77 |
| Dippe's Vilmorin | 14.7 | 80 |
| Klein Wanzleben | 13.5 | 74 |
| Florimond Deprez | 13.2 | 74 |
| Simon LeGrande | 13.5 | 76 |

The others were of so low a per cent. that from the few specimens sent it was judged that poor ones were taken, or else some circumstance or condition of growth rendered them unfit to be examined and ranked with the others. Beets have been examined from several parts of State east of the Continental Divide, with results showing from 9 to 16 per cent. of sugar content. The sugar enterprise in Nebraska and Kansas is a success. It remains for capitalists who understand the business and who will employ expert help to demonstrate its success in Colorado on a large scale. The preliminary work has now been done by the Experiment Station.

The farmers in various parts of the State have also demonstrated that good crops of sugar beets can be raised. The best reliable report comes from Logan County, near Sterling, where Col. A. F. Spoor raised one ton of beets on two square rods of ground, or at the rate of eighty tons per acre; samples sent to Grand Island, Nebraska, showed 16 per cent. sugar.

The Botanic Section has done much labor in collection and herbarium work, and will in the near future, by a system of exchanges, seek to have a large and valuable collection of plants for reference and study. The work in this line is not so obvious to the casual observer, but a large amount of time has been used advantageously in it.

The Grass Station, in conjunction with the Department at Washington, D. C., has been in charge of this section, and a separate report will be made upon this feature of our work.

The Section of Irrigation Engineering has carried forward its meteorological work, changing assistants June 7, Mr. Bert C. Buffum assuming charge of the observations. The irrigation survey of the State has gone forward and much has been accomplished. A complete gauging of the Poudre and its tributaries to Chamber's Lake Reservoir has been made. Other schedule work has been faithfully done.

Special reports have been asked at the hands of our men in various directions:

In Engineering Section—On Artesian Wells, Underflow of Water, Radiation and General Irrigation.

In Botany—Report on Grasses and Forage Plants, Tobacco, Loco and other weeds.

In Chemistry—Loco Plants, Larkspur, Yucca Plant, Poppy Plant, Nitrogen in Water of Precipitation, Sugar Question, in reference to cane and beets; Artesian Water, Irrigation Water, Mineral Spring Water, and the Composition of Grasses, have engaged attention, and thorough work has been performed here, as elsewhere in the Station.

The work of the Director has much increased during the year, as people have become better informed of the design and work of the Station. The correspondence has taken a wide range, and often single communications have required several hours of research and collection of data before an intelligent reply could be given.

During the year, the Director visited the sub-stations in the season of active operation, and was pleased with the earnestness and faithfulness exhibited by the Superintendents and employes.

He heartily concurs with the judgment of your committee on the subject of change of site for the San Luis Valley Station, for obvious reasons, and hopes that next season will find the Station located where better conditions obtain.

Visits were also made to the sugar factory at Grand Island, Nebraska, in company with the Chemist, and to the Convention of Agricultural Colleges and Experiment Stations, in company with the Secretary. This gave an opportunity to notice carefully the work of the Colleges and Experiment Stations of Indiana and Illinois, which were visited during the absence. Comparing the work of Colorado, it is our opinion that with smaller working force and with fewer conveniences, we are accomplishing work of more direct value to our State than are these stations. They are doing deeper scientific work in several lines that we scarcely touch.

I wish to especially mention and emphasize our want of entomological work and work on the fungi; we have been able to do nothing this year in these lines. In bacteriology is a valuable and rich field yet untouched by us and which promises fine results to the worker and explorer.

The Station has literally been picking up the results most easily obtained; soon we must delve deeper. This will require more specialists and assistants, and we cannot hope to retain our present position without expansion in the directions indicated.

Again, there are feeding experiments that should be begun soon in various lines, including those having reference to milk as well as meat production; others having in view the proper ration of food to produce distinct results in this climate, and with our chief forage plant, alfalfa, as a basis. The botanic work in the State should be pushed to early completion, as there is demand for it. The subjects of forestry and fruit culture are being pressed upon us as important, and demanding more attention at our hands than they have hitherto received.

The work published in our bulletins and annual reports has been highly commended by disinterested persons outside our State, and esteemed by nearly all within

the State. Our desire is to have the Station, as a whole, continue to do appreciative work and gradually take in the fields indicated, as well as others which are equally important.

The Director desires to express to all his thanks for favors extended, by which his labors have been lessened and the work forwarded in many directions.

The usual reports and the plan of experiments accompany this, and explain to you in detail the work of the various sections and their wants for the ensuing year. I am, very respectfully,

Your obedient servant,

C. L. INGERSOLL.

*Director.*

FORT COLLINS, Colo., Dec. 10, 1890.

# PLAN OF EXPERIMENTS.

## SCHEME FOR 1890.

### AGRICULTURAL SECTION.

PLAT I. Consisting of twenty-five quarter-acre plats next to College avenue.

Plats 9, 10, 11, 12 and 13, to be continued in tests for soil variation with Pride of the North corn, as has been done already for two seasons.

Plats 14, 15, 16, 17 and 18, to be continued in tests for soil variation with Amethyst wheat, as has been done already for two seasons.

Each division to be treated alike, as follows:

Same time plowing and preparing the soil.
Same time planting and sowing the seed.
Same quantity of seed in each plat.
Same time of cultivation and irrigation.
Same time harvesting and weighing products.
Same amount of water, as near as possible, to each plat.

Plats 1, 2, 3, 4, 5, 6, 7 and 8, to be cultivated in the best varieties of wheat, oats, barley and rye, to test their vitality, germinating power, growth in all respects, seed selection, maturity, effects of sulphate of copper to prevent smut and of salt to prevent rust.

Also, thick and thin seeding, deep and shallow sowing, early and late sowing, amount of grain and straw compared, each variety compared with the others and a study and description of

all, relation to their habits of growth and their characteristics.

Plats 19, 20, 21, 22, 23, 24 and 25, to be tested in the sorghums, both saccharine and non-saccharine, broom corn, espersette, milo-maize, kaffir corn, dourra, teosinte, millets, etc., etc.

Vetches, lupins, lentils, serradilla, spurry, buckwheat, burnett, alfilaria, marcite, comfrey, etc., etc.

Flax, hemp, rami, okra, hibiscus, etc., for fibre.

PLAT II.—Of two acres next to the railroad, to be sown in part to alfalfa, the other clovers and plants, for fertilizers and to test the value of different manures, salt, lime, plaster and commercial fertilizers.

## CHEMICAL SECTION.

1. Study of the loco question from chemical standpoint.

2. Co-operative work with other sections.

## SECTION OF METEOROLOGY AND IRRIGATION ENGINEERING.

The outline prepared for 1889 was intended for that and subsequent years. It needs but slight change for this year.

### IRRIGATION.

I. The duty of water. The subsidiary questions include a study of the proportion directly useful to crops, the amount that is lost by evaporation and the amount passing away as seepage. It is not expected that these latter can be determined this year. It is intended to carry on some experiments indicating the best way of determining the desired questions:

II. Evaporation.

(*a*) Verification of laws found true last year.

(*b*) Observations of evaporation

1. From a canal.
2. From a reservoir.
3. From a river.

III. Seepage observations.*

1. From a reservoir.
2. From a canal.

IV. The alkalied lands of the Poudre Valley.

V. Tests of modules.

VI. Continuation of soil moisture determination.

VII. Completion of the irrigation survey of the lower Platte and San Luis Valleys.

VIII. Collection of irrigation data, photographs, charts, etc.

METEOROLOGY.

I. To continue the record of those meteorological elements most influential in plant growth:

(*a*) Temperature of the air.
(*b*) Temperature of the soil.
(*c*) Sunshine, amount of.
(*d*) Sunshine, intensity.
(*e*) Terrestrial radiation.
(*f*) All aqueous meteors, rain, snow, dew, frost, vapor tension, etc.

II. Co-operative rainfall survey of the Cache la Poudre water-shed, in connection with the discharge of that river.

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*NOTE.—These depend on the co-operation of Mr. Ulrich in the first; of Hon. B. S. LaGrange and the Cache la Poudre Ditch No. 2 in the second.

## SECTION OF BOTANY AND HORTICULTURE.

I. The study of the flora of the State.

1. The weeds of the farm and garden.
2. Grasses, native and introduced. We now have seeds of ninety-two species and varieties of grasses and forage plants which will be grown under irrigation this season. Fifty of these species and varieties were collected in the State last season. A further collection will be attempted this year in order to complete, as far as possible, our list of native species.
3. Study and identification of the various species and varieties of loco.
4. The collection and preservation for herbarium use of all plants obtainable that are native or introduced within the State.

II. A report of the pomology of the State.

III. The introduction to the garden of such wild fruit plants as can be obtained, with observations on their behavior and future possibilities.

IV. Observations and records continued :

1. Leafage and rate of growth of
   (*a*) Orchard trees.
   (*b*) Ornamental trees and shrubs.
   (*c*) Forest trees.
2. Notes on small fruits.
3. Notes on culinary vegetables.
   (*a*) General characteristics of varieties.
   (*b*) Synonymy.
   (*c*) Adaptability to cultivation in this locality.

V. Study of the root growth of alfalfa.

VI. Grafting by various methods, with a view to future observations and the determination of best methods.

VII. Crossing and hybridizing, with a view to the production of new varieties of fruits and vegetables.

ANNUAL REPORT

OF THE

# AGRICULTURAL SECTION.

*To the Executive Committee, State Board of Agriculture:*

GENTLEMEN—The following is the report of the Agricultural Section for the season of 1890:

The land used consisted of twenty-five quarter-acre plats, situated on College avenue, also of 2 acres and 33 rods lying between the railroad and the main ditch. The avenue plats, from 1 to 8 inclusive, were sown to different kinds of oats, barley and wheat, to test varieties, thick and thin seeding, deep and shallow sowing. Plats from 9 to 13 inclusive were planted to Pride of the North corn, for continuation of test for soil variation. Plats 14 to 18 inclusive were drilled to Amethyst wheat, for continuation of test for soil variation. Two acres and 33 rods of experiment ground situated between the railroad and the main north and south ditch, was sown to alfalfa, Mammoth Red and Alsike clover, and espersette. Fifteen pounds of alfalfa seed was sown on 118.8 rods. The central portion, including some old alfalfa seeding, area 80 rods, was sown to 1 pound of Alsike, 1 pound red clover. Espersette, 152 rods, 47 pounds 10 ounces of seed were used. All the seeding on Plat 2 made a fair stand. All was irrigated once, and the alfalfa twice. A plat of 20.8 rods at the extreme north was planted to pod corn (a kind having a husk on each kernel and an outer husk over all), beets and carrots. The pod corn did well on germination

and stalk growth, but frost, September 6, was a few days early for full ripening. The twenty-five quarter-acre plats were all fall plowed, harrowed once, lapping half. Plats 1 to 8 and 19 to 25 were cultivated twice with hand cultivators, for stirring the surface and checking weeds. The hoe was used some on weeds that could not otherwise be reached. Plat 1 was sown to twelve kinds of oats. Nos. 1 to 8 were sown on March 28, and the remaining numbers sown March 29. In sowing the oats, ten rows on the west of each kind were hand sown, one kernel to each six inches, covered with a hoe as nearly two inches as possible. In dividing the quarter-acres for twelve kinds, it gave ten rows for hand sowing and nine for drilling. The seeding averaged 302 to each nineteen rows, or five pounds per acre. The hand sowing and drilling described with the oats will apply to the sowing of barley and wheat sown on plats 1 to 8. In the table D is drilled and H represents hand-sowed grain:

OATS.

| No. | NAME. | Date Sown. | Dates Cut. | | Drilled. | | | Hand Sowed. | | | Total Yield. | | Yield per Acre. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | D. | H. | Yield | | Height. Inches. | Yield. | | Height. Inches. | | | | |
| | | | | | lbs. | oz. | | lbs. | oz. | | lbs. | oz. | bus. | lbs |
| 1 | White Dutch | 3-28 | 7-24 | 7-24 | 9 | 12 | 47 | 15 | 13 | 47 | 25 | 9 | 38 | 11 |
| 8 | Pringle's No. 6 | 3-28 | 8-6 | 8-6 | 13 | 7 | 45 | 15 | 1 | 42 | 28 | 8 | 42 | 24 |
| 13 | New Zealand | 3-29 | 8-6 | 8-6 | 9 | 12 | 42 | 15 | 13 | 36 | 25 | 9 | 38 | 11 |
| 15 | Black Tartarian | 3-29 | 8-6 | 8-6 | 10 | 1 | 42 | 13 | 9 | 35 | 23 | 10 | 35 | 14 |
| 19 | Potato | 3-29 | 8-5 | 8-5 | 10 | 5 | 38 | 12 | 9 | 33 | 22 | 14 | 32 | 14 |
| 21 | Chinese Hulless | 3-29 | 7-30 | 7-31 | 9 | 13 | 49 | 6 | 13 | 45 | 16 | 10 | 24 | 30 |
| 24 | Rust Proof | 3-29 | 7-24 | 7-28 | 6 | 1 | 30 | 10 | 11 | 29 | 16 | 12 | 25 | 4 |
| 28 | S. C. Black | 3-29 | 7-23 | 7-25 | 9 | 1 | 38 | 10 | 5 | 32 | 19 | 6 | 28 | 25 |
| 50 | Golden Giant | 3-29 | 8-6 | 8-6 | 7 | 13 | 40 | 11 | 9 | 36 | 19 | 6 | 28 | 25 |
| 57 | Algerian No. 1 | 3-29 | 7-23 | 7-26 | 9 | 5 | 39 | 7 | .. | 37 | 16 | 5 | 24 | 15 |
| 58 | Algerian No. 2 | 3-29 | 7-23 | 7-23 | ..... | | 24 | ..... | | .... | 15 | 7 | 23 | 5 |
| 59 | Cape | 3-29 | 7-22 | 7-22 | ..... | | .... | ..... | | .... | 5 | 9 | 8 | 11 |

Plat 2 was sown to twelve kinds of barley on March 28, with results as noted below:

BARLEY.

| No. | NAME. | Date Sown. | Dates Cut. | | Drilled. | | | Hand Sowed. | | | Total Yield. | | Yield per Acre. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | D. | H. | Yield. lbs. | oz. | Height, Inches. | Yield. lbs. | oz. | Height, Inches. | lbs. | oz. | bus. | lbs |
| 1 | Smooth Hulless | 3-28 | 7-22 | 7-24 | 19 | 4 | 34 | 16 | 5 | 31 | 35 | 9 | 35 | 27 |
| 2 | Winnipeg | " | 7-22 | 7-23 | 18 | 9 | 32 | 15 | 9 | 29 | 34 | 2 | 34 | 6 |
| 7 | Winter 6-rowed | " | 7-25 | ..... | 15 | 1 | 28 | 13 | 13 | 23 | 28 | 14 | 28 | 42 |
| 8 | Purple | " | 7-21 | 7-23 | 20 | 9 | 35 | 13 | 1 | 31 | 33 | 10 | 38 | 30 |
| 18 | Guy Malye | " | 7-21 | 7-23 | 27 | 13 | 31 | 14 | 12 | 31 | 42 | 9 | 42 | 27 |
| 20 | Tricks | " | 7-22 | 7-24 | 15 | 1 | 37 | 12 | 13 | 35 | 27 | 14 | 27 | 42 |
| 32 | Berkley | " | 7-22 | 7-26 | 17 | 1 | 35 | 8 | 9 | 34 | 25 | 10 | 25 | 30 |
| 37 | ..... | " | 7-25 | 7-26 | 10 | 8 | 32 | 9 | 9 | 32 | 20 | 1 | 20 | 3 |
| 38 | ..... | " | 7-26 | 7-28 | 10 | 13 | 32 | 10 | 1 | 32 | 20 | 14 | 20 | 42 |
| 39 | Algerian No. 1 | " | ..... | 7-26 | 11 | 5 | 29 | 11 | 5 | 28 | 22 | 10 | 22 | 3 |
| 40 | Algerian No. 2 | " | 7-23 | 7-26 | 6 | 9 | 24 | 11 | 9 | 24 | 18 | 2 | 18 | 6 |
| 41 | Algerian No. 3 | " | 7-23 | 7-26 | 16 | 9 | 30 | 15 | 5 | 29 | 31 | 14 | 31 | 42 |

Plats 3 to 8 were sown to different kinds of wheat, with results noted in table on wheat. The rate of seeding per acre was approximately twenty-four pounds. On plat 8 was sown wheat from numbers 370 to 387; Carter's cross-bred wheats numbers 388 to 396; 299, Oregon Amber; 400 to 407 consisted of samples received from several foreign countries. These were sown in one row each two rods in length.

## WHEAT.

| No. | NAME. | Dates Sown. | Dates Cut. | | Drilled. | | | Hand Sowed. | | | Total Yield. | | Area in Feet. | Yield per Acre. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | D. | H. | Yield. lbs. | Yield. oz. | Height. Inches. | Yield. lbs. | Yield. oz. | Height. Inches. | lbs. | oz. | | bus. | lbs. | oz |
| 40 | Centennial | March 18 | Aug. 29 | Sept. 8 | 71 | 2 | 45 | 5 | .. | 36 | 76 | 2 | 103 x 34 | 15 | 19 | 9 |
| 42 | Granite | March 24 | July 29 | ..... | 134 | 13 | 47 | 19 | 12 | 43 | 154 | 9 | 80 x 34 | 41 | 14 | 9 |
| 100 | Dallas | March 22 | Aug. 2 | Aug. 11 | 107 | 6 | 48 | 15 | 4 | 46 | 122 | 10 | 80 x 34 | 32 | 48 | 7 |
| 118 | Sardius | March 22 | Aug. 4 | Aug. 6 | 92 | 12 | 50 | 12 | 7 | 43 | 105 | 3 | 80 x 34 | 28 | 4 | .. |
| 120 | Beryl | April 1 | July 31 | July 31 | 73 | 10 | 38 | 20 | 1 | 38 | 93 | 11 | 74 x 34 | 27 | 1 | 10 |
| 145 | Red Oregon Club | March 25 | July 28 | July 31 | 120 | 8 | 41 | 19 | 12 | 38 | 140 | 4 | 80 x 34 | 37 | 25 | 6 |
| 153 | Nox No. 2 | March 25 | July 28 | Aug. 4 | 103 | 8 | 40 | 15 | 4 | 40 | 118 | 12 | 80 x 34 | 31 | 41 | 3 |
| 154 | Nox No. 1 | March 22 | Aug. 2 | Aug. 2 | 85 | 7 | 45 | 11 | 4 | 38 | 96 | 11 | 80 x 34 | 25 | 47 | 15 |
| 157 | Nox No. 5 | March 25 | July 26 | July 31 | 89 | 2 | 39 | 12 | 4 | 38 | 101 | 6 | 80 x 34 | 27 | 3 | .. |
| 163 | Northcote's Amber | March 24 | July 26 | July 31 | 110 | 8 | 41 | 16 | 12 | 37 | 127 | 4 | 80 x 34 | 33 | 56 | 4 |
| 196 | Winnipeg Russian | April 1 | July 30 | Aug. 4 | 67 | .. | 43 | 18 | 5 | 42 | 85 | 5 | 80 x 34 | 21 | 5 | 13 |
| 201 | Sibley's No. 1 | March 18 | Aug. 2 | Aug. 4 | 93 | 7 | 51 | 12 | 1 | 49 | 105 | 8 | 103 x 34 | 21 | 14 | 7 |
| 207 | Whittington | March 25 | July 24 | July 26 | 132 | 5 | 39 | 16 | 1 | 37 | 148 | 6 | 93 x 34 | 34 | 2 | 15 |
| 223 | Rye | March 25 | Aug. 4 | Aug. 6 | 79 | 15 | 50 | 11 | 4 | 42 | 91 | 3 | 80 x 34 | 24 | 19 | 15 |
| 290 | Niagara | March 17 | Aug. 1 | Aug. 4 | 190 | 7 | 48 | 16 | 9 | 45 | 216 | .. | 160 x 34 | 28 | 7 | 8 |
| 300 | Gypsum No. 38 | March 17 | Aug. 2 | Aug. 4 | 215 | 1 | 46 | 12 | 8 | 40 | 227 | 9 | 160 x 34 | 30 | 19 | 8 |
| 360 | Missoyen | March 25 | July 24 | July 28 | 49 | 7 | ..... | 9 | 5 | 38 | 58 | 12 | 67 x 34 | 18 | 43 | 5 |
| 361 | Atlanti | April 1 | Aug. 8 | Aug. 8 | ..... | | 47 | ..... | | ..... | 49 | 1 | 80 x 34 | 13 | 5 | 8 |
| 366 | Ontario | March 22 | Aug. 2 | Aug. 6 | 54 | 2 | 52 | 8 | 2 | 46 | 62 | 4 | 80 x 34 | 16 | 36 | 11 |
| 401 | Algerian No. 2 | March 29 | July 29 | July 29 | ..... | | 43 | ..... | | ..... | 24 | 5 | 25 x 34 | 20 | 45 | 8 |
| 307 | Trap No. 45 | March 18 | Aug. 27 | Sept. 8 | 73 | 9 | 52 to 64 | 6 | 9 | 40 | 80 | 2 | 106 x 34 | 16 | 7 | 14 |

WINTER WHEAT.

In the fall of 1889, a portion of section 11, 1.12 acres, was sown to winter wheat. On the same section, same date, 47.7 rods were sown to Fultz. Both kinds showed a very scattering stand in the fall, but improved as the season advanced. The Fultz was harvested July 19 and the Ruby July 30. The Fultz threshed 6 bushels, 48 pounds; the Ruby yielded 30 bushels.

CORN.

Plats 9 to 13 inclusive were planted, April 29, to Pride of the North corn, being a continuation of test for soil variation, using a hand planter. On 10, 11, 12 and 13, one pound and eight ounces of seed was used. Owing to slight imperfect working of the planter, one pound and six ounces was used on 9.

The corn came up May 17; was cultivated May 24–29 and June 25; irrigated once, July 11; August 26 was cultivated to check weeds that had started after irrigating. Some stalks measured 8 feet 4 inches, others 7 feet 5 inches and 6 feet 7 inches.

Corn was cut September 8, drawn October 22 and put in small stacks for husking, which was done one plat per day, October 22, 23, 24, 27, 29 and 30. Owing to the fact that both fodder and corn were well dried when drawn and the difficulty of getting all the leaves together in this dry and, at times, slightly breezy climate, the weight of ears was taken from fodder, and the remainder credited to fodder.

| No. of Plat. | Ears, lbs. | oz. | Fodder, lbs. | oz. | Total Crop, lbs. |
|---|---|---|---|---|---|
| 9 | 472 | 8 | 572 | 8 | 1,046 |
| 10 | 495 | | 605 | | 1,100 |
| 11 | 459 | 8 | 589 | 8 | 1,049 |
| 12 | 405 | 4 | 541 | 12 | 947 |
| 13 | 403 | | 538 | | 941 |

WHEAT.

Five quarter-acre plats, from 14 to 18 inclusive, were drilled March 11 to Amethyst wheat, for continuation of test for soil variation. These plats were sown at the rate of forty pounds of seed per acre, irrigated once, July 11, harvested July 31, stacked August 26 and threshed November 1, with the following results:

| No. of Plat. | Grain. lbs. | oz. | Straw. lbs. | oz. | Total. lbs. |
|---|---|---|---|---|---|
| 14 | 243 | | 320 | | 563 |
| 15 | 209 | 8 | 267 | 8 | 477 |
| 16 | 225 | 13 | 271 | 3 | 497 |
| 17 | 374 | 9 | 468 | 7 | 948 |
| 18 | 283 | 13 | 326 | 3 | 610 |

Avenue, quarter-acre plats, wheat. The total yield on the five quarter-acre plats was twenty-two bushels, one pound and eleven ounces. These plats were sown to wheat for the past three years. It will be noticed that the results from 17, with same treatment, ground rather higher, were the greatest.

SORGHUM.

Plat 19 was sown, April 2, to seventeen kinds of sorghum. Rows two rods in length, six rows to each kind, No. 67 having fifteen rows, sown thirty-two inches apart, with a drill. The stand was not the best, the Dutch Hybrid germinating but a few seeds. It was further injured with late frosts, the frosts that severely injured the corn and made it necessary to re-sow buckwheat and milo maize.

No. 12 is rather slender cane, but leads in maturing; grows from 7.5 feet to 9 feet tall. No. 10 grows taller than 12 and closely follows in maturing. From a field standpoint, Nos. 12, 16, 33, 36 and 44 seem to be of most value for this section.

| No. | Name. | Seed in lbs. and oz. |
|---|---|---|
| 2 | Dutch Hybrid | ---- |
| 3 | Black Amber | ---- |
| 4 | Price's New Amber | ---- |
| 5 | Amber Early | ---- |
| 6 | Amber Orange | ---- |
| 8 | Medium Orange | ---- |
| 10 | Swan's Early Golden | 7 |
| 12 | Early Tennessee | 8 4 |
| 14 | Cross | ---- |
| 15 | Cross | ---- |
| 16 | Cross | ---- |
| 19 | Cross | ---- |
| 33 | | 9 13 |
| 35 | Early Amber | ---- |
| 36 | | 8 |
| 44 | | 9 14 |
| 67 | | 10 13 |
| 17 | Whitney's Early | 3 4 |

Seed in pounds is given of a few kinds doing the best. From each kind sown two to four heads were kept for samples.

On plat 20, the few rows of Mexican wheat made a moderate growth and are unthreshed. The twenty-seven rows of Russian sunflower, sown April 17, made a fair growth, yielding nineteen pounds twelve ounces, with a dozen largest heads for seed. One hundred rows sown to canary and forty-four rows sown to hemp failed to germinate well. We have of hemp seed, one pound; canary, ten pounds. The yields of sunflower hemp and canary were reduced by birds.

### MILO-MAIZE.

Plats 21 and 22, sown to milo-maize and buckwheat, not having a full stand from the start and being injured by late frosts, were well harrowed with the Randall, June 17. Both plats were irrigated June 19; milo-maize resown June 26 at the rate of thirty-two pounds of seed per

acre. The second sowings were up in about three days, the maize growing 4 feet high, but not fully ripened September 6, when further growth was stopped by frost.

The buckwheat, Silverhull, made a fine stand and grew well until September 6. A few pounds of the seed saved has the appearance of sufficient ripeness to grow, but is not warranted.

VETCHES AND LUPINS.

Plat 23 was sown, April 11, to vetches, seventeen rows each, blue and white lupins, lentils, chuma, Aztec coffee and cow-peas. The latter failing entirely to germinate, the ground was re-sown to Chinese buckwheat. We have of

| | lbs. | oz. |
|---|---|---|
| Aztec coffee | 11 | 2 |
| Chuma | 18 | 14 |
| Lupins, blue | 2 | |
| Lupins, white | 11 | 7 |
| Lentils | 17 | 5 |
| Vetches | 4 | 5 |

FLAX.

Plat 24 was sown to flax April 7.

| Name. | Rows. | Seed, lbs. | Seed, oz. | Yield, lbs. | Yield, oz. |
|---|---|---|---|---|---|
| European | 130 | 1 | 11 | 88 | 3 |
| Common | 50 | | 15 | 20 | 4 |
| Yellow | 30 | | 7 | 13 | 2 |
| Yellow Mixed | 25 | | 6 | 14 | 3 |

All kinds of flax made a fair growth; irrigated once. The European was rather later than the other kinds. There was not enough difference in time of ripening, August 1, of the four kinds sown to be of much practical importance. In the yields, some estimates necessarily had to be made by weighing straw and flax before and after threshing, on account of samples sent the Boyce Fibre Co., of New York City, and Locke & Co., of Omaha, Nebraska, the latter firm having expressed a desire to operate

a branch house in Colorado, provided sufficient flax could be secured.

MILLET.

Plat 25 was sown, April 4, to millet; rows sixteen inches apart, two rods in length. Golden millet, 20 rows; common millet, 20 rows; German millet, 97 rows; Hungarian millet, 97 rows. The millets made a moderate growth. We have seed threshed:

| | lbs. | oz. |
|---|---|---|
| Common | 2 | |
| German | 27 | 7 |
| Hungarian | 30 | 7 |

Golden kept in samples, unthreshed, excepting two pounds and fourteen ounces.

GRASS AND FORAGE PLANTS—FARM EXPERIMENTS.

The following grasses and forage plants were sown on the south part of plat 5 in the spring of 1889: Italian Rye grass, Yellow Oat, Meadow Soft, Red Top, Orchard grass, Blue grass, Timothy, Perennial Rye grass, Hassack grass, Brome grass, Wood grass, Water Meadow, Rough Stalk Meadow, Tall Meadow Oat, Hard Fescue, Tall Fescue, Sheep Fescue, Japan clover, Crimson clover, Alsike clover, Yellow Trefoil, alfalfa, Waite clover, Mammoth clover, Red clover, Bee clover, Trigonella, Sanfoin Burr clover.

The Fall Meadow Oat, for early starting in the spring, good growth without irrigation and show for fall seed, is promising. The Tall Fesue is worthy of further trial. Wood grass, Water Meadow, Rough Stalk Meadow, Hassack grass, Hard Fescue and Red Fescue—largely or entirely dead. Yellow Trefoil showed some blossoms, May 6, and not entirely out of bloom until July 1. Red and Mammoth clover growing on adjoining plats showed very little difference, the Mammoth rather coarser and blooming a few days later than the Red clover. Several of the Rye grasses have the appearance of furnishing good fall pasture.

## FOREIGN WHEAT.

Single rows, each thirty-four feet long. Unthreshed.

| NAME. | No. | Date Sown. | No. Grains. | No. Grains Germinated. | Height Inches. | Date Cut. |
|---|---|---|---|---|---|---|
| 1—Egyptian | 370 | March 14. | 41 | 24 | 28 | August 1. |
| 2 | 371 | " | 24 | 14 | 26 | " |
| 3 | 372 | " | 25 | 16 | 24 | " |
| 4 | 373 | " | 55 | 29 | 27 | " |
| 5 | 374 | " | 26 | 16 | 26 | " |
| 6 | 375 | " | 31 | 5 | 25 | " |
| 7 | 376 | " | 23 | 4 | 26 | " |
| 8 | 377 | " | 34 | 18 | 30 | " |
| A | 378 | " | 35 | 20 | 27 | " |
| B | 379 | " | 35 | 20 | 27 | " |
| C | 380 | " | 45 | 33 | 30 | " |
| D | 381 | " | 43 | 34 | 30 | " |
| E | 382 | " | 35 | 17 | 21 | " |
| F | 383 | " | 30 | 17 | 27 | " |
| G | 384 | " | 30 | 13 | 27 | " |
| H | 385 | " | 47 | 35 | 28 | " |
| Poland | 386 | " | 48 | 41 | 36 | " |
| Reedlan | 387 | " | 65 | 58 | 43 | August 18. |
| A—Carter's Cross | 388 | " | 70 | 70 | 33 | " |
| B—Carter's Cross | 389 | " | 79 | 57 | 35 | " |
| C | 390 | ..... | 81 | 76 | 32 | " |
| D | 391 | ..... | 79 | 79 | 33 | " |
| E | 392 | ..... | 81 | 70 | 33 | " |
| F | 393 | ..... | 78 | 63 | 38 | " |
| G | 394 | ..... | 81 | 62 | 26 | " |
| H | 395 | ..... | 80 | 62 | 36 | " |
| I | 396 | ..... | 79 | 68 | 36 | " |
| J | 397 | ..... | 76 | 68 | 28 | " |
| K | 398 | ..... | 79 | 67 | 47 | " |
| Oregon Amber | 399 | ..... | 50 | 35 | 39 | " |
| Algerian No. 1 | 400 | March 29. | 50 | 35 | 39 | August 1. |
| Algerian No. 2 | 402 | " | 50 | 31 | 37 | " |

The foreign wheats mentioned in the table, under numbers 370 to 402 were raised only for the season of 1890, one row thirty-four feet long to each kind. The heads were short and thick; straw short. It will need further trial to prove that they are of more value to the Colorado farmer than kinds now in use.

R. H. McDOWELL,
*Assistant Agriculturist.*

# Report of Chemical Section.

*To the Executive Committee, State Board of Agriculture:*

GENTLEMEN—I have the honor to submit the following report of the year just closed:

The Station has earned and turned over to the Treasurer, during the year, $35 for chemical work, the Station charging about one-half the usual price of the analysis when it is for private purposes; all other analyses are free of charge.

Much of the work of the Chemical Section has already appeared in print in the bulletins issued during the year.

Bulletin No. 10, on Tobacco, issued January, 1890, contains the analysis of the ash of eighteen samples of home-grown tobacco, and the analyses of the soil on which they were grown.

Bulletin No. 11, on Sugar Beets, issued April, 1890, gives the composition of the ash of varieties grown on rich and on poor soil; the per cent. of sugar in sections of the beet, and the feeding value of the beets. This work has been carried forward this year, and fifty-seven additional samples of sugar beets have been analyzed. A visit has been made to Grand Island, Nebraska, by the President and myself, to inspect the manufacture of the sugar beet and collect information that might be of value to the farmers of the State. As good sugar beets can be raised in Colorado as in any State in the Union.

In Bulletin No. 12, on Colorado Grasses, issued July, 1890, ninety-nine analyses were made; eighteen samples

were duplicated to confirm the work; this work occupied about three months. The work in this line has been continued, and forty-nine additional samples have been analyzed this year.

The investigation of the composition of the water of the reservoirs and lakes about Fort Collins, of the river water during different stages (high and low), has been repeated to see what fertilizing properties, if any, the water contains. In this connection, an examination for nitrates and ammonia was made of the rain and snow during the season, and forty-two samples were analyzed. A number of analyses were made of the solid matter dissolved in the water used to irrigate and fertilize the land, to ascertain what constituents were taken up, or given up to the soil, by irrigation; these results will appear in a future bulletin. The loco and larkspur have been examined for alkaloids, and none were found. Considerable time was spent on the loco; the leaves and stems, fruit and roots were separately analyzed. Approximate organic analysis was made of the loco and larkspur. The composition of the ash of all kinds examined was determined, in all, eighteen analyses. During the summer I received a visit from Professor Sayre, of Lawrence, Kansas, to consult with me about the loco question. Two visits were made to the neighborhood of Livermore, to find locoed animals. I succeeded in making one post-mortem, and found cause enough to produce death without any loco weed. If future post-mortems confirm the one already made, I think something can be done to help ranchmen with their locoed horses. It is an important question for the stockmen, and deserves a corresponding amount of attention. I have found great difficulty in obtaining specimens for post-mortem; very few of the ranchmen want it known that they have locoed stock. With a few more post-mortems, I may be able to reach some conclusion as

to the cause of the disease, and possibly suggest some remedy. In this connection I might say I have received a number of letters from ranchmen on the Medicine Bow, Wyoming, about the analysis of soils, etc., claiming that it is the cause of the horses losing their hoofs, manes, tails, etc. On receiving a sample of the hay used, I find, by a microscopic examination, that it contains large quantities of ergot, that causes the trouble.

Analysis of the stomach, liver, kidneys, etc., of two mules, from Boston, Colorado, were made for arsenic and alkaloids, and none were found. Investigation was made of the Fort Collins cheese, to find out the chemical changes that took place during the process of ripening. The short time that it was kept (three weeks) did not enable me to arrive at any very definite conclusion. The water gradually diminished, and this made the fat relatively increase; it was good, whole milk cheese. The cheese were analyzed every four days during the process of curing. Six analyses were made. The wild poppies were examined for opium, and only qualitative results were obtained. The cultivated varieties did not mature this year, and will be tried next year. I desire very much to see the Committee, to confer with them about the desirability of obtaining more room for the Station work, and some more money to purchase some of the modern appliances for the Station. Chemistry is a progressive science, and the methods in use ten years ago are not the methods used to-day. With more room and modern appliances, more and better work could be accomplished. There is but one workroom for the Station quarters; it is simply impossible to do two or three kinds of work in the same room. Water analyses should have a separate room, and the same is true of many other kinds of work. There are many pieces of apparatus that should be put up and kept in place, as taking them apart,

be there ever so much care, results in more or less damage to the apparatus. All the work laid out for the Chemical Section this year has been accomplished. The number of analyses made during the year was as follows:

| | |
|---|---|
| Sugar beets, sp. gr. and per cent. sugar | 12 |
| Sugar beets, for sugar | 69 |
| Sugar beets, for feeding | 5 |
| Sugar beets, for ash ingredients | 4 |
| Granite, white and red | 2 |
| Palm nut meal | 2 |
| Impure marl | 1 |
| Water residue from well, etc. | 13 |
| A. O. A. Chemists | 7 |
| Denver Sanitary Fertilizing Co. | 3 |
| Stomach, etc., two mules | 2 |
| Fort Collins cheese | 6 |
| Seepage water, residues | 3 |
| Anthracite coal | 1 |
| Sand for glass | 1 |
| Cotton-seed meal | 1 |
| Bone meal | 1 |
| Linseed meal | 1 |
| Canon City water | 3 |
| Residues from Hoag's Lake | 2 |
| Loco and larkspur | 18 |
| Nitrates in water and snow | 32 |
| Grasses | 49 |
| Ammonia in water and snow | 10 |
| Water for sanitary purposes | 10 |
| Sundry analyses | 20 |
| Total | 279 |

The whole number of analyses to date is 820.

Thanking the members of the Board for their kindness to me and for the interest they have taken in my department, this report is respectfully submitted,

DAVID O'BRINE.

*Chemist.*

REPORT OF

# Section of Botany and Horticulture.

*To the Executive Committee, State Board of Agriculture:*

GENTLEMEN—I have the honor to submit the following as my report of work done in connection with the Experiment Station:

The work of the section has been carried on through the season, according to the pre-arranged schedule.

Early in the season it became apparent that the area in charge of this department was in excess of its real needs. We have exerted ourselves to keep this area and the crops upon it in good condition, but the available working force has proved inadequate, and some portions of the work have not been to my satisfaction. The area now in my charge is 42.72 acres; of this about 8 acres is occupied by buildings and lawns, leaving about 34.5 acres of arable land to be cared for. Could this area be somewhat reduced, so that there would be a better proportion between working force and land to care for, it would enable us to bring about results more satisfactory to all concerned. A source of much annoyance during the season has been the uncertainty of the water supply from the No. 2 Ditch. In the early part of July there was one period of ten days when there was no water available. The crops in that portion of the garden under that ditch suffered severely and did not recover from the injury. There were other periods when we found it impossible to get water sufficient for our needs, so that we labored under

a great disadvantage in working this portion of the garden. From what I learn of similar experiences in previous years, it would appear that we will not be relieved from the annoyance until the College is provided with a direct connection with the main ditch, or with improved measuring gates on the present ditch.

The report on pomology, laid down as a portion of the work for this department, was, at the suggestion of the Director, deferred. It would seem that, in view of the present rapid development of fruit culture in the State, it might be well to make the report on pomology a feature of next season's work. A considerable portion of my time has been devoted to the Grass Station. Frequent visits were made and careful notes taken. These are embodied in a separate report, to which I beg leave to refer you.

To my assistant, Mr. C. M. Brose, I am much indebted for hearty co-operation in carrying out the plans of the department. Mr. Brose has had the late charge of the apiary, and his report of the work done there accompanies this.

## ORCHARDS.

The apple orchard was pruned in the spring, and has been given clean culture during the season. In the older part of the orchard the trees are too thick; they are crowding each other, and can make little growth. It is proposed to rectify this by the removal of a portion of the trees during this winter. The small trees at the north end of the orchard, on low, alkaline soil, are making but little advancement. The young trees on the higher land have made a fair growth, and promise well. A few vacancies were filled last spring, and such trees as suffered severely from blight last season were removed. The blight has made no progress this season; no new trees were attacked, and the removal of previously affected trees leaves the orchard

free from disease. I believe we may now look for one of those periods of inactivity characteristic of the disease

The pear and plum trees in the west orchard have made a good growth during the season. A high wind in August did considerable damage in this orchard; limbs were broken off, and several plum trees were blown over and entirely ruined. Tomatoes and corn were grown between the rows. The only trees fruiting were the Miner plums, which bore sparingly. There are now growing in this orchard ninety-four trees, representing fourteen varieties of pears, and 133 trees, representing thirteen varieties of plums.

STRAWBERRIES.

Our strawberry bed at the beginning of the present year was small; it contained thirty-one varieties, nearly all of which had fruited three seasons. Good plants were abundant, and in the spring a new setting was made of twenty-six of the varieties represented. The plants set made an excellent growth and are now in good condition for the winter. Seven varieties were added by purchase, viz., Bubach, Crawford, Cumberland, Gold, Jessie, Parker Earle, Warfield. In addition, four varieties were received for trial. These were, Chuster's Gem and Lovett's Early, from J. T. Lovett & Co., of Little Silver, New Jersey; Loudon's No. 15, from M. Crawford, Cuyahoga Falls, Ohio, and Vandeman, from Jacob C. Bauer, Judsonia, Arkansas. During the summer orders were received to destroy the Lovett's Early, as not true to name: September 13 a second consignment of plants of this variety were received. They were very dry when opened and we failed to revive them. We now have represented thirty-six varieties. After the fruiting season was over, the old bed was plowed up. It is proposed to enlarge the present bed, adding next spring such varieties as may seem promising.

*Chuster's Gem*—Of the plants received, five lived. These made a very strong growth, and were allowed to form runners sufficient to fill vacancies. None of the plants blossomed. This variety comes highly recommended as being unusually strong and very productive. It is a New Jersey seedling, a cross between Crescent and Sharpless—pistillate.

*Loudon's No. 15*—Seven of the twelve plants received lived. Plants received late and made a fair growth, and did not blossom.

*Vandeman*—Twelve plants were received, nine of which lived and made a vigorous growth. One plant produced one truss which bore four blossoms; three of these were perfect, having numerous very plump anthers. The other was pistillate, showing no stamens at all; these blossomed June 13. Mr. Bauer writes that he has fruited this variety for five seasons, and says: "It is a cross of Captain Jack and Crescent; staminate, vigorous, rust and blight proof with me, size large, extremely firm, crimson color, extra flavor, season from very early to late, productive."

*Bubach*—Our setting of this variety was practically a failure; four plants died after being set; the balance made a weak growth and seven of these finally died; only one plant remained and that is not vigorous.

*Crawford*—The plants of this variety all lived. Their growth in the early part of the season was very weak, but later they improved, and now appear healthy and vigorous. One plant produced a few blossoms; they were first observed May 21.

*Cumberland*—Failed as did Bubach. Only one plant lived; that one, however, is now a very strong, healthy plant.

*Jessie*—Of twelve plants, one was lost; the remaining eleven grew with great vigor. When last observed, October 30, they appeared very promising.

*Parker Earle*—This variety was slow in starting, but when at last established the plants grew with remarkable vigor; October 30, they were the largest and strongest of any plants in the bed. A few blossoms were produced; the first opened June 7, perfect.

*Warfield*—Of twelve plants, seven lived; these gave little promise till late in the season, when they developed vigorously. The plants, when last examined, Oct. 30, were strong and healthy, and had produced numerous runners.

The plantation was irrigated on the following days: May 5, 13, 22, 27, June 6, 16, July 5, August 10, September 20. Accompanying is a tabulation of the varieties of the old bed which fruited:

| VARIETY. | Perfect or Imperfect. | Date of Ripening. | First Picking. | Last Picking. | Use, Family or Market. | Production. | Vigor. |
|---|---|---|---|---|---|---|---|
| Albany | Perf. | May 12 | June 10 | June 30 | Fam. | Medium | Vigorous |
| Atlantic | " | May 16 | June 13 | July 6 | " | Unprod. | Not Vig. |
| Bomba | " | May 13 | June 10 | June 30 | " | Prod. | Vigorous |
| Cornelia | Imper. | May 19 | June 12 | July 6 | Mark. | | Medium |
| Captain Jack | Perf. | May 14 | June 16 | June 30 | Fam. | Medium | Vigorous |
| Constantina | " | May 16 | June 10 | | | | " |
| Crescent | Imper. | May 11 | June 10 | June 30 | Mark. | | " |
| Crystal City | Per. | May 11 | June 3 | June 27 | " | Unprod. | Not Vig. |
| Downing | " | May 14 | June 16 | June 30 | " | Medium | Vigorous |
| Gaudy | " | May 18 | June 10 | July 6 | " | " | " |
| Glendale | Imper. | May 19 | June 14 | June 30 | F. or M. | " | |
| Ironclad | Perf. | May 11 | June 12 | June 30 | | | |
| Jewel | " | May 15 | June 10 | June 30 | Mark. | Prod. | Not Vig. |
| Jucunda | " | May 15 | June 16 | July 6 | Fam. | Medium | Vigorous |
| Jumbo | " | May 16 | June 15 | July 6 | | | |
| Kentucky | " | May 11 | June 12 | July 6 | Fam. | Prod. | Vigorous |
| Lady Rusk | Imper. | May 11 | June 10 | July 6 | Mark. | Medium | " |
| Lida | Perf. | May 15 | June 9 | June 30 | | | |
| Logan | " | May 12 | June 15 | July 6 | F. or M. | Prod. | Vigorous |
| Louise | " | May 11 | June 10 | June 30 | | " | " |
| Manchester | " | May 15 | June 10 | July 6 | Mark. | Very Prod. | " |
| Monarch | " | May 12 | June 9 | July 6 | " | | " |
| Ontario | " | May 15 | June 12 | June 30 | " | Prod. | " |
| Scarlet Queen | " | May 12 | June 10 | June 30 | | | Not Vig. |
| Sharpless | " | May 15 | June 12 | July 6 | Mark. | Prod. | Vigorous |
| Summit | | May 12 | June 12 | June 30 | " | Unprod. | Not Vig. |

BLACKBERRIES.

The only variety of blackberry represented in the Station garden was the Wilson. It being necessary to change the location, the plants were cut back and transplanted. There were added twelve plants each of Wilson, Jr., Early Harvest, Taylor and Snyder. A few plants died. Those living made a fair season's growth. The canes have been shortened to three feet; they are stout and healthy. None of the plants fruited this season. They have been covered for the winter. Three plants of the variety Jewett were received April 8th, from J. T. Lovett & Co., of Little Silver, N. J. The plants seem healthy, but have made a small growth; the canes reaching a length of 2.5 feet.

RASPBERRIES.

The old planting of raspberries comprised the following varieties: Red—Cuthbert, Superb, Lost Rubies, Surprise, Crimson Beauty, Thwack, Reliance. Black—Tyler, McCormick, Gregg. Yellow—Caroline, Beebe's Golden. To these were added twelve plants each of Cuthbert, Hansel, Shaffer and Ohio. Most of the old plants were transplanted in order to bring the varieties together into one plat. The growth made during the season was very satisfactory. The following varieties fruited:

*Superb*—Fruits large, deep red, of very good flavor. It is a family rather than a market berry; ripens the first week in July; prolific.

*Lost Rubies*—Ripens with Superb. Fruit dark red, rather soft, but of excellent flavor; with us it is very prolific.

*Thwack*—Is a little later than the two above; the fruit is handsome, bright red, medium size, very good for family use, and firm enough to ship well.

*Reliance*—Ripens with Thwack. Fruits large red, of good flavor, valuable as a table fruit, and will stand shipping. It is not very prolific.

*McCormick (Mammoth Cluster)*—Fruits of medium size, black, ripening the last week in July. Plants very strong in growth; prolific. Does not rank high as a table fruit, but is excellent for market or canning.

*Caroline*—Fruits large, yellow, becoming dull orange when fully ripe. When ripe they are soft, and drop from the plants. Flavor excellent. It is distinctively a fruit for the home table, valuable for no other purpose, and should be planted sparingly. The plants of the Lovett's Black Cap received for trial April 8th, from J. T. Lovett & Co., have made a vigorous growth. All the raspberries have been covered for the winter.

GRAPES.

There are at present eighty-seven varieties represented in the vineyard. In the appended list those marked with an asterisk fruited this season, and below are brief notes on these varieties. Last spring two vines of the Green Mountain grape were received for trial from Stephen Hoyt's Sons, of New Canaan, Conn. These did not make a very vigorous growth. The length of new cane is only 14 inches. They have been covered for the winter, and their behavior next season will be noted.

Agawam,
Amber,
Amber Queen,
August Giant,
Bachus,
Black Eagle,
Black P.,
Bland's Black,
*Brighton,
Butter,
Cambridge,
Eldorado,
*Elvina,
Empire State,
Etta,
Eumelan,
Francis B. Hayes,
*Goethe,
Green Mountain,
Green's No. 2,
Hartford,
H. Blano,
Norfolk,
*Norman's Muscadine,
Norton's Virginia,
*Norwood,
Oneida,
Oriental,
Pearl,
*Perkins,
*Pocklington,
Reindeer,

| | | |
|---|---|---|
| Challenge, | Highland, | Rogers' No. 28, |
| Champion, | Iowa, | Rogers' No. 39, |
| Concord, | Isabella, | Rogers' No. 41, |
| *Cottage, | Poughkeepsie, | Rogers' No. 43, |
| *Creveling, | Prentiss, | Rogers' No. 44, |
| Crystal City, | Rochester, | Rogers' Seedling, |
| Cynthiana, | *Lady, | Senasqua, |
| *Delaware, | *Lady Washingt'n, | *Taylor's Bullet, |
| Diana, | Lindley's No. 2, | Transparent, |
| *Janesville, | *Marion, | Telegraph, |
| Jefferson, | Martha, | Triumph, |
| Jessica, | Massoit, | *Ulster Prolific, |
| Downing, | Merrimack, | *Vergennes, |
| Dracut Amber, | Mentefiore, | Welding, |
| Early Delaware, | Morris Diamond, | Wilder, |
| Early Victor, | Niagara, | *Woodruff Red, |
| Early York, | *Moore's Early, | *Worden. |
| Eaton, | Noah, | |

*Brighton*—Bunch large, shouldered; berry of medium size, and red or purplish, flavor excellent; a valuable table berry. Some bunches were colored September 1. Crop ready September 20. Vines strong and healthy. Average growth of cane this year, 12 feet. Vines bore sparingly.

*Concord*—Too well known to need remark. It is the best all-purpose black grape we have.

*Cottage*—Bunch rather small; berry large, black, of good flavor. Good for table use, or for market. Ripens September 5. Vines of medium vigor; average growth of cane 8 feet.

*Creveling*—Bunch shouldered, long and loose; berry of medium size, black; flavor good, sweet and juicy. A good table grape, ripening September 10. Vines of good vigor, canes averaging 10 feet this season; moderately productive.

*Delaware*—Bunches small, compact, shouldered; berries small, red. Very popular for table or market. Vines

not robust, average growth 6 feet. This variety requires the best of treatment to insure even average productiveness. Ripe September 20.

*Elvira*—This is a small, greenish white grape. The berries were not nearly ripe when frosts killed them. It appears to be too late for northern Colorado. The vine is not a strong grower, and even were it earlier I see no value in it.

*Goethe*—A large grape of greenish yellow color. The flavor is excellent. It is not fully ripe until the last of September. Vines of medium vigor, and fairly productive.

*Janesville*—Bunch of medium size, shouldered; berry rather small, black, of fair quality. Fully matured September 10. A good early market variety. Vines of fair vigor; canes average 10 feet.

*Lady*—Bunches large, berries of good size, greenish white, flavor excellent. A good table grape, ripening September 15 to 20. Average growth of canes 8.5 feet.

*Lady Washington*—Bunches large, shouldered; berries very large, yellowish green. Good for either table or market. Ripens ten days later than Lady.

*Marion*—This is a black grape of medium size, and ripening late. There are so many better varieties that I would not plant this one.

*Moore's Early*—Bunches large, compact, shouldered; berry large, black, of excellent flavor. One of the best for this region, for either table or market. Ripens August 30. Vines of good vigor, and productive.

*Norman's Muscadine*—A small, fairly productive red grape of good flavor, ripening September 15; vines vigorous.

*Norwood*—Bunch of medium size; berry small, black, of fair quality. Ripens early in September. Vines very vigorous.

*Perkins*—Bunch compact, shouldered, of medium size; berry large, color pale red. Ripens September 20. Of very good quality; not productive with us. Vines strong, average canes 10 feet.

*Pocklington*—Bunch large, shouldered; berry large, yellowish green, of fine flavor; moderately productive. Vines not strong, canes this season only 5 feet. It ripens quite late, last of September.

*Taylor's Bullet*—Of no value for this region.

*Ulster*—Berries large, shouldered bunches; red, very sweet, quite productive. An excellent table variety. Vines not very vigorous.

*Vergennes*—Bunches of medium size, shouldered; berries large, red, thick skinned. Ripens about the first of September. Vines of medium vigor, productive.

*Woodruff*—Bunches very compact, shouldered; berries large, red; flavor excellent, sweet and juicy. One of the best for table, and good for market. Ripens about September 15 to 20. Vines vigorous, productive.

*Worden*—Bunches medium to large, compact, shouldered; berry large, black, flavor good, rather better than Concord. A very fine market grape, ripens first week in September, a few days earlier than the Concord. The vine is not a very strong grower; canes averaged 8 feet.

POTATOES.

We grew this season forty named varieties, and twenty-five numbered seedlings. The ground chosen was a part of the west garden. It had been used for garden purposes for several years, and last season was heavily manured and planted with tobacco. The soil is a clay loam containing some gravel. After plowing and harrowing, rows 50 feet long and 3.5 feet apart were marked off, one row being assigned to each variety. The tubers were cut to two eyes in a piece, and fifty pieces of

each variety were used. The planting was all done May 27. The ground was then quite dry, and it was not until June 11 that water was applied. The plants came up slowly and irregularly, but when once started grew rapidly. To the late planting and dryness at the time of planting was due the inferior product harvested. The plat was irrigated on the following dates: June 11 and 27, July 11, 22 and 23, August 12, and September 2 and 3. The potato beetle gave very little trouble, one application of London purple was all that was found necessary. Below is found a list grown:

Agnoth's Favorite,
Beauty of Sheba,
Brownell's No. 56,
Bouton's,
Crandall's Seedling,
Dakota Red,
Durham,
Early Sunrise,
Early Rose,
Early Telephone,
Early Jenks,
Early Perfection,
Empire State,
Excelsior,
Farina,
Fremont,
Gold Flake,
Grange,
Gunnison,
Henderson's Early Perfection.
Late Ohio.
Magnum Bonum,
Mammoth Pearl,
New Queen,
Pearl of Savoy,
Prairie Farmer,
Pride of Ireland,
Pride of Japan,
Perfect Peach Blow,
Putnum's New Rose,
Rochester's Favorite,
Seek-No-Further,
Shannon Seedling,
Stray Beauty,
Summit,
Vermont Champion,
White Beauty of Hebron,
Watson's Seedling,
White Elephant,
Yankee Notion.

Of these varieties, eight will be discarded as unworthy of further trial. The decision to discard them is based not only upon their behavior this year, but upon their previous record. They are: Early Sunrise, Durham, Fremont, Putnam's New Rose, Rochester's Favorite, Seek-no-Further, Summit, Yankee Notion. Further com-

parative tests of the varieties will be made. The named varieties which did best are:

*Early Rose*—Too well known to need description; gave a total yield at the rate of 238 bushels to the acre. An unusual proportion were small; by our method of sorting, we had as the yield of marketable potatoes 114.6 bushels.

*Beauty of Sheba*—Skin smooth, yellowish, somewhat russety; eyes few, prominent raised; in shape, flat oblong. Total yield per acre, 173.6 bushels; of marketable tubers, 126 bushels.

*Bouton's*—Skin smooth; in color light pinkish, with dark pink about the eyes; eyes numerous and deep; shape cylindrical, tapering to the seed end. Total yield per acre, 248 bushels; of marketable tubers, 167.4 bushels.

*Empire State*—Skin smooth, yellowish white; eyes numerous, of medium depth; in shape, long, nearly cylindrical. Total yield per acre, 198.4 bushels; marketable tubers, 144.6 bushels.

*New Queen*—Skin smooth, yellowish, with light pink spots; eyes prominent, entirely on the surface; in shape, irregularly oblong. Total yield per acre, 144.6 bushels; of marketable tubers, 109.5 bushels.

*Mammoth Pearl*—Skin smooth, yellowish; eyes few, of medium depth; in shape, flat, roundish, somewhat irregular. Total yield per acre, 223.2 bushels; of marketable tubers, 160.2 bushels.

*Seedlings*—Of the twenty-five seedlings grown, there are twenty-one yielding so poorly that I consider their further trial useless, and propose discarding them. The remaining four give promise, and will be tested next season. These are: No. 4—Skin smooth, yellowish, with small russety spots; eyes few, small, and partly on the surface; shape long, cylindrical, tapering to the seed end.

This gave a total yield per acre of 167.4 bushels, of which 119.7 bushels were marketable. No. 15—Skin smooth, yellowish, very russety; eyes few and deep; shape irregular round. Total yield per acre, 241.3 bushels; of marketable tubers, 76.5 bushels. No. 37—Skin smooth, yellowish white; eyes very few, all on the surface; shape oblong. Total yield per acre, 181.8 bushels; of marketable tubers, 95 bushels. No. 65—Skin rough, dark purple, eyes few, mostly on the surface; shape irregular oblong. Total yield per acre, 128.1 bushels; of marketable tubers, 95 bushels.

I find from the statistics of Agriculture, compiled by the Secretary of the State Board of Agriculture for the year ending 1886, that the average yield per acre of potatoes in the State for the year 1883 was 73.3 bushels; for the year 1886, 129.6 bushels; the acreage for 1886 being 17,767½.

TOMATOES.

Forty-seven varieties of tomatoes were grown the past season. The seed, except of one variety, was sown in boxes in the green-house February 24. Haines' No. 64 for trial was received later, and sown on March 13. Twelve plants of each variety were planted in the open ground June 6. The growth made was not satisfactory; it was slow. The plants were late in blossoming, and late in ripening fruit. It was the intention to obtain a record of relative productiveness by weighing the fruits as picked, and this work was begun, but the havoc made by the first frost, September 6, was so great, and came so soon after bearing commenced, that it was decided to relinquish the attempt, as accurate results would here be impossible. Below is a list of varieties grown with record of first blossoms and first ripe fruits. Of the varieties grown, thirty-two were from seed raised at the Station. Twenty-eight of these varieties have been previously reported on, so I append brief notes only on those varieties new to the Station:

## TOMATOES.

| NAME. | Where Seed was Obtained. | First Bloom. | First Ripe Fruit. |
|---|---|---|---|
| Acme | Station | June 20 | August 10 |
| Beauty | " | June 15 | August 10 |
| Canada Victor | " | June 16 | August 2 |
| Cardinal | " | June 16 | August 21 |
| Dwarf Champion | " | June 16 | August 10 |
| Early Jersey | " | June 16 | August 4 |
| Essex Hybrid | " | June 20 | August 5 |
| Essex Round Red Smooth | " | June 16 | August 12 |
| Fijii Island | " | June 20 | August 21 |
| Fulton Market | " | June 20 | August 12 |
| General Grant | " | June 23 | August 30 |
| Golden Queen | " | June 23 | August 17 |
| Golden Trophy | " | June 20 | August 15 |
| Green Gage | " | June 21 | August 10 |
| Haines' No. 64 | " | June 20 | August 21 |
| Haines' No. 64 | N B. & G. Co. | June 16 | August 12 |
| Hathaway | Station | June 21 | August 20 |
| Hathaway's Excelsior | " | June 20 | August 12 |
| Ignotum | V. H. Hallock & Son | June 21 | August 15 |
| Island Beauty | Station | June 16 | August 10 |
| Ivory Ball | " | June 21 | August 21 |
| Livingston's Favorite | Henderson & Co. | June 16 | August 10 |
| Perfection | Station | June 16 | August 4 |
| Mayflower | " | June 23 | August 2 |
| Mikado | " | June 16 | August 12 |
| New Jersey Ruby | Henderson & Co. | June 10 | August 8 |
| New Zealand | V. H. Hallock & Son | June 21 | August 12 |
| Optimus | Station | June 20 | July 28 |
| Paragon | " | June 16 | July 28 |
| Peach | Henderson & Co. | June 15 | August 15 |
| Pear Shaped | Station | June 16 | August 1 |
| Perfection | " | June 15 | August 12 |
| Potato Leaf | Michigan College. | June 16 | August 12 |

**TOMATOES—Continued.**

| NAME. | Where Seed was Obtained. | First Bloom. | First Ripe Fruit. |
|---|---|---|---|
| Puritan | Michigan College. | June 20 | August 12 |
| Queen | Station | June 23 | August 10 |
| Red Cherry | Henderson | June 16 | August 1 |
| Red Currant | " | June 16 | August 30 |
| Reed's Island Beauty | Station | June 23 | August 12 |
| Scoville's Hybrid | " | June 16 | August 12 |
| Station | V. H. Hallock & Son | June 21 | August 14 |
| Sunrise | Henderson | June 10 | August 12 |
| Lorillard | " | June 23 | August 12 |
| The Shah | " | June 15 | August 5 |
| Trophy, Extra Selected | Station | June 23 | August 10 |
| Vaughan's Earliest of All | J. C. Vaughan | June 16 | August 8 |
| Volunteer | V. H. Hallock & Son | June 16 | August 8 |
| Yellow Cherry | Henderson & Co. | June 6 | August 5 |

*Golden Queen*—Bright, clear yellow, some fruits having a faint blush of carmine on one side; in shape flattish, somewhat angular about the stem; 2 or 3 inches in diameter; the best of the yellow variety.

*Haines' No. 64*—From the Northrup, Braslan & Goodwin Co., is of medium size, smooth, light red, firm, thick skinned, prolific, ripening August 12.

*Haines' No. 64*—From Station seed. In size and color like the above, but more angular, not so prolific, and ripening nine days later. Where seed of this variety was originally obtained I am unable to ascertain.

*Hathaway's Excelsior*—From Station seed. Fruit bright red; varies in shape from nearly round to flattened. The round ones are smooth, the flat ones are angular about the stem; ripened August 12; the quality of fruit is excellent, and aside from the variation in shape is a valuable variety.

*Ignotum*—From V. H. Hallock & Sons. Fruit showed none of the characteristics of Ignotum. They were flat, mostly angular, and rather small. All the plants bore fruit of the same character, from which fact I

infer that it is not a degeneration of Ignotum, but an entirely different variety.

*Perfection*—An apple-shaped variety much like the old Paragon; fruits smooth, regular in size, firm, of good flavor; one of the best; early; ripened August 4.

*New Early Ruby*—Not as early as Perfection by four days. It is a promising variety. The fruits are smooth, 2 to 3½ inches in diameter, apple-shaped, of good color and very firm. We shall give it further trial.

*New Zealand*—A small, round, firm fleshed yellow variety, resembling yellow cherry, but larger. Fruit is from ¾ to 1¼ inches in diameter.

*Peach*—A singular variety, somewhat resembling a peach; round, averaging 1.5 inches in diameter; color pinkish, with darker red and purplish spots. It is of good quality.

*Potato Leaf*—One of the pink varieties, resembling Acme; apple-shaped, smooth, firm, 2 to 3 inches in diameter. Our fruits averaged smaller than the type of the variety; ripens August 12.

*Puritan*—A bright red, apple-shaped variety, much like Paragon; fruits are even in size, smooth, solid; ripened August 12. I rate it among the best for market.

*Red Currant*—Grown only as a curiosity. The foliage is small, and the long racemes of bright red fruits are very handsome.

*Station*—An upright, or tree tomato; fruits somewhat angular, light red, solid; ripened August 14. Produces too few fruits to be of value.

*Sunrise*—A bright yellow variety, apple shaped, smooth, firm; ripened August 12.

*The Lorillard*—Fruits dark red, smooth, apple shaped, averaging small; ripened August 12; flesh firm, and of good flavor. It is excelled in size and productiveness by several varieties.

*The Shah*—Dark yellow; large, but too irregular to be valuable.

*Vaughan's Earliest of All*—This variety was disappointing. As seen last year in Michigan it was ten days

earlier than any other variety. The fruits were of fair size, somewhat flattened, angular about the stem. It promised well for an early variety. With us this season the fruits are small, very angular, and not the earliest. It ripened with the Volunteer and New Early Ruby, and was preceded by May Flower, Perfection, Essex, Hybrid, Early Jersey and Canada Victor. It exhibited no valuable qualities.

*Volunteer*—Fruits 2 to 3.5 inches in diameter; even in size; bright red, smooth; apple shaped; ripened August 8; a productive variety; one of our best.

PEAS.

Forty-three varieties were planted in double rows 10 inches apart, and these 4 feet apart. The Algerian was planted April 18. Burpee's Profusion was planted April 12. All the rest were planted on March 24. The unusually long period between sowing and blossoming is due to the lateness of the spring. The low temperature of April and the first half of May allowed no growth. Had the seed been sown May 15, I think maturity would have been reached just as soon. The table gives the date of first bloom, with the dates of edible and marketable maturity. The varieties which appear to us most valuable are Earliest Alaska No. 1, Daniel O'Rourke, First and Best, Philadelphia, Extra Early, Extra Early Premium Gem. Alaska No. 1 led them all in earliness, and was closely followed by Daniel O'Rourke and First and Best. These varieties are all productive, plants from 2 to 3 feet high, except the Extra Early Premium Gem, which is only 18 inches high. Among the later varieties are the G. F. Wilson and Bliss' Abundance, which are about 2.5 feet. In both varieties the peas are wrinkled. The pods are long and well filled. For a tall-growing late variety, the American Champion was our best.

## PEAS.

| NAME. | Seedsman. | First Bloom. | Eatable Maturity. | Market-able Maturity. |
|---|---|---|---|---|
| Alaska No. 1 | A. R. Pierce | May 22 | June 4 | June 12 |
| Alaska No. 2 | " | May 24 | June 10 | June 14 |
| Algerian | Algerian Dept. Agriculture. | June 14 | June 26 | July 4 |
| American Wonder | Agr. College | May 28 | June 10 | June 20 |
| American Champion | " | June 10 | June 22 | June 28 |
| Blue Imperial | " | June 8 | June 14 | June 22 |
| Burpee's Quality | " | June 16 | June 24 | June 26 |
| Burpee's Profusion | B. & Co. | June 14 | June 24 | July 26 |
| Bliss Abundance | Agr. College | June 12 | June 18 | June 24 |
| Bliss Everbearing | " | June 8 | June 18 | June 24 |
| Carter's Anticipation | N. B. G. & Co. | June 4 | June 14 | June 22 |
| Champion of England | Agr. College | June 14 | June 20 | June 28 |
| Culverwell's Telegraph | " | June 10 | June 18 | June 23 |
| Daniel O'Rourke | " | May 24 | June 10 | June 14 |
| Dr. McLain's Little Gem | " | June 14 | June 21 | June 28 |
| Extra Early Premium Gem | " | June 4 | June 16 | June 22 |
| Everbearing | A. R. Pierce | June 4 | June 12 | June 20 |
| Eugenie | Agr. College | June 12 | June 18 | June 24 |
| Fill Basket | " | June 12 | June 18 | June 24 |
| First and Best | " | May 28 | June 8 | June 14 |
| G. F. Wilson | " | June 10 | June 18 | June 26 |
| Horsford's Market Gem | " | June 12 | June 18 | June 26 |
| John Bull | " | June 16 | June 24 | June 30 |
| Kentish Invicta | " | May 28 | June 10 | June 14 |
| Laxton's Alpha | " | May 25 | June 18 | June 30 |
| Laxton's Minimum | " | May 28 | June 14 | June 18 |
| Laxton's William I | " | June 8 | June 20 | June 28 |
| Laxton's Marvel | " | June 12 | June 16 | June 26 |
| Laxton's Charmer | " | June 8 | June 16 | June 22 |
| McLain's Blue Peter | " | June 4 | June 12 | June 20 |
| Pride of the Market | " | June 10 | June 18 | June 30 |
| Philadelphia Extra Early | " | June 4 | June 14 | June 20 |
| Payne's Conqueror | " | June 16 | June 22 | June 30 |

**PEAS.—Continued.**

| NAME | Seedsman. | First Bloom. | Eatable Maturity. | Marketable Maturity. |
|---|---|---|---|---|
| Rural New Yorker | A. R. Pierce | May 26 | June 12 | June 18 |
| Stratagem | Agr. College | May 30 | June 10 | June 20 |
| Sander's Marrow | " | June 10 | June 20 | June 26 |
| Sander's Marrow | P. H. & Co. | July 8 | July 20 | July 26 |
| Telephone | Agr College | June 8 | June 18 | June 22 |
| Tom Thumb | " | May 28 | June 12 | June 20 |
| Veitch's Perfection | " | June 12 | June 18 | June 24 |
| White Marrowfat | A. R. Pierce | June 10 | June 16 | June 26 |
| Yorkshire Hero | Agr. College | June 12 | June 20 | June 26 |

PEPPERS.

| NAME. | Seedsman. | Date of Sowing. | First Bloom. | Date Set out. | Edible Maturity. | Marketable Maturity. |
|---|---|---|---|---|---|---|
| Large Bell, or Bullnose. | Henderson & Co. | Feb. 24 | July 1 | June 9 | July 30 | Sept. 20 |
| Ruby King | " | " | July 3 | " | July 30 | Sept. 20 |
| Oxheart | " | " | June 24 | " | July 26 | Sept. 10 |
| Cardinal | " | " | June 30 | " | July 28 | Sept. 12 |
| Long Yellow Cayenne | " | " | June 30 | " | July 30 | Sept. 20 |
| Long Red Cayenne | " | " | June 30 | " | July 30 | Sept. 20 |
| Golden Dawn | " | " | June 24 | " | July 28 | Sept. 15 |
| Red Cherry | " | " | June 24 | " | July 26 | Sept. 12 |
| Sweet Spanish | " | " | July 6 | " | Aug. 14 | Sept. 30 |

*Ruby King*—Fruits bright red, from 4 to 6 inches long by 3 to 4 inches in diameter. Very prolific, and excellent market sort.

*Oxheart*—Color deep red, smooth, 2 inches in diameter by 1 inch transverse. Yields abundantly.

*Cardinal*—Fruits bright red, very long and slender, 6 to 8¾ inches long, 1 to 1.5 inches in diameter at the stem, tapering to a point. Very prolific.

*Long Red Cayenne*—Fruits 3 to 5 inches long, .5 to 1 inch in diameter, tapering to a point. Color deep red.

*Long Yellow Cayenne*—Similar to the long red, except in color.

*Golden Dawn*—In shape like the Bell. In color a clear yellow.

*Red Cherry*—Fruits small, of little value.

*Sweet Spanish*—Fruits large, cylindrical, 4 to 6 inches long, 2 inches in diameter; late. Requires a long season.

CUCUMBERS.

Seven varieties were grown. Seed all planted May 21.

| | | | | | |
|---|---|---|---|---|---|
| Improved Early White Spine | reached | edible | maturity | July | 30 |
| Extra Long Green Prolific | " | " | " | " | 20 |
| Siberian | " | " | " | " | 10 |
| Nichols' Medium Green | " | " | " | " | 21 |
| War Club | " | " | " | Aug. | 22 |
| White Perfection | " | " | " | " | 20 |

The two varieties of White Spine show no difference, except in the length. Both are standard varieties, excellent for pickles or for table use.

*Extra Early Green Prolific*—Is very prolific, and the fruits are smooth and regular. An excellent variety for market.

*Nichols' Medium Green*—Is one of the best for table use; fruit very straight and smooth. The vines bear abundantly.

*Siberian*—Appears to be identified with the variety Early Russian; fruits short and thick, remaining green but a short time. It is earlier than any of the other varieties grown, and in this lies its only merit.

*War Club*—Fruits long, slender, dark green, soon becoming crooked and enlarged at the blossom end; used when 5 or 6 inches long; as a table fruit is good. The variety is not prolific.

CABBAGE.

Six varieties were grown. Early Winningstadt and the Early Jersey Wakefield (Henderson's selected strain), were much the most satisfactory. Though many new introductions have competed for the favor these varieties have so long held, none have succeeded in supplanting them. I have seen no variety that combined the qualities of earliness, solidity of head and sureness to form heads so well as they are combined in these two. The Wakefield is ready for market with us July 25, and the Winningstadt follows ten days later.

*Express*—Does not do well with us. A large proportion do not head, and the heads that do form are not solid. It is in marketable condition July 25.

*Early French Oxheart*—Forms small, but compact heads. The stems are very short, and the variety will bear planting very close. The quality is good. It is marketable August 10.

*Large Early York*—Heads small, and not compact. We do not consider it a desirable variety. Ready five days later than Wakefield.

*Early Schweinfurt*—Very short stemmed, heads large, but loose. The outer leaves spread widely. Not a desirable variety.

Most of the late varieties grown have been reported before. I will therefore mention only those which have shown greatest excellence this season:

*American Drumhead Savoy*—A valuable variety; heads evenly; the heads large, and fairly solid. Planted 4 feet apart; they will cover the ground. The lower leaves are very large, and spread widely.

*Bloomsdale Late Flat Dutch*—Indistinguishable from Late Flat Dutch, and no difference in time of maturing; both are among the latest.

*Fotler's Improved Brunswick*—Is a valuable variety for market. It heads with certainty. The heads are of good size, very solid; outer leaves seem large, spreading. The crop ready September 30.

*Premium Flat Dutch*—The best of our late varieties; heads flat, very large; loose outer leaves few, and not wide spreading; stem very short.

ONIONS.

Fourteen varieties were grown. Ten of these, mostly well-known standard varieties, have been grown and reported upon in previous years, and need no further comment. The yield with all varieties grown was good. Four varieties had not been grown at the Station until this year.

*The Adriatic Barletta*—A very excellent early variety; bulbs greenish white, very even in size, flat, 3 to 4 inches in diameter. The bulbs form rapidly, attain full size early in August, and are mature by the 20th. The flavor is mild; of value for family use; does not keep well.

*Red Bermuda*—Bulbs yellowish white, averaging small in size. Matures about August 20, but does not ripen as evenly as the Barletta. Will keep but a short time.

*Spanish King*—Bulbs globe shaped, white or yellowish, very large. Late, requiring the full length of the season. The bulbs are very solid, and promise to keep well.

SUGAR BEETS.

Three varieties of sugar beets were grown from seed raised by the Station. The original stock of seed came from Peter Henderson & Co. two years ago. These were Excelsior, Vilmorin, Improved Imperial. The seed was sown April 12, in rows 3 feet apart. The roots of all these varieties grew to large size, all being much larger

than the type of root most valued for sugar. The land on which they were grown is low and very rich. In October the samples were taken for analysis. In selecting these we chose specimens smaller than the average. The single specimen of Improved Imperial weighed six pounds; root cone shaped, tapering abruptly above, less abruptly below; color orange below, greenish russeted above; length of leaves, 22 inches; blade and petiole green; total length of root, 18 inches; length of fleshy root, 9 inches; diameter, 6 inches; upper half irregularly indented and rough. The product of one row 240 feet long was weighed, showing a yield at the rate of 22.31 tons per acre.

*Vilmorin*—Sample weighed 4.5 pounds; taper at the top abrupt, below gradual; fibrous roots below numerous; color white; one quarter of the length above ground, and greenish in color; leaves 18 inches long; blade and petiole green; surface of root somewhat indented and rough; total length, 16 inches; length of fleshy root, 12 inches; transverse diameter, 4.5 inches. One row 240 feet long weighed, shows a yield at the rate of 27.21 tons per acre.

*Excelsior*—Sample weighed 4.8 pounds; shorter and thicker than the sample of Vilmorin; color whitish, marked with spots and splashes of rose color; leaves 20 inches long, green, rough; length of fleshy root, 10 inches; total length, 14 inches; transverse diameter, 5 inches. One row 240 feet long weighed shows a yield at the rate of 29.12 tons per acre. The samples mentioned were photographed and delivered to the Chemical Section October 7, 1890.

We received from the United States Department of Agriculture six packages of sugar beet seed, representing the following varieties: Bulteau Desprez, Dippe's Vilmorin, Dippe's Klein Wanzleben, Florimond Desprez,

Simon LeGrand's White Improved. There were two packages of seed of the first named variety. The seed was sown with a hand drill May 21, in rows two feet apart, two rows from each package; the two samples of Bulteau Desprez and Dippe's Vilmorin in rows 125 feet long. The other three varieties in rows 135 feet long. The soil was a clay loam, of rather poor quality. The plants came thick, and at the first weeding were thinned somewhat, but I think not sufficiently. The proportion of very small roots was greater than it should have been. They were given clean culture, and were irrigated as follows: June 6 and 13, July 11, and on October 5 and 6. October 14 and 15 the beets were harvested. Average rows of each variety were taken and divided for samples. The whole was first divided into halves, the halves again equally divided, and so on. Four specimens of each variety were taken, numbered, weighed and photographed. Two of each variety were sent to the Chemical Division of the United States Department of Agriculture, and two were taken to the Station Chemist for analysis.

The following table shows the analysis of beet samples sent to Washington, as reported by Dr. H. W. Wiley, Chemist.

| VARIETIES. | Average weight, grams. | Cane sugar, per cent. of Beets. | Cane sugar, per cent. of Juice. | Ash, per cent. of Juice. |
|---|---|---|---|---|
| Bulteau Desprez No. 1 | 395 | 15.20 | 16.00 | .95 |
| Bulteau Desprez No. 2 | 460 | 14.73 | 15.50 | .95 |
| Vilmorin | 1320 | 12.92 | 13.60 | .99 |
| Klein Wanzleben | 805 | 15.11 | 15.90 | .95 |
| Florimond Desprez | 475 | 15.39 | 16.20 | .90 |
| Simon LeGrand's White Improv'd | 665 | 11.50 | 12.10 | .94 |

WEEDS.

The study of the weeds of this locality has been carried on during the season as time and opportunity allowed.

The list of those observed now number 170. Those which are very abundant and very persistent in cultivated ground number forty-two. It requires constant cultivation and attention to keep them in subjection, and we may call them our worst weeds. There is another class less persistant in cultivated ground, but unsightly by reason of their abundance in neglected and waste places, and giving more or less trouble, which may be classed as bad weeds. These number thirty-one.

The balance of the 170 plants so far catalogued as weeds, ninety-seven in number are mostly inoffensive. They inhabit the roadsides and ditch banks. Some of them are common on pasture lands and in meadows moist from seepage.

A satisfactory report on this subject cannot be made from the observations of one season, confined to a limited territory. The work so far is only preliminary. It will require extended observation over wider areas to determine many of the questions that have arisen regarding distribution, duration, persistence and noxious qualities, before an intelligent estimate of many of the species can be made. Further study and observation will increase the list, and may change, in some instances, the rating I have given from observations of this season.

## HERBARIUM.

In connection with the study of the flora of the State, a start has been made toward the building up of an Herbarium. For the nucleus, we are indebted to the Botanical Division of the United States Department of Agriculture. That department has very kindly contributed 1,013 specimens of plants. Of these, 557 specimens were received some years ago, and a portion of them mounted. Four hundred and fifty-six specimens were received in January last. These have all been mounted

and labeled, and are now classified and ready for use. Of the 1,013 species, 250 are grasses, representing seventy-four genera, and 763 are flowering plants of other orders, and represent 392 genera. An Herbarium case, sufficient for present needs, was constructed for us by the students of the Mechanical Department of the College. This was placed in the Botanical Laboratory June 4. The system of labeling is what is known as Durand's Index, based upon the arrangement of Bentham & Hooker. This system is in use in the National Herbarium at Washington. It is simple, and renders reference to particular plants easy. Besides the plants above mentioned, I have added from my private Herbarium 255 species, representing 150 genera and 64 orders, making a total of 1,268 species now in cases.

None of these plants were collected in Colorado. They came from various localities, from Maine to Florida, and Texas. The collection which I have made this summer will be mounted during the winter, and be ready for use in the spring. The collection numbers about 700 species. Over 500 have been determined and are labeled, ready to mount. Those still undetermined will be worked out as I find time during the winter. In collecting, I have, where possible, secured a number of each species, and it is hoped that by exchanging with the other botanists the Herbarium may be largely increased. I shall aim mainly at getting together as soon as possible a flora of our own State. It will take time to make it complete, but it can be accomplished by persistent effort.

Respectfully submitted,

CHARLES S. CRANDALL,

*Botanist and Horticulturist.*

# REPORT OF APIARY.

*To the Executive Committee, State Board of Agriculture:*

SIRS—Through the Director, I have the honor to submit the following report of the Apiary for 1890:

My report of the Apiary for the past season is rather limited, owing to the fact that there was other work of seemingly more importance demanding my attention at times which should have been devoted to the bees. The only care that they received was the placing on of the supers, and exchanging those filled for empty ones.

We have at present thirty-one colonies, strong, and with plenty of stores to winter on. Amount of honey sold, $80.92.

The question, Does it pay to cultivate a honey-producing plant exclusively for the use of bees? has been agitated for several years among the apiarists of the country, and to answer this question satisfactorily, experiments ought to be tried on a larger scale with such plants, at times when the usual honey producing plants are scarce, to be assured that the bees actually gather honey in paying quantities from these flowers, and get definite results. Two years ago we received a package of seed of the Chapman honey plant (*Echinops sphærocephalus*) from the Department of Agriculture. The seed was sown at once, covering four rows eighteen inches apart, fifty feet long. A good stand was secured.

The plant looks like a thistle, is very vigorous, and grows to a height of about 4 feet. It being a biennial plant, it was in bloom the past season. The flowers are globe shaped. The blossoms begin to open on the lower margin, continuing towards the center; flowers waxy, of a pale blue color. July 21 the blossoms began to open, and from that time until the end of bloom, which was August 24, bees worked continuously on the same. From early morn until dusk at night a swarm of the busy little workers was hovering over the flowers, coming and going, and I have counted as many as fifteen bees on a single head.

It is truly a wonderful plant, and I think to get a definite answer to above query, this plant would be the one to test, there being only one objection—it is a biennial plant, consequently would not get results the first season. In our region, where we have an abundance of flowers secreting honey during the larger part of the growing season, it is doubtful to my mind whether it would pay to cultivate plants for the exclusive use of the bees, except in waste places, and along ditch banks.

Respectfully submitted,

CHAS. MAX BROSE,

*Assistant to Horticulturist.*

REPORT OF

# Section of Meteorology and Irrigation Engineering.

*To the Executive Committee, State Board of Agriculture:*

GENTLEMEN—I have the honor of submitting to you the following report of various features of work of this section during the past year. The work of this department has two very different sides, that relating to meteorology and that relating to the irrigation questions of the State. In this latter line it has been my endeavor to collect all the information obtainable in regard to the irrigation question in its various phases, both by correspondence and by personal visits to localities where information is to be obtained. Canals have been gone over with their Superintendents, hundreds of miles traversed by horse and thousands by rail. The amount of this data which we have collected is useful and gratifying. It lacks in completeness, and it would perhaps be better to report the detailed observations at a later time. In connection with this you will find some useful summaries of the progress of irrigation in our State at present.

In meteorology I have endeavored to bring up our back records, so as to make them accessible for current comparison. The amount of work required has been great in addition to the current work which presses constantly and cannot be neglected. In this I have been ably assisted by Mr. B. C. Buffum, of the last graduating class, who succeeds Mr. Meyers. The summaries and records as

handed you with this are incomplete, as the calendar is not quite closed. It is so much more convenient, as a means of comparison, to have the summaries include the whole year that I desire to add to this the remaining results of the year. By adopting a new form of records the coming year and the employment of current help when necessary, I think that this part of the work can be done more easily. The amount of labor involved in the reductions is very great and is very hard to understand by those who have not had occasion to do work of the same kind.

## WATER SUPPLY.

The water supply of the year, while in some respects better than in previous years, has still been insufficient, and in many localities, including this, there has been a stringency. In the latter part of October of 1889 a series of snow storms occurred, making the precipitation of that month at this place 3.16 inches, nearly three times the average. This heavy fall covered most of the mountain region as far south as the Arkansas Valley. The reports from the mountains during the winter were very encouraging, and the farming community, prepared for reports of much snow by the heavy precipitation of October, believed that there would be an ample water supply in 1890. In consequence, many farmers did not irrigate early in the season when water was to be had. In this valley, which has been the more closely under our observation, the river increased in flow as usual through April and May. On April 1 the flow was 73 cubic feet per second. The average for the whole month was 200 cubic feet per second. In May the river increased from 435 cubic feet at the first to about 1,600 at the close, giving an average for the whole month of over 1,000 cubic feet per

second. There was nothing to indicate that the flow would not increase, as in most years, for a fortnight longer. But just at this time, when many were preparing for the first irrigation, and when all were wanting water, a week of cold weather suddenly dropped the flow from 1,800 cubic feet, on the second of June to between 1,100 and 1,200 a few days later, and the flow remained at about that point for the remainder of the month. The supply of water was consequently shortened at the most inopportune time, and there was some loss of crops. The amount needed at this time to meet the wants of the canals is some 2,500 cubic feet per second, or, in other words, the supply was one-half of that needed at that time. The supply throughout the Platte Valley was likewise shortened. In the Arkansas and the Rio Grande Valleys, where there is not so much area under cultivation and the streams are relatively larger, there was little, if any, suffering for water this year. The lower Platte suffered somewhat. The flow was larger than in the year 1888, which was an exceptionally low year.

The following table gives a comparison between the maximum flows of the two years of several of the streams of the State:

| STREAM. | Maximum Flow, 1890. | Date of Maximum. | Maximum Flow, 1888. | Date of Maximum. |
|---|---|---|---|---|
| Cache a la Poudre | 1804 | June 2 | 1550 | June 19 |
| Big Thompson | 675 | July 21 | 830 | June 16 |
| St. Vrain | 544 | June 2 | 490 | June 19 |
| Boulder Creek | 1200 | August 11 | 325 | June 19 |
| South Boulder | 544 | May 28 | 230 | June 19 |
| Bear Creek | 75 | July 22 | 130 | June 1, 2, 3 |
| Clear Creek | .... | ..... | 490 | June 13, 14 |
| South Platte (in canon) | 626 | July 26 | 780 | July 21, 22 |
| Arkansas River | 3270 | May 28 | 2750 | June 19 |

For other years we have the maximum flow of the Cache a la Poudre: In 1884, 5,600 feet, June 28; 3,850 feet, June 5, 1885; 2,730 feet, May 30, 1886. The Arkansas, May 29, 1886, had a flow of 7,700 cubic feet per second, and on July 18, 1887, 6,500 cubic feet per second. These small discharges of the rivers for the past few years, after the country has been irrigated more or less for thirty years, recalls, by contrast, the statement made by Professor Thomas in his report on the Agriculture of Colorado, in Hayden's Geological Report for 1873, that the effect of irrigation was to increase the flow of streams, because then there were streams flowing that were formerly dry. It would be as hasty to suppose that our seasons are to continue as dry as they have been for the past two or three years. The effect of the scarcity of water has been to keep before the public the water question, and to cause them to consider the means of utilizing the present water supply to its fullest extent.

The following is a table showing the average discharge of the Poudre for each day since the 1st of November, 1889:

**Table Showing Daily Discharge and Mean Depths of the Cache la Poudre River from Nov., 1889, to Nov. 8, 1890.**

| Day. | Nov. | | Dec. | | Jan. | | Feb. | | March. | | April. | | May. | | June. | | July. | | August. | | Sept. | | Oct. | | 1890. Nov. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. | Mean Depth. | Discharge. |
| 1 | .87 | 91.9 | .78 | 68.7 | .63 | 45.6 | .91 | 104.2 | .86 | 88.9 | .80 | 73.0 | 1.53 | 435.5 | 3.25 | 1736.0 | 2.30 | 970. | 1.41 | 260.2 | 1.05 | 159.0 | .71 | 57.0 | .86 | 88.9 |
| 2 | .79 | 70.8 | .82 | 78.0 | .76 | 65.1 | .99 | 133.5 | .91 | 104.2 | .79 | 70.8 | 1.62 | 494.0 | 3.33 | 1801.0 | 2.29 | 963. | 1.38 | 342. | 1.08 | 173.0 | .70 | 55.0 | .84 | 83.3 |
| 3 | .81 | 75.4 | .77 | 66.9 | .78 | 68.7 | 1.00 | 137.6 | .90 | 101.1 | .78 | 68.7 | 1.71 | 552.7 | 3.12 | 1625.0 | 2.28 | 957. | 1.35 | 324. | 1.10 | 183.0 | .70 | 55.0 | .83 | 80.7 |
| 4 | .85 | 86.0 | .70 | 54.9 | .82 | 78.0 | .99 | 133.5 | .87 | 91.9 | .79 | 70.8 | 1.88 | 666.7 | 2.98 | 1510. | 2.20 | 896. | 1.30 | 294. | 1.05 | 159.0 | .72 | 58.0 | .82 | 78.0 |
| 5 | .78 | 68.7 | .71 | 56.5 | .90 | 101.1 | .91 | 104.2 | .82 | 78.0 | .80 | 73.0 | 2.02 | 764.4 | 2.77 | 1339. | 2.14 | 852. | 1.23 | 255. | 1.03 | 150.3 | .73 | 59.7 | .78 | 68.73 |
| 6 | .79 | 70.8 | .73 | 59.7 | .90 | 101.1 | .82 | 78.0 | .79 | 70.8 | .87 | 91.9 | 1.96 | 722.0 | 2.63 | 1225. | 2.10 | 822. | 1.17 | 222.5 | 1.00 | 138.0 | .75 | 73.0 | .77 | 66.9 |
| 7 | .80 | 73.0 | .73 | 59.7 | .84 | 83.3 | .81 | 75.4 | .77 | 66.9 | .92 | 107.5 | 1.83 | 633.36 | 2.52 | 1139. | 2.02 | 764.4 | 1.10 | 183.0 | .98 | 130.0 | .75 | 73.0 | .79 | 70.8 |
| 8 | .87 | 91.9 | .76 | 65.1 | .81 | 75.4 | .81 | 75.4 | .76 | 65.1 | .90 | 101.1 | 1.88 | 666.7 | 2.57 | 1178. | 1.98 | 726. | 1.08 | 173.0 | .98 | 130.0 | .75 | 73.0 | .80 | 73.0 |
| 9 | .93 | 111.0 | .76 | 65.1 | .73 | 59.7 | .86 | 88.9 | .79 | 70.8 | .89 | 98.0 | 1.97 | 729.0 | 2.59 | 1193. | 2.15 | 857. | 1.13 | 198.0 | .96 | 122.0 | .75 | 73.0 | .79 | 70.8 |
| 10 | .96 | 121.8 | .73 | 59.7 | .82 | 78.0 | .92 | 107.5 | .72 | 58.0 | .86 | 88.9 | 1.99 | 743.0 | 2.62 | 1217. | 2.03 | 770. | 1.37 | 336.0 | .93 | 111.0 | .75 | 73.0 | .... | ..... |
| 11 | .96 | 121.8 | .65 | 48.0 | .85 | 86.0 | .91 | 104.2 | .66 | 49.2 | .89 | 98.0 | 2.07 | 800.4 | 2.60 | 1201. | 1.95 | 712.5 | 1.48 | 403.6 | .92 | 108.0 | .77 | 66.9 | .... | ..... |
| 12 | .89 | 98.0 | .80 | 73.0 | .89 | 98.0 | .89 | 98.0 | .64 | 46.8 | .92 | 107.5 | 2.12 | 836.8 | 2.58 | 1186. | 1.79 | 601. | 1.39 | 348.0 | .90 | 101.0 | .86 | 88.9 | .... | ..... |
| 13 | .88 | 84.9 | .80 | 73.0 | .91 | 104.2 | .85 | 86.0 | .68 | 51.9 | .96 | 121.8 | 2.07 | 800.4 | 2.65 | 1242. | 1.76 | 550. | 1.40 | 354.0 | .89 | 98.0 | .95 | 118.1 | .... | ..... |
| 14 | .85 | 86.0 | .82 | 78.0 | .90 | 101.1 | .82 | 78.0 | .68 | 51.9 | 1.00 | 137.6 | 1.97 | 729.0 | 2.63 | 1225. | 1.70 | 546. | 1.48 | 403.6 | .86 | 89.0 | .95 | 118.1 | .... | ..... |
| 15 | .90 | 101.1 | .86 | 88.9 | .90 | 101.1 | .80 | 73.0 | .73 | 59.7 | 1.00 | 137.6 | 1.98 | 736.0 | 2.70 | 1282. | 1.80 | 618. | 1.47 | 397.4 | .88 | 84.9 | .95 | 118.1 | .... | ..... |
| 16 | .89 | 98.0 | .85 | 86.0 | .90 | 101.1 | .81 | 75.4 | .88 | 84.9 | .99 | 133.5 | 2.08 | 807.6 | 2.74 | 1315. | 1.68 | 533.5 | 1.45 | 385.0 | .88 | 84.9 | .90 | 101.0 | .... | ..... |
| 17 | .92 | 107.5 | .84 | 33.3 | .82 | 78.0 | .81 | 75.4 | .91 | 104.2 | .99 | 133.5 | 2.19 | 888.6 | 2.76 | 1331. | 1.60 | 481. | 1.45 | 385.0 | .88 | 84.9 | .83 | 80.76 | .... | ..... |

## Discharge and Mean Depth of the Cache la Poudre – Continued.

| Day. | Nov. | | Dec. | | Jan. | | Feb. | | March. | | April. | | May. | | June. | | July. | | August. | | Sept. | | Oct. | | 1890. Nov. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. | Mean Depth. | Dis-charge. |
| 18 | .92 | 107.5 | .83 | 83.9 | .82 | 78.0 | .80 | 73.0 | .93 | 101.1 | 1.01 | 141.8 | 2.41 | 1073.0 | 2.77 | 1339. | 1.65 | 515. | 1.32 | 305.0 | .83 | 80.7 | .83 | 80.7 | .... | ..... |
| 19 | .93 | 111.0 | .80 | 73.0 | .83 | 80.7 | .78 | 63.7 | .93 | 101.1 | 1.09 | 178.0 | 2.48 | 1109.0 | 2.72 | 1293. | 1.72 | 559. | 1.28 | 382.7 | .83 | 80.7 | .83 | 80.7 | .... | ..... |
| 20 | .93 | 111.0 | .77 | 63.9 | .82 | 78.0 | .69 | 49.2 | .90 | 101.1 | 1.20 | 237.6 | 2.58 | 1185.3 | 2.68 | 1255 | 1.72 | 579. | 1.42 | 335 4 | .85 | 86.0 | .84 | 83.3 | .... | .... |
| 21 | .90 | 101.1 | .74 | 61.4 | .81 | 75.4 | .61 | 43.2 | .90 | 101.1 | 1.21 | 243.2 | 2.83 | 1383.0 | 2.63 | 1235. | 2.34 | 1000.8 | 1.30 | 348.0 | .86 | 89.0 | .84 | 83.3 | .... | ..... |
| 22 | .87 | 91.9 | .70 | 54.9 | .82 | 78.0 | .68 | 51.9 | .92 | 107.5 | 1.23 | 271.4 | 3.03 | 1592.0 | 2.67 | 1278. | 3.27 | 1023.9 | 1.30 | 294 0 | .87 | 91.9 | .79 | 70.8 | ..... | ..... |
| 23 | .89 | 98.0 | .72 | 58.0 | .84 | 83.3 | .63 | 49.2 | .97 | 125.6 | 1.31 | 309.0 | 2.92 | 1431.0 | 2.70 | 1282. | 1.89 | 613 0 | 1.25 | 271.4 | .82 | 78.0 | .80 | 73.0 | .... | ..... |
| 24 | .86 | 88.9 | .75 | 73.2 | .87 | 91.9 | .54 | 33.8 | .91 | 114.5 | 1.37 | 331.0 | 2.85 | 1495.0 | 2.63 | 1225. | 1.63 | 502 | 1.23 | 282.7 | .80 | 73.0 | .82 | 78.0 | .... | ..... |
| 25 | .77 | 63.9 | .74 | 61.4 | .80 | 73.0 | .65 | 49.2 | .91 | 104.2 | 1.55 | 455.1 | 2.93 | 1453.0 | 2.60 | 1290 22 | 1.55 | 478.5 | 1.22 | 274.0 | .80 | 73.0 | .82 | 78 0 | .... | ..... |
| 26 | .72 | 58.0 | .79 | 70.8 | .80 | 73.0 | .62 | 44.4 | .99 | 101.1 | 1.59 | 474.5 | 3.07 | 1563.9 | 2.55 | 1163. | 1.48 | 403.6 | 1.20 | 238.0 | .80 | 73.0 | .82 | 78.0 | .... | ..... |
| 27 | .63 | 45.6 | .83 | 89.7 | .82 | 78.0 | .68 | 51.9 | .89 | 98.0 | 1.60 | 481 0 | 3.15 | 1654.0 | 2.54 | 1175. | 1.48 | 403.6 | 1.19 | 234 0 | .80 | 73 0 | .86 | 88 9 | .... | ..... |
| 28 | .71 | 56.5 | .77 | 63.9 | .84 | 83.3 | .78 | 63.7 | .89 | 98.0 | 1.53 | 435.5 | 3.22 | 1710.0 | 2.52 | 1159. | 1.41 | 369.2 | 1.10 | 183.0 | .80 | 73.0 | .86 | 88.9 | .... | ..... |
| 29 | .76 | 65.1 | .61 | 43.2 | .86 | 88.9 | .... | ..... | .88 | 84.9 | 1.43 | 372.6 | 3.15 | 1650.0 | 2.42 | 1052. | 1.39 | 348. | 1.09 | 178.0 | .75 | 65.1 | .87 | 88.9 | .... | ..... |
| 30 | .80 | 73.0 | .59 | 41.2 | .83 | 80.7 | .... | ..... | .82 | 78.0 | 1.42 | 355.4 | 2.98 | 1540.0 | 2.35 | 1046. | 1.37 | 335. | 1.05 | 159.0 | .72 | 58.0 | .86 | 88.9 | .... | ..... |
| 31 | .... | ..... | .57 | 39.4 | .82 | 78.0 | .... | ..... | .82 | 78.0 | .... | ..... | 3.01 | 1575.0 | .... | ..... | 1.42 | 355 4 | 1.03 | 150.3 | .... | ..... | .87 | 91.9 | .... | ..... |
| Sums. | 2333.1 | .... | 1994.4 | .... | 2515 | .... | 2214.4 | .... | 2638.5 | .... | 6035 3 | .... | 32373.16 | .... | 38418.2 | .... | 20103.4 | .... | 9001.48 | .... | 3100.1 | .... | 2191.86 | .... | 681.13 | |
| Means | 87.77 | .... | 64.34 | .... | 84.35 | .... | 79.09 | .... | 85.11 | .... | 200.21 | .... | 1044 30 | .... | 1280.67 | .... | 648.5 | .... | 290.5 | .... | 103.34 | .... | 83.48 | .... | 75.68 | |

This is a fair type of all our mountain streams, small in the fall, because there is no snow to be melted, and in the winter because the cold allows of no melting. With the returning heat of spring the stream begins to rise, and increases steadily as long as the temperature rises and the extent of snow to be acted on remains essentially the same. A shower increases the flow, and a cold spell lessens it. But in June the snow fields become diminished in extent, and as the snow remaining is largely packed in the gulches or sheltered by the timber, the flow gradually diminishes.

If the stream were more uniform in flow, or could its irregularities be lessened, the stream would be better for the needs of irrigation. It is interesting to compare the above flow, taken from the actual gaugings, with the flow which would best serve the needs of the irrigator. At my request, Mr. J. L. Armstrong, the Water Commissioner for this District, whose duties include the distribution of water among the various ditches, and who is therefore well acquainted by experience with their needs, has made an estimate of the amount of water which would fill the needs of the ditches in this water district in the various portions of the year, provided they could be assured of the amount given at each other period. This he desires to have considered as a preliminary estimate.

Thus, if the ditches could depend upon 2,500 cubic feet per second from June 10 to July 10, and the other amounts at the corresponding dates, then 250 feet would satisfy the needs from March 1 to April 15. As things are now, when there is uncertainty that there will be water enough later in the season, the tendency is to irrigate whenever water can be had, whether there is present need of it or not. This practice is necessarily to some extent more wasteful than if water could be applied when needed.

ESTIMATE OF THE QUANTITY OF WATER THAT WOULD BE REQUIRED TO SUPPLY DISTRICT NO. 3 DURING THE SEASON.

| From. | Cubic feet per second. |
|---|---|
| March 1 to April 15 | 250 |
| April 15 to May 10 | 500 |
| May 10 to June 1 | 1,000 |
| June 1 to June 10 | 1,800 |
| June 10 to July 10 | 2,500 |
| July 10 to August 1 | 1,800 |
| August 1 to September 1 | 1,200 |
| September 1 to October 1 | 750 |
| October 1 to November 1 | 350 |
| November 1 to December 1 | 250 |

A comparison with the table of discharge shows the faults to be found in the present distribution of the flow. Coming as it does without certainty of plenty when most needed, the irrigator is forced to use water when he can get it, and often when it would be better for the crops to wait to some subsequent time.

The flow of one cubic foot per second for twenty-four hours covers an acre two feet deep, correct within one per cent. and less than the error of the discharges, hence we have the actual flow of each of these months expressed in acre feet as follows:

| | | | |
|---|---|---|---|
| November, | 1889 | 5,266 | acre feet. |
| December, | " | 3,989 | " |
| January, | 1890 | 5,230 | " |
| February, | " | 4,429 | " |
| March, | " | 5,277 | " |
| April, | " | 12,012 | " |
| May, | " | 64,747 | " |
| June, | " | 76,836 | " |
| July, | " | 40,207 | " |
| August, | " | 18,009 | " |
| September, | " | 6,201 | " |
| October, | " | 4,990 | " |

Or a total for the twelve months of 248,193 acre feet; *i. e.*, enough to cover 248,193 acres one foot deep; or, this amount would be enough to cover 386 square miles one foot deep. As the area of the watershed of the Poudre above the measuring weir is 1,008 square miles, this is equal to a run-off of a sheet of water 4¾ inches deep over the whole area.

For these same twelve months the precipitation at the College was 11.21 inches, and at Middle Pine, the highest station reporting to us, the amount was 14.25 inches. The crest of the Divide varies from 11,000 to 14,000 feet in elevation. There are other mountains, not on the Divide, approaching this latter height. We can only estimate the precipitation on these higher areas. Pike's Peak has been the only high station in Colorado. Its average for thirteen years was 29.63 inches, nearly twice that of Denver for the same time. But in some years its precipitation was much less than that of Denver. The Continental Divide lies west of our watershed, and while not as high as the Front range, it is probable that it lessens the precipitation. Taking the basin as a whole, the average precipitation above the point where the gauging station is placed, may be fairly estimated at 14 inches. This being true, the total run-off equals one-third the precipitation.

## DUTY OF WATER.

Comparing the flow of the river during the irrigation season with the area cultivated, we get an approximation to the average duty of water as it has been in this valley during this year. It cannot, however, be said to be a just estimate, as the water was confessedly not sufficient. A just measure of the duty of water should be based on the amount that is sufficient to furnish the crop the needed amount of moisture. Much of the land this year did not receive all that was needed, and the late crops were suc-

cessful only because of the copious rains of August. We may take the season as from April to September, as the water between the first days of these months was nearly all used for irrigation, much of that of April being stored and used subsequently. In these five months the total flow was 211,811 acre feet, or, as the area watered from the waters of the river is very nearly 135,000 acres, it was equivalent to a depth of 18.6 inches over the irrigated area. Hence, during these five months each cubic foot per second was called upon to furnish water for 196 acres. This is greater than the duty when there is sufficient water, for as stated above, much land suffered from a scarcity.

In addition to the water from the river, there was a rainfall which amounted to 9.64 inches at the College—near the exit of the river from the foothills—and of about 8 inches at Greeley, at the lower end of the valley, or an average of over 8 inches from the rain. The total depth of water from both sources has then been nearly 27 inches.

The duty of water found for the whole district by the method above used, gives a result that seems excessive to all who are intimately acquainted with this valley. The method is defective, inasmuch as it does not take into account the areas which did not have sufficient water. To get the duty of water which is practically useful, we should know the amount that would be used if the irrigator had all that he needed, and at the times when he needed it, and a supply scant enough to insure that none goes to waste.

The duty found by taking the whole water district and dividing the total flow of water by the acreage, is misleading and unfair, as it gives results that are uniformly too large, unless in the years when there is an abundant supply.

Since the portion relating to the duty of the whole valley was in type, through the courtesy of Superintendent S. A. Bradfield, of the Cache a la Poudre Canal, we are enabled to make a comparison with a single canal.

DUTY UNDER THE CACHE A LA POUDRE CANAL NO. 2.

The Cache a la Poudre Canal No. 2 is one of the oldest of the large canals on the river, its last appropriation dating from 1877, and, consequently, it has usually enough water to supply its needs. The land underneath is farmed by those who have had a number of years of experience. The canal seems to be one which will give the fairest estimate of the duty of water in the Poudre Valley. Fortunately, the company kept a record of the depth of the water entering the canal for the greater portion of the past irrigating season, which is presented in the first of the following tables. The third table gives the official rating of the canal, or the amount flowing in cubic feet per second for various depths, and the second table gives the quantity entering the canal as shown by the other tables, with the assumed average flow for each day. The record begins May 27, but water had been running for some time previously, for how long or in what quantities we are not informed. But neglecting the flow before the beginning of the record, we observe that for the last four days in May the amount flowing into the canal equals the flow of 1,791 cubic feet per second for one day; in June, 10,425 cubic feet per second for one day; in July, 6,213; in August, 3,186, and for the portion of September here given, to 662, or, for the whole period, to 22,277 cubic feet per second for one day. As the flow of one cubic foot per second is sufficient to cover one acre two feet deep, very nearly, or two acre-feet in one day, the amount of water used by this canal from May 27 to September 10 was 44,500 acre-feet. As it is known with some

degree of accuracy that the area which depends on water from this ditch is between 24,000 and 25,000 acres, this flow would therefore be sufficient to cover the whole area with water over 21 inches deep. If the flow during May and April be added, this depth would be increased. The rainfall also increases the depth of the water that has been used on the land. In the interval covered by these measures, the average duty, excluding rain, is nearly 120 acres per second foot, while for the valley as a whole, as shown on page 66, it is 196 acres. During the month of June, water was used at the rate of 72 acres per second foot, assuming that all the land was irrigated. As a matter of fact, the irrigation of this month was confined almost entirely to the crops of cereals and alfalfa, which occupied about two-thirds of the 25,000 acres.

The above facts suggest that if one wishes to use the duty of water to determine the amount of water he will need to water a given area, that the *average* duty is very misleading, and that during the period when water is wanted in greatest quantities, the duty ordinarily taken as the basis of water rights in Colorado, viz., 55 acres per second foot, is the safer guide.

The writer hopes to develop this thought further at the end of another year.

## Observed Depths, Cache a la Poudre Canal No. 2, 1890.

S. A. BRADFIELD, Superintendent.

| Day. | May. | | June. | | | July. | | | August. | | September. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 a. m. | 6 p. m. | 5 p. m | 12 m. | 6 p. m. | 5 a. m. | 12 m. | 6 p. m. | 5 a. m. | 6 p. m. | 5 a. m. | 6 p. m. |
| 1 | ..... | ..... | 3.55 | ..... | 3.8 | 3.8 | .... | 2.1 | 2.2 | 1.6 | 1.35 | 1.4 |
| 2 | ..... | ..... | 3.7 | ..... | 3.9 | 2.6 | .... | 2.25 | 1.6 | 1.4 | 1.4 | 1.4 |
| 3 | ..... | ..... | 3.8 | ..... | 3.9 | 2.5 | .... | 2.1 | 1.4 | 1.4 | 1.35 | 1.4 |
| 4 | ..... | ..... | 3.25 | ..... | 3.7 | 2.7 | ... | ..... | 1.25 | 1.3 | 1.55 | 1.5 |
| 5 | ..... | ..... | 3.6 | ..... | 2.3 | 2.7 | 2.6 | 2.7 | 1.1 | ..... | 1.4 | 1.35 |
| 6 | ..... | ..... | 2. | ..... | 3. | 2.5 | 2.4 | 2.8 | ..... | ..... | 1.3 | 1.25 |
| 7 | ..... | ..... | 3. | ..... | 2.8 | 3. | .... | 3. | ..... | ..... | 2. | 1.15 |
| 8 | ..... | ..... | 2.6 | ..... | 2.9 | 2.7 | .... | 2.7 | ..... | ..... | 1.15 | 1.15 |
| 9 | ..... | ..... | 3.3 | 3.9 | 3.8 | 2.5 | .... | 3.4 | ..... | 1. | 1.1 | 1.1 |
| 10 | ..... | ..... | 3.7 | ..... | 3.8 | 3. | .... | 2.9 | 1.4 | 1.4 | 1. | .9 |
| 11 | ..... | ..... | 3.6 | ..... | 3.6 | 2.7 | .... | 2.7 | 2. | 2.6 | ..... | ..... |
| 12 | ..... | ..... | 3.6 | ..... | 3.7 | 2.6 | .... | 2.4 | 2.2 | 1.9 | ..... | ..... |
| 13 | ..... | ..... | 3.8 | 3.8 | ..... | 2.4 | .... | 2.3 | 2.1 | 2.1 | ..... | ..... |
| 14 | ..... | ..... | 3.2 | ..... | ..... | 2.3 | .... | 2.3 | 3.9 | 1.9 | ..... | ..... |
| 15 | ..... | ..... | 3.9 | 3.7 | 3.5 | 2.4 | .... | 2.8 | 2.7 | 1.9 | ..... | ..... |
| 16 | ..... | ..... | 3.3 | 3.2 | 3.4 | 2.7 | .... | 2.4 | 1.9 | 1.9 | ..... | ..... |
| 17 | ..... | ..... | 3.2 | 3.5 | 3.5 | 2.3½ | .... | 2.2 | 1.9 | 2. | ..... | ..... |
| 18 | ..... | ..... | 3.3 | 3.5 | 3.3 | 2.2 | .... | 2.2 | 1.7 | 1.7 | ..... | ..... |
| 19 | ..... | ..... | 3.3 | 3.6 | 3.65 | 2.3 | .... | 2.7 | 1.9 | 1.9 | ..... | ..... |
| 20 | ..... | ..... | 3.25 | 3.6 | 3.5 | 2.6 | .... | 2.3 | 2.4 | 2. | ..... | ..... |
| 21 | ..... | ..... | 3. | 3.4 | 3.35 | 2.5 | .... | 2.3 | 2.4 | 2.1 | ..... | ..... |
| 22 | ..... | ..... | 2.9 | 3.6 | 3.6 | 4. | .... | 2.5 | 1.9 | 2. | ..... | ..... |
| 23 | ..... | ..... | 3.3 | ..... | ..... | 3.7 | .... | 2.3 | 2. | 1.7 | ..... | ..... |
| 24 | ..... | ..... | 3.4 | 3.65 | 4. | 2.4 | .... | 2.2 | 1.9 | 1.9 | ..... | ..... |
| 25 | ..... | ..... | 3.1 | 3.4 | ..... | 2. | .... | 2. | 1.85 | 1.6 | ..... | ..... |
| 26 | ..... | ..... | 3.4 | 3.7 | 3.5 | 2.1 | .... | 2. | 1.55 | 1.5 | ..... | ..... |
| 27 | 3. | 3. | 3.4 | 3.5 | 3.4 | 2.2 | .... | 1.9 | 1.5 | 1.5 | ..... | ..... |
| 28 | 3.5 | 3.5 | 3.2 | 3.3 | 3.4 | 1.8 | ... | 1.8 | 1.5 | 1.5 | ..... | ..... |
| 29 | 3.6 | 3.7 | 2.8 | 1.8 | 1.8 | 1.7 | .... | 1.65 | 1.5 | 1.3 | ..... | ..... |
| 30 | 3.5 | 3.55 | 1.8 | ..... | *2.6 | 1.6 | .... | 1.55 | 1.5 | 1.5 | ..... | ..... |
| 31 | 3. | 3.7 | ..... | ..... | ..... | 1.6 | .... | 1.6 | 1.4 | 1.4 | ..... | ..... |

* 3 p. m.

**Amount of Water Taken Into the Cache a la Poudre Canal No. 2.**

| Day. | May. | | | June. | | | | July. | | | | August. | | | September. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 a. m. | 6. p. m. | Mean for day. | 5 a. m. | 12 m. | 6 p. m. | Mean for day. | 5 a. m. | 12 m. | 6 p. m. | Mean for day. | 5 a. m. | 6 p. m. | Mean for day. | 5 a. m. | 6 p. m. | Mean for day. |
| 1 | .... | .... | .... | 384 | .... | 438 | 411 | 438 | .... | 150 | 294 | 162 | 93 | 128 | 68 | 73 | 70 |
| 2 | .... | .... | .... | 417 | .... | 460 | 438 | 217 | .... | 169 | 193 | 93 | 73 | 83 | 73 | 73 | 73 |
| 3 | .... | .... | .... | 438 | .... | 460 | 449 | 203 | .... | 150 | 177 | 73 | 73 | 73 | 68 | 73 | 71 |
| 4 | .... | .... | .... | 325 | .... | 417 | 371 | 233 | .... | .... | 233 | 59 | 63 | 61 | 88 | 82 | 85 |
| 5 | .... | .... | .... | 395 | .... | 175 | 285 | 233 | 217 | 233 | 228 | 47 | .... | 23 | 73 | 68 | 70 |
| 6 | .... | .... | .... | 137 | .... | 282 | 210 | 203 | 189 | 248 | 213 | .... | .... | .... | 63 | 59 | 61 |
| 7 | .... | .... | .... | 282 | .... | 248 | 265 | 282 | .... | 282 | 282 | .... | .... | .... | 137 | 51 | 94 |
| 8 | .... | .... | .... | 217 | .... | 263 | 240 | 233 | ... | 233 | 233 | .... | .... | .... | 51 | 51 | 51 |
| 9 | .... | .... | .... | 333 | 460 | 438 | 410 | 203 | .... | 353 | 273 | .... | 39 | 20 | 51 | 51 | 51 |
| 10 | .... | .... | .... | 417 | .... | 438 | 427 | 333 | .... | 263 | 298 | 73 | 73 | 73 | 39 | 32 | 36 |
| 11 | .... | .... | .... | 395 | .... | 395 | 395 | 233 | .... | 233 | 233 | 137 | 217 | 177 | .... | .... | .... |
| 12 | .... | .... | .... | 395 | .... | 417 | 406 | 217 | .... | 189 | 203 | 162 | 126 | 144 | .... | .... | .... |
| 13 | .... | .... | .... | 438 | 438 | .... | 438 | 189 | .... | 175 | 182 | 150 | 150 | 150 | .... | .... | .... |
| 14 | .... | .... | .... | 316 | .... | .... | 316 | 175 | .... | 175 | 175 | 460 | 126 | 293 | .... | .... | .... |
| 15 | .... | .... | .... | 460 | 417 | 374 | 417 | 189 | .... | 248 | 218 | 233 | 126 | 180 | .... | .... | .... |
| 16 | .... | .... | .... | 333 | 316 | 353 | 334 | 233 | .... | 189 | 211 | 126 | 126 | 126 | .... | .... | .... |
| 17 | .... | .... | .... | 316 | 374 | 374 | 355 | 182 | .... | 162 | 172 | 126 | 137 | 131 | .... | .... | .... |
| 18 | .... | .... | .... | 333 | 374 | 333 | 347 | 162 | .... | 162 | 162 | 104 | 104 | 104 | .... | .... | .... |
| 19 | .... | .... | .... | 333 | 395 | 406 | 378 | 175 | .... | 233 | 204 | 126 | 126 | 126 | .... | ... | .... |
| 20 | .... | .... | .... | 325 | 395 | 374 | 365 | 217 | .... | 175 | 196 | 189 | 137 | 163 | .... | .... | .... |
| 21 | .... | .... | .... | 282 | 353 | 343 | 326 | 203 | .... | 175 | 189 | 189 | 150 | 170 | .... | .. | .... |
| 22 | .... | .... | .... | 263 | 395 | 395 | 351 | 483 | .... | 203 | 343 | 126 | 137 | 131 | .... | ... | .... |
| 23 | .... | .... | .... | 333 | .... | .... | 333 | 417 | .... | 175 | 296 | 137 | 104 | 121 | .... | .... | .... |
| 24 | .... | .... | .... | 353 | 406 | 483 | 414 | 189 | .... | 175 | 182 | 126 | 126 | 126 | .... | .... | .... |
| 25 | .... | .... | .... | 297 | 353 | .... | 325 | 137 | .... | 137 | 137 | 120 | 93 | 106 | .... | .... | .... |
| 26 | .... | .... | .... | 353 | 417 | 374 | 381 | 150 | .... | 137 | 144 | 88 | 82 | 85 | .... | .... | .... |
| 27 | 282 | 282 | 282 | 353 | 374 | 353 | 360 | 162 | .... | 126 | 144 | 82 | 82 | 82 | .... | .... | .... |
| 28 | 374 | 374 | 374 | 316 | 383 | 353 | 334 | 114 | .... | 114 | 114 | 82 | 82 | 82 | .... | .... | .... |
| 29 | 395 | 417 | 406 | 248 | 114 | 114 | 179 | 101 | .... | 98 | 101 | 82 | 63 | 73 | .... | .... | .... |
| 30 | 374 | 384 | 379 | 114 | .... | *217 | 165 | 93 | .... | 88 | 90 | 82 | 82 | 82 | .... | .... | .... |
| 31 | 282 | 417 | 350 | .... | .... | .... | .... | 93 | .... | 93 | 93 | 73 | 73 | 73 | .... | .... | .... |
| Sums | .... | .... | 1791 | .... | .... | .... | 10425 | .... | .... | .... | 6213 | .... | .... | 3186 | .... | .... | 662 |

* 3 p. m.

INTAKE CORRESPONDING TO DIFFERENT DEPTHS, CACHE A LA POUDRE CANAL NO 2.

| Depth. | Cubic feet per second. | Depth. | Cubic feet per second. | Depth. | Cubic feet per second. | Depth. | Cubic feet per second. |
|---|---|---|---|---|---|---|---|
| 2 | 1.56 | 1.2 | 55.12 | 2.2 | 162.49 | 3.2 | 315.70 |
| .3 | 3.52 | 1.3 | 63.44 | 2.3 | 175.28 | 3.3 | 333.32 |
| .4 | 6.26 | 1.4 | 72.71 | 2.4 | 189.17 | 3.4 | 353.18 |
| .5 | 9.78 | 1.5 | 82.17 | 2.5 | 202.92 | 3.5 | 373.62 |
| .6 | 13.93 | 1.6 | 93.12 | 2.6 | 217.15 | 3.6 | 394.63 |
| .7 | 19.00 | 1.7 | 103.82 | 2.7 | 232.55 | 3.7 | 417.18 |
| .8 | 25.26 | 1.8 | 114.16 | 2.8 | 247.74 | 3.8 | 438.37 |
| .9 | 31.94 | 1.9 | 125.95 | 2.9 | 263.40 | 3.9 | 460.29 |
| 1.0 | 39.15 | 2.0 | 137.28 | 3.0 | 281.56 | 4.0 | 483.37 |
| 1.1 | 46.51 | 2.1 | 149.63 | 3.1 | 296.93 | ... | ..... |

## IRRIGATION STATISTICS OF 1890.

In the older portions of the State, the insufficient supply of water for the existing ditches under the present systems has shown that the limit of new ditch construction is reached for the present. Thus District No. 3, in the Poudre Valley, is an example of most of the others of Divison I. The amount decreed to the various canals is 4,636 cubic feet per second. The canals would be well supplied with from 2,500 to 2,700, and the flow of the river averaged this year during the irrigation season less than 700 cubic feet. The new construction of ditches in the valley of the Platte is then only on a small scale, and consists largely in the development of sources of water other than the natural streams. But this scarcity has emphasized the necessity of conserving to the fullest extent the present supplies. Consequently there has been much discussion on the reservoir question in this section

of the State, and building, both on a small and a large scale.

The Arkansas Valley has been the field where canal construction has been the most active during the past year. Four canals of the first magnitude have been partly constructed, and bring under ditch an immense area. Several others have been enlarged or continued until they are among the large ones of the State. The area brought under ditch aggregates some 600,000 or 700,000 acres.

AREA UNDER DITCH.

The following is an estimate of the area under ditch in Colorado at the present time. By this area, we mean that which lies under the line of some existing canal, and could receive water from it by gravity. The possibility that there may not be sufficient water to supply these areas is not taken into account.

The estimate of areas as published in the annual report of the Colorado Agricultural Experiment Station for 1889, was based largely upon unpublished data, including maps of the routes of canals. The present one is based upon additional information of the same kind, supplemented by information collected by personal visits to various parts of the State, and includes the canals constructed during 1889–90, but only to the points where constructed. Still, the record must be looked upon as incomplete, especially for the divisions west of the Continental Divide. These divisions consist almost entirely of narrow mountain valleys, where the ditches are short and small, and where it is difficult to secure accurate data. In these divisions, the aggregate area may quite likely exceed that given here by a considerable amount. The estimate of 1889 made the area under ditch 4,500 square miles in round numbers, or 3,000,000 acres. The present estimate makes it to be more than a third greater. This

increase is not entirely due to new construction. The area assigned to Divisions IV., V. and VI. was shown by more complete information to be too small. But the area brought under ditch for the first time this year exceeds three quarters of a million of acres.

SQUARE MILES AND ACRES COVERED BY DITCH IN COLORADO.

| | | Sq. Miles. | Acres. |
|---|---|---|---|
| Div. I.—Platte below Poudre | 283.21 | | |
| Platte above Poudre, with Bear and Clear Creeks | 551.04 | | |
| St. Vrain and Boulder | 294.59 | | |
| Big Thompson | 134.21 | | |
| Poudre | 393.54 | | |
| North Park | 250 | | |
| South Park | 200 | | |
| District 65, added since last year | 40 | | |
| | | 2,146.59 | 1,373,817.6 |
| Div. II.—Arkansas river east of Pueblo, north side | 1,080.5 | | |
| Arkansas river east of Pueblo, south side | 139.2 | | |
| Huerfano, Cucharas, LaVeta, Apishapa and others | 173.6 | | |
| Upper Arkansas and Canon City and Fountain | 250 | | |
| | | 1,648.3 | 1,054,918 |
| Div. III.—San Luis | | 1,575 | 1,008,000 |
| Div. IV.—Dolores | 120 | | |
| Mancos | 60 | | |
| Pine | 20 | | |
| Florida | 10 | | |
| LaPlata | 7 | | |
| Animas | 50 | | |
| | | 267 | 170,880 |
| Div. V.—Grand River above Junction | 50 | | |
| Grand Junction | 120 | | |
| Montrose | 250 | | |
| Additional | 100 | | |
| | | 520 | 332,800 |
| Div. VI.—Bear and White rivers | | 200 | 128,000 |

Making a total of 6,336.89 square miles in the State, or 4,068,409 acres.

AREA IRRIGATED.

The following is an estimate of the area irrigated in some portions of the State during 1889 and 1890. The areas given for the various districts of Division I.

are mostly obtained from the official reports of the various Water Commissioners to the State Engineer. The amounts reported by them are generally based upon reports to them by the various ditch Superintendents, and while these cannot be looked upon as strictly accurate, they have the advantage of estimates made by men who are familiar with the lands watered by the various ditches. The area given for Division I. is the most reliable, followed by those for Divisions II. and III. The estimate for the other divisions may be very far from the truth, but are here given as a basis for correction.

| | Irrigated Area. | | |
|---|---|---|---|
| DIVISION I.—(Platte Division): | 1889. | 1890. | |
| District 1—South Platte | 24,175 | 16,775 | |
| " 64— " " | 24,610 | 24,610 | |
| " 2— " " | 49,419 | 51,000 | |
| " 8— " " | 20,297 | 20,297 | |
| " 3—Cache la Poudre | 135,000 | 139,227 | |
| " 4—Big and Little Thompson | 91,037 | 89,790 | |
| " 5—St. Vrain and Left Hand | 94,013 | 94,565 | |
| " 6—North and South Boulder | 77,683 | 81,175 | |
| " 7—Clear Creek | 87,926 | 104,671 | |
| " 9—Bear Creek | 4,965 | 4,893 | |
| " " (from reservoirs) | 5,191 | 3,201 | |
| North Park (est. of H. F. Sturdevant) | ..... | 75,000 | |
| South Park | ..... | 75,000 | |
| Republican River, Frenchman's Creek | ..... | 2,000 | |
| Total, | | | 782,204 |

| | Irrigated Area. | |
|---|---|---|
| DIVISION II.—(Arkansas Valley Division): | 1890. | |
| Arkansas River proper, under the Colorado and Kansas canal | 1,000 | |
| Amity | 4,000 | |
| Black's Canals | 2,000 | |
| Las Animas Town Ditch | 1,000 | |
| Riverside | 2,000 | |
| Jones | 2,000 | |
| A. R. L. R. & C. Co | 35,000 | |
| Rocky Ford Ditch | 4,000 | |
| Catlin | 10,000 | |
| Fowler or Oxford | 4,000 | |
| Private Ditches | 2,500 | |
| Total, Arkansas Valley below Pueblo | | 68,000 |

| | | |
|---|---|---|
| District 14 | 9,000 | |
| " 15 | 5,000 | |
| " 16 | 13,000 | |
| " 10 | 20,000 | |
| " 11 | 40,000 | |
| " 12 | 20,000 | |
| " 18 | 6,000 | |
| " 19 | 30,000 | |
| | | 143,000 |
| Total, Division II | | 211,000 |
| DIVISION III.—(Rio Grande Division): | | |
| District 20—Rio Grande River | 150,000 | |
| " 21—Alamosa | 50,000 | |
| " 22—Conejos | 35,000 | |
| " 24—Culebra | 5,000 | |
| " 25—San Luis Creek | 30,000 | |
| " 26—Saguache | 30,000 | |
| " 35—Trinchera | 20,000 | |
| Total, Rio Grande Division | | 320,000 |
| DIVISION IV.—(San Juan Division): | | |
| Total, rough estimate | | 75,000 |
| DIVISION V.—(Grand River Division): | | |
| Total, rough estimate | | 195,000 |
| DIVISION VI.—(Bear River Division): | | |
| Total, rough estimate | | 50,000 |
| Total for the State, approximate | | 1,635,000 |

MILEAGE OF CANALS IN COLORADO.

By adding the lengths of the canals in the various Districts, we obtain the following approximation to the lengths of the primary canals. With present knowledge it would be useless to make an estimate of the secondary. The estimate is quite reliable for all of Division I., with the exception of District 23, or South Park, and is closely approximate for most of Divisions II. and III.

| DIVISION I. | Miles. |
|---|---|
| District 1 and 64 | 238 |
| " 2 | 217 3/4 |
| " 3 | 340 2/3 |
| " 4 | 236.66 |
| " 5 | 250 |
| " 6 | 258 |
| " 7 | 255.63 |
| " 8 | 240.35 |
| " 9 | 62.25 |
| " 23 (estimated over 200 ditches) | 200 |
| " 46, 47, 48 (estimated are some 300 ditches) | 500 |
| " 65 | 50 |
| Total, Division I | 2,849.39 |

| | | |
|---|---|---|
| DIVISION II. | | |
| District 10 | 61.25 | |
| " 11 | 55.75 | |
| " 12 | 24.25 | |
| " 13 | 25 | |
| " 14 | 214 | |
| " 15 | 98.25 | |
| " 16 | 331.25 | |
| " 19 | 65 | |
| " 66 | 10 | |
| " 17 and 67 | 289 | |
| " 18 | 63 | |
| " 49 | 10.25 | |
| Total, Division II | | 1,247 |
| DIVISION III.—(Rio Grande Division): | | |
| San Luis Valley | | 1,476.75 |
| DIVISION IV. | | |
| Total (incomplete) | | 235 |
| DIVISION V. | | |
| Total (incomplete) | | 324.5 |
| DIVISION VI. | | |
| Total (incomplete) | | 184.25 |
| Total for the State | | 6,316.89 |

This is undoubtedly much too small. Throughout the mountain regions are numerous ditches, mostly short, but whose great number make a large number of miles.

### COST OF IRRIGATION WORKS IN COLORADO.

The following is a rough estimate of the cost of the irrigation works of Colorado. It cannot be considered other than an approximation, which is based on imperfect data, but as it is almost impossible to secure the data sufficient to make a perfectly reliable estimate, the above is furnished as the best that can be had at present, and in the belief that it is a fair estimate, not far from the truth. If anything, it is below the actual amount of money that has been invested, but it is my belief that with a more minute summation the sum total will not exceed

$15,000,000. The sums here given are based upon a personal knowledge of much of the State, and of the cost of most of the large canals. Each water district has been summed up separately, by adding the known cost of the individual canals, or the assumed cost based upon a more or less intimate knowledge of the size, length and circumstances of construction. These have been added, and the sum is given for each of the principal water districts east of the mountains. A summation of the capital stock of the corporations would give a sum in excess of this, but their capital stock is often much greater than the actual cost.

This estimate includes only the main canals, and does not include the capital invested in laterals, reservoirs, or other irrigation works.

ESTIMATED COST OF CANAL CONSTRUCTION.

| | | |
|---|---|---|
| DIVISION I. | | |
| Districts 1 and 64—South Platte, | $ 400,000 | |
| " 2—South Platte, | 300,000 | |
| " 8— " " | 900,000 | |
| " 23— " " | 100,000 | |
| " 3—Cache la Poudre, | 950,000 | |
| " 4—Big Thompson, | 600,000 | |
| " 5—St. Vrain, | 400,000 | |
| " 6—Boulder, | 400,000 | |
| " 7—Clear Creek, | 300,000 | |
| " 9—Bear Creek, | 200,000 | |
| " 46, 47 and 48—North Park, | 200,000 | |
| " 65—Republican, | 50,000 | |
| Total, | | $ 4,400,000 |
| DIVISION II. | | |
| District 67 and 17—Arkansas River, | $ 1,180,000 | |
| " 14— " " | 220,000 | |
| " 12— " " | 100,000 | |
| " 11— " " | 50,000 | |
| " 19—Purgatoire River, | 50,000 | |
| " 18—Apishapa, | 50,000 | |
| " 16—Huerfano, | 100,000 | |
| " 15—St. Charles, | 160,000 | |
| " 13—Grape Creek, | 50,000 | |
| " 10—Fountain, | 75,000 | |
| Total, | | $ 2,035,000 |

| | | | |
|---|---|---|---|
| DIVISION III. | | | |
| District 22—Conejos River, | | $ 225,000 | |
| " 21—LaJara, | | 100,000 | |
| " 24—Culebra, | | 40,000 | |
| " 35—Trinchera, | | 100,000 | |
| " 25—San Luis, | | 60,000 | |
| " 27—Carnero, LaGarita, | | 40,000 | |
| " 26—Saguache, | | 75,000 | |
| " 20—Rio Grande, | | 1,250,000 | |
| Total, | | | $ 1,890,000 |
| DIVISION IV. | | | |
| District 29—Piedra, etc., | | $ 50,000 | |
| " 30—Las Animas, | | 100,000 | |
| " 31—Pinos, | | 75,000 | |
| " 33—LaPlata, | | 50,000 | |
| " 34—Mancos, | | 100,000 | |
| " 32—McElmo, Hovenweep, | | 480,000 | |
| Total, | | | $ 855,000 |
| DIVISION V. | | | |
| Total, | | | 1,400,000 |
| DIVISION VI. | | | |
| Total, | | | 400,000 |
| Grand total for the State, | | | $10,980,000 |

## IRRIGATION LITERATURE.

One cannot attempt to study the irrigation question without being struck with the small number of works accessible to the English reader. And those in foreign languages are as often difficult to learn of as to procure. That difficulty of this kind has been felt at other Stations besides this, is evident by the requests that have been received for lists of titles. For the basis of an advance we need the means of knowing what other countries have done and are doing. The following list of works bearing on irrigation includes only those which are in the library, either of the College or Station, or in that of Professor Carpenter. An asterisk is prefixed to those in the latter collection. Short comments are given in some cases:

*A. RONNA. Les Irrigations. Firmin Didot, Paris. 3 vols.; 12mo. I. Les Eaux d'Irrigation et les Machines. 739 pp.; 1888. II. Les Canaux et les Systemes d'Irrigation. 618 pp.; 1889. III. Les Cultures Arrosees; l'Economie des Irrigations; Historie, Legislation et Administration. 810 pp.; 1890.

One of the most complete studies of irrigation in all its phases extant.

*J. CHARPENTIER DE COSSIGNY. Hydraulique Agricole. Boudry & Co., Paris. Second edition, 1889; 8vo.; 400 pp.

The best work of its class in any language. The first edition was published by the French Society of Agriculturists in 1874.

*J. KEELHOF, Chief Engineer of the Irrigation Service of Belgium. Traite Pratique de l'Irrigation des Prairies. Louvain and Paris. Second edition, two vols., 1888; Vol. I., text; Vol. II., atlas, of eleven plates.

The first edition has had a deservedly high reputation. The second is better. It contains experiments on the amount of water used in irrigation.

VILLEROY AND MULLER. Manuel des Irrigations. Maison Rustique, Paris. Second edition, 1867; 12mo.; 264 pp.; 123 cuts.

Has to do almost entirely with meadows.

F. VIDALIN. Pratique des Irrigations en France et en Algerie. Maison Rustique, Paris. Second edition, 1883; 12mo.; 156 pp.; 22 cuts.

This received the second premium at the French Agricultural Society.

*A. R. POLONCEAU. Des Eaux Relativement a l'Agriculture. Mathias, Paris, 1846; 12mo.; 256 pp.

*A. DE BAUVE. Des Eaux en Agriculture. Dunod, Paris, 1884; two vols.; text, 8vo., and atlas, 4to.

This is one of the excellent engineering manuals pre-

pared for the Ecole des Ponts and Chausseas. It treats of drainage and irrigation.

*N. DE BUFFON. Cours d'Agriculture et d'Hydraulique Agricole. Paris, 1853; three vols.; numerous plates.

Vol. I., 1853, devoted to agricultural crops and implements. oVl. II., 1855, mostly drainage. Vol. III., 1858, irrigation.

RAPHAEL PARETO. Irrigation et Assainissement des Terres. Roret, Paris, 1852; three vols. text, 16mo.; one vol. tables, 4to; one vol. plates, 4to.

*RAFAELE PARETO. Irrigazione e Bonificazione dei Terreni. Milano, 1855; two vols.; Vol. I., text; Vol. II., plates and tables.

This is an Italian translation and revision of the preceding by Angelo Parrochetti. It contains much valuable information. The Italian translation is more convenient than the French, because of the size of the volumes and type, as well as the valuable notes. The plates, however, are not so good.

*HERVE MANGON. Experiences sur les Emploi des Eaux dans les Irrigations. Paris, Dunod. Second edition, 1869; 8vo.; 198 pp.

A series of valuable experiments undertaken by Mangon, Engineer des Ponts and Chausses in 1859 and 1860, to determine if there was any reason why more water was used in cold climates than warm ones for irrigation. He therefore carried on experiments in the south of France, and in the Vosges, on various areas, measured the water applied to the soil, that running off, analyzed both the supply and the waste water to determine the change, if any, which had occurred.

*JAUBERT DE PASSA. Recherches sur les Arrosages chez les Peuples Anciens. Paris, 1846; six vols., bound in four; 8vo. Part I.—The Assyrian Empire. II.—Hindostan and the Valley of the Ganges. III.

—China. IV.—Syria, Arabia, Egypt. V.—Orient. VI.—Roman Empire, Sicily, etc.

These are extracted from the reports of the Royal and Central Agricultural Societies of France.

*ALFRED DEAKIN, M. P. Irrigation in Egypt and Italy. Govt, Melbourne; 12mo.; 146 pp.

This is the fourth progress report of the Royal Commission on Water Supply, of which Mr. Deakin is President. It is an admirable summary, in short space, of the irrigation in these countries.

W. WILLCOCKS. Egyptian Irrigation. Spon, London and New York, 1889; 8vo.; 367 pp.

H. L. ROTH. Continental Irrigation. Trubner, London, 1882; 8vo.; 34 pp.

Intended to give agriculturists an idea of the practical application of water. Notes on the Rhone Valley, Valentia, Grenada, Seville, Milan and Lucca.

C. C. SCOTT MONCRIEFF. Irrigation in Southern Europe. Spon, London, 1868; 12mo.; 372 pp.; numerous plates.

The report of a tour of inspection of the irrigation works of France, Spain and Italy for the government of India.

*VIGAN. Etude sur les Irrigations des Pyrenees Orientales. Paris, 1867; 8vo.; 70 pp.; one plate.

This is an investigation of the phenomenon known by the French as the Reproduction of Waters, or the return of the waters from irrigation to the stream through invisible sources, a phenomenon that is attracting some attention in Colorado at present. This investigation was begun to settle certain disputed claims between the canals of the mountains and plains of that valley. The mountain canals claimed that irrigation by them was actually beneficial to those on the plains, as the river was therefore more regular, and larger because of seepage, while

the plains people had attempted to close down those of the mountains, which were of later date.

*J. A. BARRAL. Irrigations de Vaucluse. Govt, Paris, 1887; two vols.; 4to.

Both volumes devoted to the canals of irrigation of a small department whose irrigated area is not more than 75,000 acres, much less than that in the Poudre Valley.

*ELIA LOMBARDINI. Dell Origine e del Progresso della Scienza Idraulica nel Milanesi ed in altre Parti d'Italia. Third edition. Milano, 1872; 4to; 78 pp.

Concerned with the labors of Leonardo da Vinci Castelli, Guglielmimi.

*ELIA LOMBARDINI. Dei Cangiamenti cui soggiacque l'Idraulica condizione del Po. Milan, 1858; 4to; 48 pp.

*NADAULT DE BUFFON. Des Canaux d'Irrigation de l'Italie Septentrionale. Two vols; 8vo., and 4to atlas; 1861–2; second edition.

Vol. I. contains descriptions of the canals of Northern Italy, the rules to be followed in establishing canals, and the action of irrigation upon plants. Vol. II. describes the practice of irrigation and the principal crops irrigated in Northern Italy, legislation and administration, rights of way, the litigation that has arisen, and has a brief bibliographical review. The atlas contains twenty-eight maps and plans of the irrigated portions of Italy, headgates, modules, aqueducts, divisors, siphons, etc.

BAIRD SMITH. Italian Irrigation. Blackwood & Son, Edinburgh. Second edition, 1855; two vols., 8vo., of 434 and 380 pp.; atlas, 4to, sixteen plates.

Largely a translation of the preceding.

*ALBERT HERRISSON. Irrigations de la Vallee du Po. Paris, Berger-Leorault, 1883; 8vo.; 220 pp.

This is from the annals of the Institute National Agronomique, fifth year. Herrison supplements Buffon's

account of the Italian canals, and gives full descriptions of the Cavour Canal.

*ORESTE CARTON ED ETTORE MARCOLONGO. Manuale dell'Ingegnere Agronomo e dell'Agricoltore. Second edition. Firenze, 1888; 652 pp.

*GIUSEPPE BRUSCHETTI. Raccolta delle opere Idrauliche e Technologie. Two vols., about 800 pp. 4to. Turin, 1864.

It includes the history of the canals of irrigation and commerce among the Milanese, and traces their history and the changes very thoroughly and minutely.

*MAURICE AYMARD. Irrigations du Midi de l'Espagne. One vol.; 8vo.; 324 pp.; atlas, 4to.; fifteen plates. LaCroix, Paris, 1864.

Gives valuable reports on the irrigations of Valence, of Jucar, of Murviedro, of Alamansa, Alicante, Elche, Murcia, Lorca, Nijar, Granada, Andalusia, and the Spanish management of waters. The atlas has fifteen plates, map of South Spain, maps and general features of the irrigation of various provinces, dams, etc.

*JAUBERT DE PASSA Voyage en Espagne, 1816–19; Huzard, Paris, 1823; two vols.; 8vo.; six plates.

Consists of a report on the legislation and irrigation of the province of Catelonia and Valencia.

AMERICAN IRRIGATION.

*RICHARD J. HINTON. Irrigation in the United States. Washington, Department of Agriculture, 1887; 8vo.; 240 pp.

*Report of the Special Committee of the United States Senate on the Irrigation and Reclamation of Arid Lands. Washington, 1890; 8vo.

Part 1—Report of the Senate Committee. (Part 2) Vol. I., The Northwest; 460 pp. (Part 3) Vol. II., The Great Basin Region and California; 574 pp. (Part 4) Vol. III., Rocky Mountain Region. (Part 5) Vol. IV.,

Various reports and miscellaneous papers. (Part 6) Irrigation in the United States, by Richard J. Hinton; 384 pp. The report contains the interviews with citizens from all parts of the United States, and a valuable mass of information, which has been summed up in the last part, by Col. Hinton. Both the above reports are invaluable to one studying American irrigation.

*ALFRED DEAKIN. Irrigation in Western America, so far as it is related to the circumstances of Victoria. Melbourne, 1885; 8vo.; 176 pp.

The best description of American irrigation extant.

*J. D. DERRY. Some of the Engineering Features of American Irrigation. Govt, Melbourne, Victoria; 4to; 46 pp., with twenty-one plates.

*Ex. Document 222, Fifty-first Congress. Report on the preliminary investigation to determine the proper location of artesian wells. Washington, 1890.

Contains much information in regard to irrigation from artesian sources.

COLORADO. Reports of the State Engineer:

1883–4, E. S. Nettleton. Second report; 90 to 112 pp. This gives the decreed appropriations for Districts 1 to 11, 14, 23, 24.

1885–6, E. S. Nettleton, engineer; 246 pp.

1887–8, J. S. Greene, engineer; two vols. Vol. I., 424 pp.; Vol. II., maps of various water districts, graphical discharge of the rivers, etc.

WYOMING. Second Annual Report of the Territorial Engineer, 1889; E. Mead, Engineer. Cheyenne, 1890; 8vo.; 100 pp.

DAVID BOYD. History of Greeley. 8vo.; 440 pp.

Throws much light upon the progress of irrigation and irrigation legislation in Colorado.

*CALIFORNIA. State Engineer's Report, sessionof 1880.

Part 4—Irrigation of the Plains, of 128 and 182 pp., is a valuable part. Includes report of W. H. Hall, of

128 pp., and appendices by J. D. Schuyler, of 182 pp. on Irrigation in Los Angeles and San Bernardino Counties. App. B—Irrigation in Kern County. App. C—Irrigation in Tulare and Fresno Counties. App. D—Irrigation in San Joaquin, etc.; Canals. App. E—Irrigation in Yolo County.

AUG. J. BOWIE, JR. Hydraulic Mining in California. New York. Second edition, 1887; 8vo.; 314 pp.

Gives more or less information regarding construction of dams, flumes, etc.

W. HAM HALL. Irrigation Development. Sacramento, Cal., 1886; 8vo.; 622 pp. The introductory part of the report of the State Engineer of California on irrigation and the irrigation question.

Vol. I. contains a compendium of the history, laws, customs and administrative systems relating to irrigation, water-courses, waters in France, Italy and Spain. Vol. II., Irrigation in Southern California, 1888; 672 pp.; San Diego, San Bernardino and Los Angeles Counties.

IRRIGATION IN AUSTRALIA.

Victorian Water Supply. First Annual General Report, 1887; 4to.; 28 pp. Third Annual General Report, 1889; 54 pp.

VICTORIA. Royal Commission on Water Supply. Progress Report, 1885; 304 pp.

Water Supply to the Lower Lodden.

Storage and Regulation of the River Lodden.

Irrigation in the Avoca Valley.

Irrigation in Egypt and Italy.

Reports on Victorian Irrigation Trusts:

Western Wimmera.

Eastern Wimmera.

Mincha.

Millewa.

Carrum.

Bairnsdale.
Wandella.
Yarrawonga.
Lake Charm.
North Boort.
Rochester.
Echueashire.
Echuea and Warauga.
Cohuna.
Schedule of Works of the Coliban System.
Report of Chief Engineer of Water Supply on the Coliban System.
Contracts, etc.

HYDRAULICS, EXPERIMENTS, ETC.

*BENEDETTO CASTELLI. Della Misura dell'Acque Corriente. Rome, 1639; 72 pp.

Castelli was a pupil of Galileo. The work is one of the first that attempted to study hydraulics, and is historically valuable. The above seems to be the second edition.

*DOMENICO GUGLIELMINI. Della Natura de' Fiumi. Enlarged edition, Milan, 1852; two vols.; 8vo.; about 300 pp. each.

A mathematical and physical treatise, written at the close of the 17th century. One of the earliest works.

THOS. TREDGOLD. Tracts on Hydraulics. Second edition. Spon, London, 1862.

Contains Smeaton's experiments with Water and Wind Mills; Venturi's Experiments on the Motion of Fluids; Young's Summary of Practical Hydraulics.

LOWIS D'A. JACKSON. Hydraulic Manual. Fourth edition. Crosby, Lockwood & Co., London, 1883; 12mo.; 308 and 184 pp.

NATHANIEL BEARDMORE. Manual of Hydrology. Waterlow & Sons., London, 1872; 8vo.; 388 pp.

*M. LESBROS. Experiences Hydrauliques sur les Lois de l'Ecoulement de l'Eau. Made in 1828, 1829, 1831 and 1832.

This is published among the Memoires Presentes Par divers Savants a l'Academie des Sciences de l'Institut National de France, and forms a volume of some 580 pp., together with thirty-seven plates. This work forms the continuation of the one presented to the Academy in 1829 by Poncelet and Lesbros.

*DARCY AND BAZIN. Recherches Hydraulique Enterprises per M. H. Darcy, continuees per M. H. Bazin. Dunod, Paris, 1865; 4to. Part I.—Recherches Experimentales sur l'Ecoulement de l'Eau dans les Canaux Decouverts. 500 pp. text, with plates. Part II.—Sur les Propagations des Ondes.

*CESARE CIPPOLETTI. Il Canale Villoresi, Modulo per la Dispensa delle Acque. Published by the Societa Italiana per la Condotte d'Acque. Milan, '86.

This includes a thorough study of the sources of error in weir measurement, the means of partially avoiding them, and the proposal of a new module, based on the weir, but trapezoidal in form, and designed to automatically neutralize the contraction, which is a source of disturbance in the rectangular weir. The considerations adduced by him are further treated of in Bulletin No. 13, of the Colorado Agricultural Experiment Station, 1890.

A. E. BOWSER. Hydro Mechanics. Van Nostrand, New York, 1886; 12mo.; 298 pp.

MANSFIELD MERRIMAN. A treatise on hydraulics. Wiley, New York; second edition, 1890; 384 pp.

THOS. CRAIG. Theory of Fluid Motion. Van Nostrand, New York, 1879.

Entirely mathematical.

P. M. RANDALL. Practical Hydraulics. Dewey & Co., San Francisco, 1886; 12mo.; 250 pp.

HAMILTON SMITH, JR. Hydraulics, the flow of water through orifices, over weirs, and through open conduits and pipes. Wiley, New York, 1886; 4to; 362 pp.

J. B. FRANCIS. Lowell Hydraulic Experiments. Van Nostrand, New York, 1883. Fourth edition, 286 pp.; twenty-three plates.

Includes the experiments on which the weir formula are based.

J. T. FANNING. Treatise on Hydraulic and Water Supply Engineering. Van Nostrand, New York, 1887. Sixth edition. 8vo.; 644 pp.

GANGUILLET AND KUTTER. Flow of Water in Rivers and other Channels. Translated and increased by R. Hering and J. C. Trautwine, Jr. Wiley, New York, 1889; 8vo.; 240 pp.

This contains over 1,200 gaugings, compared with Kutter's formula. Invaluable for the practicing engineer.

P. J. FLYNN. Hydraulic tables, based on Kutter's formula. Van Nostrand, New York, 1883; 18mo.; 136 pp.

M. A. GRAEFF. Traite d'Hydraulique. Govt, Paris. 4to.

Part 1—Theoretical; 330 pp.; 1882. Part 2—Practical; 530 pp.; '83 Part 3—Tables and plates; '83.

CAPT. ALLAN CUNNINGHAM. Roorkee Hydraulic Experiments. Roorkee, India, Thomason College Press. 8vo.; 1880–81; Vol. I., text, 400 pp.; Vol. II., tables, 156 and 50 pp.; Vol. III, fifty-two plates.

An excellent and valuable set of experiments performed on the Ganges canal.

JOHN NEVILLE. Hydraulic tables, coefficients and formulas. Lockwood & Co., London. Third edition, 1875; 12mo.; 494 pp.

J. C. TRAUTWINE, JR. Trautwine's Engineer's Pocket-Book. Wiley, New York. 12mo.; 832 pp.

Has convenient tables of the coefficients for the Kutter formula.

*GUSTAVE WEX. First treatise on the decrease of water in springs, creeks and rivers. Translated by Weitzel. Washington, 1881; 8vo.; 58 pp.

L. F. VERNON-HARCOURT. Rivers and Canals. Two vols, 8vo.; Clarendon Press, 1882. Vol. I., text, 348 pp.; Vol. II., plates, 21 pp.

J. BAILEY DENTON. The Storage of Water. Spon, London, 1874; 8vo.; 18 pp.

HARRY POOL SLADE. On Dew Ponds. Spon, London, 1877; 8vo.; 32 pp.

CHAS. H. BELOE. On the construction of catch-water reservoirs. Spon, London, 1872; 8vo.; 48 pp.

ARTHUR H. JACOB. Storage Reservoirs. Van Nostrand, New York. 18mo.

EDWARD WEGMANN, JR. The Design and Construction of Masonry Dams. Wiley, New York. Second Edition, 1889; 112 pp.; 4to.; sixty-two plates.

LEGAL.

*S. W. CARPENTER. The Law of Water for Irrigation in Colorado. Lawrence & Co., Denver. 12mo.; 128 pp.

*G. GIOVANETTI. Il Regime delle Acque. G. Giovanetti, with references to Romagnosi, by G. Foschini. Naples. Third edition, 1883; 12mo.; 240 pp.

*NADAULT DE BUFFON. Des Usines et Autre Etablissements sur les Cours d'Eau. Paris, 1874; two vols.; 8vo.

Principally decisions and results obtained in France in the conflict between irrigation and previous rights. Vol. I., Navigable Rivers and Canals. Vol. II., Non-Navigable Rivers and Canals.

*ANTONIO ASCONO. Manuale Teorico-pratico sull' uso delle Acque per la Derivazione e la Condotta di esse e per le Irrigazione de' Campi, etc. Milan, Silvestri, 1836; 8vo.; 176 pp.; one plate.

## METEOROLOGICAL OBSERVATIONS AND TABLES.

### PRECIPITATION.

The larger part of the precipitation which we have occurs in the spring and summer months. The winter months furnish but little, and this, which is in the form of snow, ordinarily lasts but a short time. The winter months are almost entirely free from storms, the average of the stormy days for some years back being but 1.3 for December, 3.6 for January, 2.3 for February. The heaviest months are April, May and June, followed by October and July. The storms of June, July and August are local in character, with precipitation varying from nothing to a fair fraction of an inch. A general rain is not usual in those months. The prevailing type is the afternoon thunder shower which rarely arises before 1 p. m., covering a local area. But the local storm areas are so numerous that frequently one may see from one to five or six in progress along the flanks of the foothills. Thus, while one shower covers but a limited area, the precipitation is quite fairly distributed. These showers are first seen as they come over the second range of "hog-backs," 2,000 feet above us, forming our western horizon. When precipitation is proceeding a peculiar filamentous structure of the clouds is perceived extending downward from the clouds towards the earth. It is popularly believed that these storms are more frequent in certain localities than others, due to the influence of certain peaks lying near. After the passage of one of these showers, which is as sudden as its arrival, the sun radiates with increased energy, and thus, with the alterations of moïsture and radiation, form the conditions when vegetation grows with great rapidity.

The relative distribution of our precipitation is shown in the accompanying table, giving all the records now known. It is unfortunate that some of the early records

have been lost. But as it is, our normal precipitation is fairly indicated by a record averaging nearly ten years. While our precipitation is small, it is so distributed through the year, with the heaviest falls when moisture is needed by the crops, that it is equivalent to a much greater fall differently distributed. May is the month of greatest rainfall, followed by the other growing months of April, June and July. November and December are the least. Below is the precipitation by months:

| YEAR. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1872 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .02 | .20 | ..... |
| 1873 | .25 | .16 | *00 | 1.20 | 2.30 | 1.50 | 1.39 | .85 | .75 | .42 | .20 | .17 | 9.19 |
| 1874 | .06 | .43 | 1.20 | .77 | 2.95 | .65 | 3.15 | .25 | *.0 | 1.00 | .02 | .00 | 10.48 |
| 1879 | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1.75 | .15 | .60 | ..... |
| 1880 | .72 | 1.09 | .38 | .94 | .60 | .86 | 1.80 | .37 | 1.47 | 2.07 | .... | .10 | ..... |
| 1881 | 1.10 | .55 | 1.45 | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| 1882 | .... | .... | .17 | .... | 4.67 | 3.07 | 1.76 | .89 | 2.51 | .82 | .29 | .... | ..... |
| 1883 | 1.00 | 1.50 | .68 | .... | 2.51 | 3.18 | .... | 1.78 | 1.00 | 1.29 | T | 1.33 | ..... |
| 1884 | 1.10 | .70 | 1.15 | 3.94 | 4.84 | .... | .... | .... | .... | .10 | 1.80 | .35 | ..... |
| 1885 | 1.77 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... |
| 1887 | .86 | .23 | .45 | 1.10 | 1.23 | 1.96 | 3.05 | 2.12 | .54 | .48 | .15 | .00 | 12.12 |
| 1888 | .29 | .36 | .73 | 1.23 | 3.39 | .47 | .60 | 1.01 | .29 | .88 | .38 | .16 | 9.79 |
| 1889 | .21 | .34 | .65 | 2.07 | 3.39 | 2.06 | .79 | .95 | .42 | 3.16 | .43 | .015 | 14.48 |
| 1890 | .13 | .21 | .22 | 3.92 | 1.19 | .12 | 1.27 | 3.14 | .07 | .70 | .32 | .12 | 11.41 |
| Average | .68 | .56 | .65 | 1.89 | 2.71 | 1.54 | 1.72 | 1.27 | .78 | 1.15 | .35 | .28 | 13.58 |

* Records incomplete. T Trace.

## PRECIPITATION, 1890.

The precipitation of 1889 was slightly above the normal, in consequence of the heavy rainfall of October. This put the ground in good condition for the winter, and irrigation was not needed as early as it usually is. But the precipitation of 1890 has been below the normal for every month save April and August, which were each nearly two inches above the average for those months. The table following gives the comparison of 1890 and normal:

## PRECIPITATION, 1890, COMPARED WITH THE NORMAL.

| MONTH. | 1890. | Greater than Normal. | Less than Normal. |
|---|---|---|---|
| January | .13 | .... | .55 |
| February | .21 | .... | .35 |
| March | .22 | .... | .43 |
| April | 3.92 | 2.03 | .... |
| May | 1.19 | .. . | 1.52 |
| June | .12 | .... | 1.42 |
| July | 1.27 | .... | .45 |
| August | 3.14 | 1.87 | .... |
| September | .07 | .... | .71 |
| October | .70 | .... | 7.45 |
| November | .22 | .... | .03 |
| December | .12 | .... | .16 |
| Year | 11.41 | .... | 2.17 |

## TOTAL PRECIPITATION TO THE END OF EACH MONTH COMPARED WITH THE NORMAL.

| MONTH. | 1890. | Normal. | Greater than Normal. | Less than Normal. |
|---|---|---|---|---|
| January | .13 | .68 | ... | .55 |
| February | .34 | 1.24 | .... | .90 |
| March | .56 | 1.89 | .... | 1.33 |
| April | 4.48 | 3.78 | .70 | ... |
| May | 5.67 | 6.49 | .... | .82 |
| June | 5.79 | 8.03 | .... | 2.24 |
| July | 7.06 | 9.75 | .... | 2.69 |
| August | 10.20 | 11.02 | .... | .82 |
| September | 10.27 | 11.80 | .... | 1.53 |
| October | 10.07 | 12.05 | .... | 1.98 |
| November | 11.29 | 13.30 | .... | 2.01 |
| December | 11.41 | 13.58 | .... | 2.17 |

PRECIPITATION IN THE POUDRE VALLEY.

During the past, as the previous year, a number of observers in this valley have co-operated with us in measuring the rainfall. It was our desire to obtain as accurate a measure as posssble of the rainfall above the measuring weir located in the river. It has been difficult to find observers at the high altitudes, and in fact during the winter months there are very few who remain at an elevation greater than 8,000 feet.

The localities and the observers from whom reports have been received are:

Upper Pine — Elevation foom 8,000 to 8,500 feet, thirty-five miles from the foothills; T. W. Halliday, observer, until August, when the reports were continued by S. J. Perry.

Middle Pine—Near Livermore, elevation 6,000 feet; twelve miles from the foothills; observations carried on by G. C. Burnham, and subsequently by C. Gilpin-Brown, at the same place. During the winter, in the absence of Mr. Burnham, the records are lacking.

Elkhorn—Elevation about 7,300 feet, twenty-three miles from the foothills. Observations were begun here by Dr. G. A. Norman, and on his moving away, in January, they were carried on by R. C. Boyle and John Pearce.

Laporte—Elevation, 5,200 feet; on the plains where the river breaks its way through the foothills. Observations were furnished by N. C. Garbutt for some time, until removal, and since by Charles Gilkison.

Pinkhampton—In North Park, about — miles from the eastern rim of the Park. Observations were begun by Miss Lucy Bell, and continued at the same location by Miss Fanny L. Barnes.

Several others in the mountains have gauges, but we have few or no reports.

The Grass Station is the one used for the United States Department of Agriculture; four miles north of Fort Collins, Miss Grace Birdsall, observer.

Middle Box Elder is about five miles northeast of the College. Observations have been continued by Mr. E. F. Kerr.

Leroy is located a hundred miles east of the foothills, near Sterling. Mr. Chas. Green has furnished careful reports.

The other stations given in the summary, excepting our own sub-stations, have reported to the signal service, and from their records we have derived the amounts here given. In regard to their location, it may be added that Greeley is twenty miles southeast of us; Hardin is fifteen miles farther east, Sterling still farther east by eighty miles, and Julesburg is at the extreme northeastern corner of the State, or about 175 miles from the foothills.

The elevation of these points is: Greeley, 4,637; Hardin, 4,513; Sterling, 3,920; Julesburg, 3,456.

Fort Morgan is about fifty miles east of Greeley, and Brush eight miles farther east, both on the Burlington Railway, but near the Platte River. Their elevation, as furnished by I. S. P. Weeks, Chief Engineer, is 4,319 and 4,228 feet respectively.

Longmont is situated thirty miles south, at about the same distance from the foothills as Fort Collins, and at very nearly the same elevation. Denver is at a greater distance from the foothills and at an elevation of about 5,200 feet.

The Agricultural College at Fort Collins is located four miles from the foothills, and is at an elevation of 5,000 feet.

TABLE OF PRECIPITATION.

The monthly records in the annexed tables do not show at first sight as great increase in precipitation with elevation as we might be inclined to expect. At this date, December 1, too many months are lacking to make a very fruitful comparison. But it seems evident that there is some increase in precipitation with increase of elevation. Thus, from the records of last year, we have the following table to show the influence of elevation upon precipitation:

COMPARISON FOR THE SIX MONTHS ENDING JAN. 1, 1890.

| STATION. | Elevation. | PRECIPITATION FOR | | |
|---|---|---|---|---|
| | | 5 months. | 6 months. | Year ending Nov. 1. |
| College | 4990 | 4.97 | 5.76 | 11.43 |
| Laporte | 5060 | 4.79 | | |
| Box Elder | 4950 est. | 4.77 | 5.34 | |
| Livermore | 6000 | 6.15 | 7.62 | |
| Elkhorn | 7300 | 6.67 | 8.41 | |
| Upper Pine | 8000-8500 | 6.49 | 8.05 | 14.05 |

In comparing the time at which storms begin at the various stations, it is noticeable that the storms by no means begin first at the upper stations, but quite as frequently at the lower, or more frequently still, at those of intermediate elevation. As the hours have in general not been observed with care, these times may be misleading.

COMPARATIVE MONTHLY PRECIPITATION FOR 1890 AT CO-OPERATING STATIONS.

| STATIONS. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pinkhampton | .... | .... | .... | .... | .30 | .... | .... | 2.01 | .15 | .43 | .23 | .27 | .... |
| Upper Pine | .55 | 1.47 | 1.37 | 2.72 | 1.72 | .30 | 2.00 | 1 64 | .60 | 1.10 | .00 | .... | ... |
| Elkhorn | .... | .... | . | .... | .... | .03 | 1.60 | 2.23 | .37 | 1.07 | .07 | .02 | .... |
| Middle Pine | .... | .... | .... | 2.90 | .62 | .02 | 1.15 | 2.34 | .13 | .62 | .26 | .... | .... |
| Laporte | .... | .... | .... | .... | 1.06 | .03 | 1.39 | 2.21 | .00 | .70 | .35 | .12 | .... |
| Fort Collins | .13 | .21 | .22 | 3.92 | 1.19 | .125 | 1.27 | 3.137 | .07 | .695 | .32 | .12 | 11.41 |
| Middle Box Elder | .09 | .20 | .08 | 4.56 | 1.33 | .04 | 1.49 | .... | .... | .... | .... | .14 | .... |
| Grass Station | .... | .... | .... | 4.48 | .... | .00 | 1.28 | 2.13 | .02 | .87 | .44 | .18 | .... |
| Greeley | .10 | .25 | .36 | .... | 1.21 | .14 | .... | 1.67 | .... | .... | .... | .... | .... |
| Hardin | .18 | .05 | .05 | .... | .96 | .... | 1.12 | 3.80 | .... | .... | .... | .... | .... |
| Fort Morgan | .... | .03 | T | 2.35 | .89 | .37 | 2.94 | 1.24 | .00 | 1.00 | .... | .... | .... |
| Brush | .30 | .57 | T | 2.38 | .37 | .... | 1.33 | .99 | .01 | .92 | .40 | .... | .... |
| Le Roy | .30 | .48 | .01 | 2.80 | 1.03 | 1.96 | .47 | 1.41 | T | .98 | .48 | .... | .... |
| Sterling | .... | .... | .. | .... | .... | 1.08 | .56 | .85 | .... | 1.06 | .... | .... | .... |
| Julesburg | .... | .... | .... | 3.07 | 2.54 | 1.72 | .68 | .50 | .49 | .... | .00 | .... | .... |
| Longmont | .35 | .... | .... | 5.72 | .... | .19 | .42 | 2.75 | .16 | .... | .... | .... | ... |
| Denver | .18 | .46 | .35 | 2.50 | 2.01 | T | .79 | 1.89 | .17 | .64 | .30 | .04 | 9.33 |
| San Luis Ex. Station. | .10 | .65 | .02 | 3.49 | .02 | .21 | 1.27 | .91 | 1.33 | .21 | .55 | .00 | 8.77 |
| Ark. Val'y Ex. Stat'n. | .34 | .15 | .15 | 2.97 | .29 | .77 | 1.14 | .74 | .08 | .00 | .30 | .00 | 6.93 |

T Trace.

DEW AND FROST.

The amount of moisture furnished by dew and frost should be added to the amount, but until there is some satisfactory and standard method of estimating them, it is unsatisfactory to attempt it. Dew and frost are both local phenomena, and unlike the fall of rain, their copiousness will vary with the substance on which they fall, with its radiating power and its relation to other bodies. It is more commonly copious here after irrigation, for the atmosphere is then in a saturated, or nearly saturated,

condition immediately over the plat, and cannot cool far without depositing some of it. But though the source in such a case is not far to seek, it would seem that it should still be counted as gain, for when once in the air it may be called lost. Unless the conditions are favorable, it does not return.

The last frost occurred on June 7, and the first one in the fall on August 26. The first one doing damage occurred September 8. The number of times that dew and frost were observed each month is given in the annual summary at the close of this report.

### DEW POINT AND RELATIVE HUMIDITY.

Every one knows that the atmosphere is rarely saturated with water vapor, and also that much more may be held in suspension when the temperature is high than when it is low. By relative humidity is meant the proportion between the moisture actually present in the air, and the amount which the air would contain if completely saturated. If the temperature of the air were gradually lowered without losing any of its moisture, it would finally reach a temperature at which it would be saturated. This temperature is known as the temperature of dew point. It shows the amount of moisture present in the air. From knowing the dew point, the amount of moisture present may be obtained by means of the experiments of physicists. The dew points in summer are noticed by the following table to be much higher than in winter, but because of the higher temperature, and consequently the greater power of the air to hold moisture, the relative humidity is no higher than in the winter—in fact it is much lower.

During "Chinook" winds, the relative humidity is very much lowered. The "Chinooks" are the winds from the west, which having come over the mountains with the precipitation of all, or a large part, of their moisture, the compression due to their descent induces a much higher temperature, due to the less specific heat, than it had before the rise. During the prevalence of a "Chinook" every strong gust is indicated by a rise of the self-registering thermometer.

## DEW POINT AND RELATIVE HUMIDITY FOR 1890.

| Day. | January. | | February. | | March. | | April. | | May. | | June. | | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. |
| 1 | 5.85 | 66.50 | 17.10 | 73.00 | 2.85 | 81.00 | 21.35 | 81.00 | 42.80 | 83.50 | 45.95 | 53.325 | 49.45 | 53.00 | 55.60 | 64.60 | 54.35 | 72.45 | 33.40 | 56.10 | 17.45 | 39.10 | 17.30 | 56.60 |
| 2 | 3.50 | 100.00 | 23.00 | 40.50 | 16.65 | 49.00 | 25.75 | 75.00 | 43.85 | 83.50 | 39.65 | 40.00 | 50.25 | 60.00 | 52.55 | 55.65 | 55.20 | 72.05 | 34.30 | 58.10 | 29.00 | 55.50 | 20.20 | 64.90 |
| 3 | 8.25 | 92.00 | 24.30 | 47.50 | 17.35 | 65.00 | 19.40 | 26.00 | 41.85 | 65.00 | 42.05 | 56.45 | 55.30 | 68.50 | 50.55 | 56.50 | 46.15 | 54.20 | 22.05 | 41.35 | 22.15 | 60.30 | 19.90 | 66.05 |
| 4 | 9.25 | 95.00 | 26.30 | 48.00 | 20.85 | 49.50 | 24.30 | 45.00 | 41.30 | 77.00 | 24.25 | 32.05 | 55.85 | 64.50 | 55.95 | 75.40 | 49.10 | 63.15 | 26.55 | 70.50 | 13.55 | 35.60 | 24.60 | 74.80 |
| 5 | 15.40 | 97.50 | 31.95 | 85.00 | 31.65 | 94.50 | 27.50 | 37.00 | 32.45 | 58.50 | 30.15 | 33.00 | 52.95 | 60.50 | 51.00 | 60.20 | 42.15 | 55.05 | 25.00 | 66.05 | 18.45 | 34.50 | 25.50 | 87.20 |
| 6 | 16.75 | 92.50 | 22.10 | 63.00 | 18.50 | 40.00 | 27.30 | 44.00 | 34.10 | 58.50 | 30.50 | 45.35 | 55.00 | 60.55 | 42.65 | 43.60 | 35.80 | 47.05 | 30.25 | 47.15 | 20.85 | 79.70 | 23.05 | 100.00 |
| 7 | 7.95 | 100.00 | 18.60 | 89.00 | 24.45 | 68.00 | 24.65 | 31.00 | 35.80 | 49.50 | 39.20 | 63.10 | 55.90 | 53.75 | 47.30 | 36.95 | 33.25 | 61.70 | 24.40 | 48.35 | 25.25 | 95.20 | 21.25 | 95.40 |
| 8 | 13.95 | 91.50 | 14.60 | 61.50 | 22.90 | 61.00 | 5.75 | 27.00 | 41.75 | 62.50 | 39.50 | 58.50 | 57.30 | 66.00 | 50.25 | 60.45 | 36.85 | 60.10 | 30.90 | 73.85 | 21.45 | 100.00 | 10.55 | 94.35 |
| 9 | 13.55 | 53.00 | 14.80 | 65.00 | 15.15 | 28.00 | 13.10 | 35.00 | 41.15 | 80.50 | 41.75 | 53.30 | 57.60 | 60.00 | 54.65 | 63.50 | 32.80 | 42.90 | 35.85 | 99.10 | 16.60 | 98.85 | 21.10 | 72.30 |
| 10 | 15.90 | 64.00 | 18.70 | 78.00 | 16.80 | 69.50 | 15.10 | 26.50 | 40.80 | 79.00 | 48.75 | 57.25 | 57.20 | 63.20 | 59.80 | 82.60 | 38.55 | 45.90 | 43.35 | 84.00 | 24.05 | 94.40 | 18.25 | 53.00 |
| 11 | 10.15 | 96.50 | 5.25 | 52.50 | 7.50 | 51.50 | 18.25 | 22.00 | 35.60 | 50.50 | 47.60 | 56.10 | 57.90 | 64.10 | 59.75 | 79.60 | 38.35 | 39.10 | 34.45 | 61.00 | 25.95 | 80.90 | 20.20 | 67.05 |
| 12 | -2.85 | 100.00 | 9.10 | 71.50 | 3.90 | 51.50 | 29.95 | 60.50 | 35.95 | 68.00 | 41.40 | 56.15 | 43.80 | 38.00 | 56.65 | 81.05 | 32.60 | 60.15 | 30.90 | 71.10 | 25.75 | 95.90 | 16.40 | 88.20 |
| 13 | 6.45 | 81.00 | 17.90 | 64.50 | 5.80 | 43.00 | 32.55 | 97.00 | 27.85 | 42.00 | 47.55 | 62.80 | 52.20 | 37.90 | 58.90 | 91.15 | 21.15 | 29.75 | 21.95 | 57.10 | 24.55 | 87.20 | 22.00 | 50.60 |
| 14 | 8.70 | 100.00 | 11.70 | 67.50 | 12.80 | 43.00 | 34.05 | 97.50 | 28.00 | 37.00 | 41.75 | 49.55 | 50.90 | 53.90 | 62.40 | 86.85 | 32.40 | 44.70 | 27.35 | 78.45 | 23.65 | 70.20 | 15.65 | 78.40 |
| 15 | 3.10 | 95.00 | ..... | ..... | 15.25 | 51.50 | 31.35 | 89.50 | 35.45 | 81.00 | 40.60 | 49.15 | 57.10 | 65.00 | 59.30 | 84.55 | 35.70 | 51.60 | 1.65 | 33.20 | 15.40 | 83.00 | 8.55 | 29.30 |
| 16 | 9.65 | 65.00 | 7.10 | 41.00 | 13.25 | 40.50 | 31.75 | 80.60 | 44.55 | 72.00 | 41.05 | 50.05 | 57.60 | 59.60 | 54.90 | 82.10 | 35.55 | 42.35 | 21.70 | 53.60 | 15.25 | 78.95 | 8.20 | 78.40 |
| 17 | 12.50 | 79.00 | 18.90 | 57.50 | 20.25 | 32.00 | 27.85 | 52.50 | 34.25 | 38.60 | 40.75 | 44.70 | 58.80 | 62.65 | 54.90 | 81.35 | 34.25 | 27.05 | 26.65 | 60.00 | 17.00 | 57.45 | 9.60 | 62.05 |

## DEW POINT AND RELATIVE HUMIDITY FOR 1890—Continued.

| Day. | January. | | February. | | March. | | April. | | May. | | June. | | July. | | August. | | September. | | October. | | November. | | December. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. | D. P. | R. H. |
| 18 | 7.20 | 25.50 | 21.00 | 81.00 | 21.85 | 31.00 | 30.50 | 52.50 | 37.90 | 57.50 | 44.49 | 42.25 | 61.90 | 81.50 | 52.30 | 79.95 | 40.05 | 47.10 | 27.00 | 79.10 | 20.15 | 58.95 | 7.20 | 62.20 |
| 19 | 15.55 | 96.00 | 18.80 | 89.50 | 24.80 | 52.00 | 41.20 | 70.00 | 40.65 | 62.00 | 51.85 | 57.25 | 58.90 | 63.50 | 49.10 | 89.25 | 38.80 | 60.25 | 25.85 | 57.05 | 17.80 | 71.65 | 15.50 | 73.10 |
| 20 | 4.90 | 82.50 | 13.75 | 67.00 | 26.95 | 48.50 | 41.30 | 85.00 | 43.15 | 48.50 | 51.70 | 61.70 | 60.70 | 83.00 | 53.75 | 77.00 | 39.35 | 44.85 | 26.45 | 47.55 | 18.60 | 68.10 | 20.15 | 56.30 |
| 21 | 0.55 | 79.50 | 13.10 | 54.50 | 25.25 | 54.50 | 40.85 | 87.00 | 29.00 | 35.00 | 45.45 | 43.60 | 60.60 | 72.50 | 53.95 | 74.90 | 38.00 | 62.85 | 20.95 | 68.00 | 21.00 | 56.05 | 10.10 | 78.10 |
| 22 | 2.95 | 65.50 | 16.55 | 63.50 | 27.25 | 58.00 | 40.25 | 78.50 | 38.70 | 54.00 | 47.35 | 47.55 | 62.00 | 72.25 | 54.80 | 78.40 | 35.85 | 64.50 | 23.30 | 52.35 | 20.60 | 81.45 | 9.40 | 54.65 |
| 23 | 6.80 | 56.50 | 6.30 | 46.50 | 28.65 | 58.50 | 42.90 | 93.00 | 39.35 | 53.50 | 49.95 | 50.75 | 63.90 | 91.55 | 42.70 | 54.45 | 31.00 | 48.60 | 26.70 | 46.60 | 20.30 | 66.50 | 12.20 | 71.80 |
| 24 | 10.55 | 49.50 | 5.60 | 49.50 | 0.35 | 17.00 | 37.10 | 97.50 | 43.55 | 66.00 | 52.20 | 55.25 | 51.00 | 59.50 | 41.20 | 43.25 | 33.55 | 52.55 | 25.60 | 40.65 | 18.40 | 66.70 | 16.65 | 51.65 |
| 25 | 17.15 | 21.00 | 1.35 | 95.00 | 14.25 | 43.50 | 31.90 | 95.00 | 38.75 | 39.00 | 50.65 | 50.30 | 48.60 | 49.35 | 42.60 | 62.95 | 34.85 | 52.90 | 29.50 | 74.35 | 26.30 | 70.10 | 13.40 | 68.70 |
| 26 | 30.90 | 61.50 | -4.90 | 100.00 | 23.00 | 46.00 | 38.65 | 88.50 | 45.05 | 61.50 | 52.45 | 57.90 | 52.50 | 53.80 | 47.70 | 64.60 | 37.60 | 69.10 | 27.95 | 69.60 | 18.60 | 80.20 | 13.20 | 28.80 |
| 27 | 28.35 | 86.00 | -15.80 | 100.00 | 14.65 | 39.00 | 38.20 | 72.50 | 45.10 | 52.50 | 48.35 | 49.70 | 51.30 | 45.40 | 50.40 | 66.30 | 35.55 | 69.65 | 21.65 | 51.30 | 15.50 | 50.85 | 12.70 | 78.25 |
| 28 | 23.65 | 80.00 | -3.50 | 79.50 | 12.55 | 40.50 | 37.85 | 52.50 | 42.95 | 44.50 | 45.05 | 48.95 | 57.30 | 74.40 | 47.50 | 65.65 | 36.45 | 53.55 | 22.85 | 48.10 | 19.95 | 62.75 | 11.75 | 43.45 |
| 29 | 21.45 | 76.00 | ..... | ..... | 19.70 | 53.00 | 37.95 | 53.00 | 46.25 | 65.50 | 52.20 | 59.05 | 56.30 | 62.40 | 46.40 | 59.35 | 33.40 | 52.00 | 21.35 | 41.65 | 13.90 | 59.85 | 9.35 | 43.55 |
| 30 | 3.50 | 15.50 | ..... | ..... | 24.05 | 78.00 | 39.65 | 54.50 | 41.35 | 50.50 | 50.60 | 55.75 | 50.00 | 55.40 | 46.15 | 57.20 | 30.05 | *41.30 | 24.50 | 66.05 | 17.30 | 56.60 | 17.50 | 42.00 |
| 31 | 20.90 | 73.00 | ..... | ..... | 20.55 | 99.50 | ..... | ..... | ..... | ..... | ..... | ..... | 53.90 | 62.10 | 51.15 | 64.65 | ..... | ..... | 26.35 | 76.55 | ..... | ..... | 18.20 | 45.80 |
| Sums | 347.45 | 2336.50 | 353.65 | 1848.00 | 549.75 | 1640.50 | 908.25 | 1906.00 | 1169.55 | 1771.00 | 1321.65 | 1540.825 | 1717.00 | 1916.9 | 1607.10 | 2124.0 | 1121.70 | 1585.75 | 824.40 | 1877.30 | 604.75 | 2099.50 | 489.60 | 2016.95 |
| Mean | 11.21 | 75.40 | 13.098 | 68.44 | 17.73 | 52.919 | 30.275 | 635.33 | 38.985 | 59.1333 | 44.155 | 51.3608 | 55.38 | 61.83 | 51.84 | 68.51 | 37.39 | 52.858 | 26.59 | 60.557 | 20.158 | 69.983 | 15.79 | 65 06 |

## EVAPORATION.

The experiments on evaporation have been continued this year on the same plan as last year. The standard tank, tank A, which is 3 feet cube and sunk flush in the ground, has been read as last year. In the colder months infrequent observations were taken. When frozen, the height of the water was read only at the beginning of each month. The ice was made loose from the sides of the tank, and then the hook gauge read. The height of the water as thus observed would be the same as if the ice were melted, and then the reading made. Beginning with May, readings were made with the hook gauge twice each day, at 7 a. m. and 7 p. m. These were continued until September, when, in consequence of the early darkness, only one reading was taken daily. This was then continued until the tank froze up.

As accessory observations, the temperatures of the water surface were taken at each observation, and it having been found by hourly observations that the mean of the 7 a. m. and the 7 p. m. was not the mean temperature of the water for the day, a set of maximum and minimum thermometers was placed in the tank in August, and remained until the tank froze up.

Evaporation is a complex process, and depends on a number of elements. It is primarily a process of diffusion. The formation of the water vapor seems to be almost in direct ratio to the difference between the amount of vapor present in the air and the amount the air could contain were it at the temperature of the water surface. The temperature of the air itself seems to have but little influence directly. The diffusion is increased by wind.

These elements have been tabulated, but, in consequence of our anemometer having seen years of service,

the record for a part of the year is unreliable, it is thought best to postpone a full report upon this subject until another year.

Tanks were also placed in the canal running through the College grounds, and in Warren's Lake—at the same places as last year. The records are more or less incomplete, as these tanks have been repeatedly interfered with. The record for the periods when the tanks were undisturbed are given.

At Rocky Ford and Del Norte, evaporation were measured from tanks which were duplicates of tank A, that is, they were 3 feet cube, and sunk flush with the ground. Their temperatures were not taken, as the thermometers sent for that purpose were lost in transmission. At Del Norte after May 1 the heights were read by means of a small hook gauge, which was made by my assistant, Mr. Meyers.

MONTHLY EVAPORATION AT AGRICULTURAL COLLEGE.

| YEAR. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1887 | ..... | ..... | 4.6 | 5.55 | 5.19 | 5.75 | 5.23 | 4.24 | 4.12 | 3.26 | 1.48 | 1.6 | ..... |
| 1888 | ..... | ..... | ..... | ..... | 4.45 | 7.70 | 7.00 | 4.06 | 3.94 | 2.17 | 1.35 | .99 | ..... |
| 1889 | 1.085 | 1.027 | 2.75 | 4.06 | 3.72 | 4.336 | 5.20 | 5.15 | 5.19 | 3.28 | .62 | 1.42 | 37.83 |
| 1890 | .855 | 2.36 | 3.48 | 3.50 | 4.318 | 5.709 | 5.440 | 5.76 | 3.69 | 2.71 | 1.32 | 1.10 | 40.24 |
| Evap. per day, 1890 | .03 | .08 | .11 | .12 | .14 | .19 | .18 | .19 | .12 | .09 | .04 | .01 | ..... |
| Mean temp. 1889 | ..... | ..... | ..... | ..... | ..... | 66.6 | 72.0 | 70.5 | 61.1 | 52.7 | ..... | ..... | ..... |
| " " 1890 | ..... | ..... | ..... | ..... | 58.0 | 67.2 | 75.0 | 69.9 | 62.0 | 52.1 | ..... | ..... | ..... |

## EVAPORATION AT SAN LUIS EXPERIMENT STATION, DEL NORTE.

| PERIOD. | No. of Days. | Loss. | Rainfall. | Evaporation. | Evap. per Day. |
|---|---|---|---|---|---|
| March 18—April 1 | 14 | 2.33 | .32 | 2.65 | .19 |
| April 1—April 15 | 14 | 3.17 | .00 | 3.16 | .22 |
| April 15—May 13 | 28 | 3.38 | 3.19 | 6.56 | .24 |
| May 13—May 20 | 7 | 1.74 | .02 | 1.76 | .25 |
| May 20—May 28 | 8 | 1.47 | .00 | 1.47 | .18 |
| June 5—June 12 | 7 | 1.90 | .03 | 1.93 | .28 |
| June 12—June 19 | 7 | 3.18 | .00 | 3.18 | .45 |
| June 19—June 27 | 8 | 3.00 | .09 | 3.09 | .39 |
| June 27—July 7 | 10 | 3.47 | .53 | 4.00 | .40 |
| July 7—July 16 | 9 | 1.95 | .18 | 2.13 | .24 |
| July 16—July 23 | 7 | 2.38 | .25 | 2.63 | .38 |
| July 23—August 1 | 8 | 2.45 | .40 | 2.85 | .36 |
| August 1—August 7 | 6 | .45 | .04 | .49 | .08 |
| August 7—August 14 | 7 | 2.23 | .19 | 2.42 | .34 |
| August 14—August 29 | 15 | 3.59 | .68 | 4.27 | .29 |
| August 29—September 9 | 11 | 2.15 | .56 | 2.71 | 24 |
| September 9—September 18 | 9 | 3.94 | .00 | 3.94 | .44 |
| September 18—October 1 | 13 | .75 | .77 | 1.52 | .11 |
| October 1—October 18 | 17 | 1.72 | .21 | 1.92 | .11 |
| October 18—October 31 | 13 | 2.28 | .00 | 2.28 | .17 |
| October 31—November 14 | 14 | .66 | .40 | 1.06 | .07 |

## COMPARATIVE MONTHLY EVAPORATION, 1890.

| STATION. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| Agricultural College | 3.50 | 4.32 | 5.71 | 5.44 | 5.76 | 3.69 | 2.71 | 1.32 |
| San Luis | 7.91 | *6.70 | †11.30 | 10.01 | 7.66 | 7.69 | 4.27 | ..... |
| Rocky Ford | 5.97 | 6.71 | 9.27 | 8.64 | 7.24 | 6.08 | 4.50 | 3.03 |

* Derived from record for 28 days. † Derived from record for 26 days.

A tank was placed on Warren's Lake, a reservoir some three or four miles southeast of the College, under the same circumstances as last year. The tank, which was 1 foot square and 1½ feet deep, was filled so that the edge was about 6 inches above the surface of the water. This was necessary in order to prevent splashing. It was then surrounded by a break-water, consisting of plank placed on edge, and constructed with a prow at the end at which it was anchored. The structure was free to move, so as to face the waves. In the heavier winds the protection was not sufficient, but for moderate winds it was. The tank was placed in the lake April 19, and a reading taken. The tank was frequently disturbed, in consequence of which the record is not complete. As a rule, it was visited weekly. The portion which seems reliable, is as follows:

| DATE. | Evaporation. | Evap. per day. | Temperature. |
|---|---|---|---|
| April 30—May 6 | 1.26 | 0.21 | 57—57 |
| May 25—June 1 | 1.98 | .28 | 63—66 |
| June 28—July 5 | 1.25 | .18 | 74—74 |
| July 5—July 12 | 1.57 | .22 | 74—77 |
| July 19—July 26 | 2.24 | .32 | 77—78 |
| July 26—August 2 | 2.40 | .34 | 78—77 |
| August 2—August 9 | 2.21 | .32 | 77—72 |
| August 9—August 23 | 4.20 | .30 | 72—73 |
| August 23—September 1 | 1.40 | .10 | 73—70 |

The temperature was taken at, or close to, 3 p. m.

A small tank was placed in the canal which runs through the College grounds, on June 14. Daily readings were taken at 7 a. m., both of the height of water in the tank, and the temperature. The tank was interfered with so much that very little of the record in June, July or August is free from suspicion. From the methods of

measurement which we were forced to use, the record of any single day cannot be considered to have any high degree of accuracy. In sixteen days in September the loss was two inches. The temperature at 7 a. m. varied from 49° to 57°.

A larger tank was placed in the same canal, and was disturbed less. From this tank the loss in the last eight days of August was 1.46 inches, an average of .18 inches daily. The temperature at 7 a. m. varied from 58° to 64°.

In twenty-three days of September, with the temperature of the water varying at 7 a. m. from 45° to 57°, the loss was 2.25 inches.

In six days in October the loss was 1.06 inches. The temperature varied from 45° to 53°.

## SUNSHINE.

The method of recording the hours of sunshine consists of the simple form of sunshine recorder due to Pickering. This consists of two semi-cylinders, with the flat side of one exposed toward the eastern sky, of the other toward the western. In the sliding side of the cylinder is a minute hole, which serves to project the sun upon the sensitive paper on the curved side. Ordinary blue print paper is used. The paper does not record for a time near sunset or sunrise.

One difficulty which we had found in the use of this form of recorder was the uncertainty which existed as to the position of the noon line. Sometimes it was difficult to determine corresponding points in the forenoon and afternoon records of the same day. On our own recorders we adopted a device a year ago which has entirely disposed of the trouble, and gives us confidence, in measuring the records, that the starting points for the measurement are correct. On the movable face of the cylinder two heavy pieces of tin were soldered, with their

planes at right angles to that of the face. These form the supports for a wire which passes over the hole, and is so placed that at apparent noon of each day its shadow falls directly on the hole. The size of the wire was so selected as to cast a shadow for five minutes. After once properly orienting the recorder, there is no further trouble. The wire forms a clear and distinct mark on each sunny day, so that there is no risk of mistaking the noon line. The idea of this device was suggested by my former assistant, W. J. Meyers.

In measuring the sunshine of the day, we found the most convenient method has been to draw the line corresponding to sunset, as well as the noon line.

Preliminary to working up the records, it was necessary to compute the length of each day for each place where we have the recorders. The effect of the mountains in shortening the days at Fort Collins and the San Luis Valley was computed after measuring their altitude corresponding to the various azimuths. The amount of this daily shortening, as given in the report of the Experiment Station for 1889, averages nearly seventeen minutes for Fort Collins, and fifteen for the San Luis Valley Experiment Station. The scale of the various recorders was found by closing the openings for a given number of hours.

As a means of comparison, we place the average sunshine of each month at the sub-stations, as well as at the College, together, and also give the average monthly averages of the New York Experiment Station at Geneva, as derived from their annual reports. While the sunshine at New York averages only 36.7 per cent. for several years, that at Fort Collins is nearly 65 per cent. And when we take into account the fact that our atmosphere is much drier, and therefore offers less resistance to the sun's rays, our sunshine is much more intense, as well as greater in quantity, and therefore has much greater influence upon vegetable life.

SUNSHINE, 1890.

| MONTH. | Fort Collins. | | | San Luis Ex. Station. | | Arkansas Ex, Station, Rocky Ford | | New York Experiment Station. |
|---|---|---|---|---|---|---|---|---|
| | 1888. | 1889. | 1890. | 1889. | 1890. | 1889. | 1890. | |
| January | 71.5 | 72.1 | 65.0 | 96.2 | 77.8 | 77.0 | 56.6 | 17.1 |
| February | ..... | *67.4 | 59.1 | 87.2 | 81.6 | 71.5 | 71.7 | 24.5 |
| March | 79.1 | 60.2 | 60.5 | 80.5 | 68.4 | 61.0 | 70.4 | 28.5 |
| April | ..... | 58.7 | 56.7 | 65.6 | 74.1 | 68.4 | 58.8 | 39.1 |
| May | ..... | 51.0 | 59.1 | 67 4 | 81.0 | 63.7 | 69.7 | 46.9 |
| June | ..... | †85.1 | 71.7 | 70.8 (27) | ..... | 75.2 (9) | 81.9 | 46.8 |
| July | 69.2 | 56.5 | 67.4 | 62.7 | 62.3 | 80.4 (15) | 72.8 | 55.7 |
| August | 71.6 | 58.2 | 57.4 | ..... | 66.1 | 72.5 (23) | 70.0 | 50.1 |
| September | 83.2 | 73.4 | 75.8 | 73.3 | 72.4 | 82.2 | 83.0 | 47.9 |
| October | 63.9 | 63.0 | 68.3 | 79.1 | 83.4 | 62.5 | 72.3 | 37.5 |
| November | 60.0 | 66.5 | 73.8 | 75.8 | 82.4 | ..... | 76.06 | 25.1 |
| December | 68.8 | 64.5 | 68.9 | ..... | 69.9 | ..... | 73.51 | 21.3 |
| Year | ..... | 64.7 | 65.1 | ..... | ..... | ..... | 71.4 | 36.7 |

* Record from afternoons only. † Record from forenoons only.

Where the record has not been complete for any month, the number of days on which the record is based is indicated by the figures in parenthesis.

The diurnal variation in sunshine is noticeable when we compare either the forenoons with the afternoons, or divide the day into four periods.

At Fort Collins the sun has shone more in the forenoon of every month, except October, November and January. The same thing is true of the San Luis Station. At the Arkansas Valley Station, at Rocky Ford, the afternoons furnish more sunshine in October, November, January and February. The difference between the afternoons and forenoons is more noticeable in the summer months. In the afternoons clouds arise, and the same disturbed conditions producing them frequently result in showers, as has been mentioned elsewhere.

FORENOONS AND AFTERNOONS COMPARED.

| MONTH. | Fort Collins. | | San Luis. | | Rocky Ford. | |
|---|---|---|---|---|---|---|
| | a. m. | p. m. | a. m. | p. m. | a. m. | p. m. |
| January | 58.6 | 71.9 | 77.4 | 79.0 | 56.1 | 56.7 |
| February | 57.6 | 53.6 | 87.4 | 82.5 | 69.3 | 73.7 |
| March | 62.0 | 59.0 | 79.4 | 57.5 | 73.4 | 72.4 |
| April | 61.3 | 51.8 | 77.5 | 71.3 | 59.9 | 57.6 |
| May | 65.6 | 54.7 | 87.9 | 74.1 | 73.0 | 6.- |
| June | 84.2 | 59.3 | ..... | ..... | 89.9 | 70.2 |
| July | 82.0 | 52.0 | 84.7 | 40.3 | 77.7 | 67.9 |
| August | 66.4 | 52.4 | 83.3 | 49.1 | 75.6 | 72.6 |
| September | 81.5 | 69.7 | 89.4 | 56.1 | 85.4 | 80.6 |
| October | 66.8 | 70.1 | 87.4 | 79.2 | 70.5 | 74.1 |
| November | 64.4 | 76.7 | (25) 80.9 | 83.6 | 72.3 | 80.8 |
| December | 71.2 | 66.5 | ..... | ..... | 75.78 | 71.24 |

HOURS AND MINUTES OF SUNSHINE, FORT COLLINS, 1890.

| MONTH. | Sunrise to 9 o'clock. | | 9 to 12. | | 12 to 3. | | 3 to Sunset. | | Total for Whole Day. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Possible. | Observed. | Possible. | Observed. | Possible. | Observed. | Possible. | Observed. | Possible. | Observed. |
| January | 54-16 | 16-17 | 93 | 70-01 | 93 | 74-30 | 45-50 | 25-27 | 286-06 | 186-15 |
| February | 63-33 | 30-21 | 84 | 54-40 | 84 | 51-13 | 54-21 | 22-56 | 285-54 | 159-10 |
| March | 90-29 | 44-42 | 93 | 69-00 | 93 | 66-13 | 81-06 | 36-34 | 357-35 | 216-29 |
| April | 107-36 | 56-29 | 90 | 64-36 | 90 | 54-24 | 99-10 | 43-35 | 386-46 | 219-04 |
| May | 128-33 | 75-16 | 93 | 69-58 | 93 | 58-28 | 120-43 | 54-35 | 435-16 | 258-17 |
| June | 132-44 | 110-17 | 90 | 77-04 | 90 | 61-36 | 126-18 | 66-46 | 439-02 | 315-43 |
| July | 132-45 | 107-21 | 93 | 77-46 | 93 | 57-06 | 125-29 | 57-21 | 444-14 | 299-34 |
| August | 117-24 | 72-05 | 93 | 67-42 | 93 | 55-24 | 108-41 | 50-21 | 412-05 | 245-32 |
| September | 94-18 | 71-14 | 90 | 79-07 | 90 | 69-21 | 85-01 | 52-59 | 359-19 | 272-41 |
| October | 76-50 | 46-40 | 93 | 66-50 | 93 | 68-37 | 66-37 | 43-17 | 329-27 | 225-24 |
| November | 56-25 | 35-46 | 90 | 68-34 | 90 | 69-49 | 47-33 | 35-44 | 283-58 | 209-53 |
| December | 48-52 | 31-56 | 93 | 69-17 | 93 | 62-43 | 41-38 | 26-49 | 276-30 | 191-39 |
| Year | 1103-45 | 698-18 | 1095 | 834-35 | 1095 | 749-14 | 1002-27 | 516-24 | 4296-12 | 2797-41 |

The hours of sunshine in the various portions of the day are also given in the form of a table, from which it appears that of 4,296 hours of possible sunshine, we have had at Fort Collins some 2,798, of which 698 were before 9 a. m., 835 were between 9 a. m. and noon, 749 were between noon and 3 p. m., and 516 were after 3 p. m.

Comparing the sunshine for the day divided into four periods, from daylight to 9 o'clock, from 9 to 12, from 12 to 3, and after 3, we have the following table for each of the three Stations, expressed in percentages, of the possible sunshine for the same periods:

DIURNAL VARIATION IN SUNSHINE, 1890.

| MONTH. | Fort Collins. | | | | San Luis. | | | | Rocky Ford. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before 9 a. m. | 9 to 12 | 12 to 3. | 3 to Sunset. | Before 9 a. m. | 9 to 12. | 12 to 3. | 3 to Sunset. | Before 9 a. m. | 9 to 12. | 12 to 3. | 3 to Sunset. |
| January | 30.0 | 75.3 | 80.1 | 55.4 | 72.4 | 80.5 | 82.6 | 72.7 | 43.0 | 64.4 | 65.9 | 42.0 |
| February | 47.8 | 65.1 | 61.0 | 42.2 | 83.4 | 90.7 | 86.9 | 76.5 | 67.1 | 70.8 | 67.0 | 68.4 |
| March | 49.4 | 74.2 | 71.2 | 45.1 | 79.6 | 79.4 | 70.9 | 64.5 | 71.9 | 74.8 | 71.1 | 62.8 |
| April | 52.5 | 71.8 | 60.4 | 44.0 | *78.3 | *76.7 | *65.2 | *72.0 | 58.4 | 61.8 | 63.3 | 54.1 |
| May | 58.1 | 75.2 | 65.0 | 46.8 | 90.2 | 84.9 | 78.7 | 70.6 | 68.5 | 79.1 | 68.1 | 65.1 |
| June | 83.0 | 85.6 | 68.4 | 52.8 | ..... | ..... | ..... | ..... | 87.1 | 83.9 | 80.3 | 63 2 |
| July | 80.9 | 83.6 | 61.4 | 45.7 | 85.8 | 83.1 | 47.9 | 34.6 | 73.6 | 83.5 | 81.1 | 58.4 |
| August | 61.3 | 72.8 | 48.8 | 46.3 | 83.6 | 83.1 | 56.3 | 42.9 | *85.8 | 84.9* | 89.0* | 64.5* |
| September | 75.9 | 87.9 | 77.1 | 60.1 | 87.5 | 88.4 | 66.7 | 45.8 | 89 6 | 81.3 | 87.1 | 74.5 |
| October | 60.7 | 71.8 | 73.8 | 65.0 | 84.2 | 90.0 (25) | 81.7 | 79.2 | 59.8 | 79.6 | 78.1 | 69.1 |
| November | 63.3 | 76.1 | 77.6 | 75.3 | 79.1 | 85.6 | 87.0 | 78.0 | 58.1 | 79.2 | 82.8 | 79.1 |
| December | 65.1 | 74.5 | 67.4 | 64.4 | ..... | ..... | ..... | ..... | 76.1 | 75.55 | 73.83 | 66.68 |

## SUNSHINE, IN HOURS AND MINUTES, FOR JANUARY, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | SAN LUIS, DEL NORTE. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | Forenoon. | | | Afternoon. | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | Comp. | Observed. | | Comp. | Observed. |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 to 3 p. m. / After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 to 3 p. m. / After 3 p. m. |
| 1 | 4 35 | 0 | 57 | 4 21 | 3 | 50 | 4 42 | 1 30 | 1 45 | | 2 45 / 1 20 | 4 39 | 1 26 | 2 54 | 4 33 | 3 / 30 |
| 2 | 4 35 | 1 13 | 3 | 4 21 | 3 | 1 17 | 4 43 | 0 | 50 | | 15 / 0 | 4 40 | 1 21 | 3 | 4 34 | 3 / 1 20 |
| 3 | 4 36 | 0 | 2 36 | 4 22 | 1 12 | 22 | 4 44 | 1 17 | 3 | | 3 / 1 20 | 4 40 | 1 40 | 3 | 4 34 | 3 / 45 |
| 4 | 4 37 | 10 | 2 54 | 4 22 | 3 | 1 17 | 4 44 | 37 | 2 10 | | 1 05 / 0 | 4 41 | 12 | 2 51 | 4 34 | 2 45 / 1 15 |
| 5 | 4 37 | 0 | 0 | 4 23 | 1 21 | 00 | 4 45 | 20 | 10 | | 2 05 / 1 20 | 4 41 | 1 21 | 2 51 | 4 35 | 50 / 0 |
| 6 | 4 37 | 23 | 2 41 | 4 23 | 1 21 | 18 | 4 45 | 0 | 0 | | 20 / 20 | 4 42 | 0 | 0 | 4 35 | 0 / 0 |
| 7 | 4 38 | 34 | 3 | 4 23 | 3 | 1 08 | 4 46 | 1 25 | 3 | | 3 / 1 15 | 4 42 | 1 42 | 3 | 4 36 | 3 / 1 36 |
| 8 | 4 38 | 0 | 2 50 | 4 24 | 3 | 1 08 | 4 46 | 37 | 10 | | 0 / 0 | 4 43 | 0 | 12 | 4 36 | 0 / 0 |
| 9 | 4 39 | 1 09 | 3 | 4 24 | 3 | 1 17 | 4 47 | 1 40 | 3 | | 3 / 1 15 | 4 43 | 0 | 0 | 4 37 | 0 / 1 30 |
| 10 | 4 40 | 28 | 2 23 | 4 25 | 2 22 | 18 | 4 47 | 0 | 05 | | 10 / 1 05 | 4 44 | 1 18 | 2 36 | 4 37 | 2 35 / 45 |
| 11 | 4 40 | 0 | 0 | 4 25 | 0 | 0 | 4 48 | 0 | 0 | | 1 / 0 | 4 44 | 0 | 1 21 | 4 37 | 2 / 50 |
| 12 | 4 41 | 41 | 3 | 4 26 | 3 | 1 03 | 4 49 | 20 | 1 30 | | 3 / 1 25 | 4 45 | 1 45 | 2 48 | 4 38 | 2 07 / 1 32 |
| 13 | 4 42 | 37 | 2 32 | 4 26 | 2 04 | 0 | 4 49 | 1 20 | 2 15 | | 2 50 / 0 | 4 46 | 33 | 3 | 4 39 | 2 50 / 1 39 |
| 14 | 4 43 | 14 | 2 23 | 4 27 | 1 30 | 0 | 4 50 | 0 | 55 | | 3 / 1 20 | 4 46 | 1 36 | 2 48 | 4 40 | 2 20 / 0 |
| 15 | 4 44 | 1 04 | 3 | 4 27 | 3 | 51 | 4 51 | 1 20 | 3 | | 3 / 1 15 | 4 47 | 1 47 | 3 | 4 41 | 1 41 |
| 16 | 4 44 | 55 | 3 | 4 28 | 3 | 1 12 | 4 51 | 05 | 2 45 | | 3 / 20 | 4 48 | 1 33 | 3 | 4 42 | 1 42 |
| 17 | 4 45 | 1 04 | 1 57 | 4 29 | 3 | 40 | 4 52 | 1 30 | 3 | | 2 30 / 1 20 | 4 49 | 1 49 | 3 | 4 42 | 1 42 |
| 18 | 4 46 | 1 09 | 3 | 4 29 | 2 42 | 18 | 4 53 | 1 30 | 3 | | 3 / 1 20 | 4 50 | 1 50 | 3 | 4 43 | 1 |
| 19 | 4 47 | 37 | 2 51 | 4 30 | 3 | 1 07 | 4 54 | 1 30 | 3 | | 3 / 1 15 | 4 50 | 1 50 | 3 | 4 44 | 1 44 |
| 20 | 4 47 | 1 09 | 3 | 4 30 | 3 | 1 12 | 4 54 | 1 12 | 3 | | 3 / 1 25 | 4 51 | 1 51 | 3 | 4 45 | 1 45 |
| 21 | 4 48 | 1 09 | 3 | 4 31 | 3 | 1 07 | 4 55 | 1 20 | 3 | | 3 / 1 25 | 4 52 | 1 52 | 3 | 4 45 | 1 45 |
| 22 | 4 49 | 55 | 2 51 | 4 32 | 3 | 1 12 | 4 56 | 1 25 | 3 | | 2 15 / 1 25 | 4 53 | 1 53 | 3 | 4 46 | 1 46 |
| 23 | 4 50 | 51 | 3 | 4 33 | 2 51 | 58 | 4 57 | 55 | 1 12 | | 1 / 0 | 4 54 | 1 54 | 3 | 4 47 | 1 15 |
| 24 | 4 51 | 0 | 41 | 4 34 | 1 32 | 36 | 4 58 | 35 | 1 20 | | 0 / 0 | 4 55 | 1 55 | 2 39 | 4 48 | 2 54 / 1 30 |
| 25 | 4 52 | 0 | 18 | 4 35 | 1 52 | 1 12 | 4 59 | 0 | 0 | | 0 / 0 | 4 56 | 1 56 | 3 | 4 49 | 3 / 1 49 |
| 26 | 4 53 | 0 | 2 36 | 4 35 | 1 12 | 09 | 5 | 0 | 2 15 | | 0 / 0 | 4 56 | 0 | 0 | 4 50 | 3 / 1 50 |
| 27 | 4 54 | 0 | 45 | 4 36 | 3 | 54 | 5 | 0 | 2 35 | | 3 / 1 30 | 4 57 | 1 06 | 2 10 | 4 51 | 2 28 / 1 48 |
| 28 | 4 55 | 1 | 3 | 4 37 | 2 19 | 1 16 | 5 01 | 1 20 | 3 | | 3 / 1 05 | 4 58 | 1 45 | 3 | 4 52 | 3 / 1 52 |
| 29 | 4 56 | 0 | 23 | 4 38 | 1 12 | 56 | 5 03 | 1 18 | 2 10 | | 2 10 / 0 | 4 59 | 1 59 | 3 | 4 53 | 2 55 / 1 38 |
| 30 | 4 57 | 55 | 3 | 4 39 | 3 | 1 25 | 5 04 | 55 | 3 | | 1 05 / 0 | 5 00 | 2 | 1 21 | 4 54 | 3 / 1 54 |
| 31 | 4 59 | 0 | 2 23 | 4 40 | 3 | 1 12 | 5 04 | 50 | 1 28 | | 2 40 / 1 20 | 5 01 | 56 | 2 | 4 55 | 2 05 / 09 |
| | 147 16 | 16 17 | 70 01 | 138 56 | 74 30 | 25 27 | 150 18 | 21 51 | 19 55 | Same as for forenoons, as there are no mountains on horizon. | 61 20 / 21 20 | 149 12 | 10 10 | 71 54 | 145 54 | 76 49 / 28 28 |
| Per Cent. | | 30 | 75.3 | | 80.1 | 55.4 | | 43 | 61.4 | | 65.9 / 42 | | 72.36 | 80.48 | | 82.60 / 72.72 |

## SUNSHINE, IN HOURS AND MINUTES, FOR FEBRUARY, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 5 00 | 1 23 | 2 09 | 4 41 | 2 13 | 09 | 5 05 | 0 | 0 | | 30 | 1 30 | 5 02 | 2 02 | 3 | 4 56 | 3 | 1 56 |
| 2 | 5 01 | 09 | 2 06 | 4 42 | 2 46 | 27 | 5 05 | 2 03 | 1 21 | | 33 | 2 06 | 5 03 | 1 03 | 2 54 | 4 57 | 3 | 1 42 |
| 3 | 5 02 | 1 14 | 1 52 | 4 43 | 1 30 | 22 | 5 07 | 27 | 1 09 | 2 48 | 2 07 | | 5 04 | 1 39 | 3 | 4 58 | 2 51 | 1 58 |
| 4 | 5 03 | 0 | 51 | 4 44 | 1 39 | 1 07 | 5 08 | 2 08 | 3 | 1 54 | 2 08 | | 5 05 | 1 42 | 3 | 4 59 | 3 | 1 39 |
| 5 | 5 04 | 1 30 | 1 14 | 4 45 | 0 | 0 | 5 10 | 2 10 | 1 24 | 3 | 2 10 | | 5 06 | 2 05 | 3 | 5 00 | 3 | 2 |
| 6 | 5 06 | 0 | 1 04 | 4 46 | 1 39 | 1 32 | 5 11 | 2 11 | 3 | 0 | 0 | | 5 07 | 30 | 15 | 5 01 | 24 | 15 |
| 7 | 5 07 | 1 43 | 3 | 4 47 | 2 11 | 1 30 | 5 12 | 2 12 | 1 29 | 3 | 2 12 | | 5 08 | 2 08 | 2 42 | 5 02 | 3 | 2 02 |
| 8 | 5 08 | 0 | 1 25 | 4 48 | 2 33 | 1 35 | 5 13 | 2 13 | 3 | 0 | 45 | | 5 09 | 2 09 | 3 | 5 03 | 2 | 2 03 |
| 9 | 5 09 | 1 41 | 3 | 4 49 | 3 | 1 25 | 5 14 | 1 03 | 3 | 3 | 2 14 | | 5 10 | 2 10 | 3 | 5 03 | 3 | 2 03 |
| 10 | 5 10 | 1 04 | 28 | 4 50 | 0 | 0 | 5 15 | 0 | 0 | 2 18 | 03 | | 5 12 | 2 12 | 3 | 5 04 | 2 45 | 1 52 |
| 11 | 5 11 | 1 44 | 3 | 4 51 | 3 | 1 34 | 5 16 | 1 10 | 3 | 3 | 2 16 | | 5 13 | 2 13 | 3 | 5 06 | 3 | 2 06 |
| 12 | 5 13 | 1 44 | 3 | 4 53 | 3 | 1 39 | 5 17 | 2 17 | 3 | 2 45 | 2 17 | | 5 14 | 2 14 | 2 54 | 5 07 | 3 | 2 07 |
| 13 | 5 14 | 1 35 | 1 18 | 4 54 | 1 21 | 0 | 5 18 | 2 18 | 3 | 2 15 | 30 | | 5 15 | 2 15 | 3 | 5 08 | 2 57 | 2 08 |
| 14 | 5 15 | 1 46 | 3 | 4 55 | 3 | 1 34 | 5 19 | 45 | 3 | 3 | 2 19 | | 5 16 | 2 16 | 3 | 5 09 | 3 | 2 09 |
| 15 | 5 17 | 1 23 | 3 | 4 57 | 3 | 1 30 | 5 20 | 2 29 | 3 | 3 | 2 20 | | 5 17 | 1 33 | 3 | 5 11 | 3 | 2 11 |
| 16 | 5 18 | 0 | 1 50 | 4 58 | 1 23 | 0 | 5 22 | 2 | 2 24 | 1 10 | 0 | | 5 18 | 2 18 | 3 | 5 12 | 3 | 54 |
| 17 | 5 19 | 1 48 | 3 | 4 59 | 1 | 0 | 5 23 | 1 39 | 2 48 | 1 21 | 0 | | 5 19 | 33 | 2 57 | 5 13 | 3 | 1 12 |
| 18 | 5 20 | 1 14 | 1 41 | 5 00 | 27 | 0 | 5 24 | 0 | 1 15 | 24 | 0 | | 5 21 | 2 21 | 3 | 5 15 | 3 | 10 |
| 19 | 5 22 | 1 41 | 2 | 5 02 | 1 03 | 0 | 5 25 | 2 25 | 2 33 | 2 33 | 18 | | 5 22 | 2 15 | 2 12 | 5 16 | 3 | 1 39 |
| 20 | 5 23 | 0 | 46 | 5 03 | 05 | 0 | 5 26 | 1 27 | 2 21 | 27 | 2 27 | | 5 23 | 1 24 | 2 48 | 5 17 | 12 | 0 |
| 21 | 5 24 | 0 | 55 | 5 04 | 2 33 | 1 43 | 5 27 | 0 | 0 | 0 | 0 | | 5 24 | 0 | 0 | 5 18 | 1 02 | 21 |
| 22 | 5 26 | 02 | 2 55 | 5 06 | 2 28 | 0 | 5 28 | 2 28 | 3 | 2 42 | 2 23 | | 5 24 | 2 24 | 3 | 5 20 | 3 | 2 20 |
| 23 | 5 27 | 1 50 | 1 23 | 5 07 | 2 01 | 1 39 | 5 30 | 2 30 | 3 | 3 | 2 39 | | 5 25 | 2 25 | 3 | 5 22 | 3 | 2 22 |
| 24 | 5 28 | 1 55 | 2 34 | 5 09 | 27 | 0 | 5 31 | 2 30 | 3 | 2 18 | 2 | | 5 26 | 1 21 | 2 27 | 5 23 | 1 48 | 2 23 |
| 25 | 5 29 | 37 | 55 | 5 10 | 2 49 | 1 30 | 5 32 | 10 | 2 49 | 2 33 | 2 32 | | 5 23 | 2 25 | 3 | 5 24 | 3 | 2 24 |
| 26 | 5 31 | 1 24 | 14 | 5 11 | 0 | 0 | 5 33 | 2 31 | 36 | 3 | 2 33 | | 5 27 | 2 27 | 3 | 5 26 | 2 03 | 0 |
| 27 | 5 32 | 1 50 | 3 | 5 13 | 3 | 1 48 | 5 34 | 40 | 2 36 | 2 45 | 2 34 | | 5 27 | 2 27 | 3 | 5 27 | 3 | 2 27 |
| 28 | 5 33 | 1 14 | 3 | 5 14 | 3 | 1 52 | 5 35 | 2 35 | 1 03 | 3 | 2 35 | | 5 28 | 2 28 | 3 | 5 29 | 3 | 2 29 |
| | 147 33 | 30 21 | 54 40 | 138 21 | 51 13 | 22 56 | 149 37 | 44 15 | 59 30 | Same as for forenoons, as there are no mountains on horizon. | 56 19 | 44 54 | 147 33 | 53 00 | 76 09 | 145 06 | 73 02 | 46 42 |
| Per cent.. | | 47.8 | 65.1 | ..... | 61.0 | 42.2 | ..... | 67.43 | 70.83 | | 67.04 | 68.43 | ..... | 83.40 | 90.65 | ..... | 89.94 | 76.51 |

## SUNSHINE, IN HOURS AND MINUTES, FOR MARCH, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 5 35 | 1 56 | 3 | 5 16 | 1 21 | 54 | 5 37 | 2 37 | 3 | Same as for forenoons, as there are no mountains on horizon. | 3 | 2 37 | 5 29 | 2 29 | 3 | 5 30 | 3 | 2 21 |
| 2 | 5 36 | 2 06 | 2 07 | 5 17 | 2 56 | 2 01 | 5 38 | 2 38 | 3 | | 3 | 2 38 | 5 29 | 2 30 | 3 | 5 32 | 2 51 | 2 32 |
| 3 | 5 37 | 1 38 | 3 | 5 18 | 2 43 | 0 | 5 39 | 1 45 | 3 | | 3 | 2 39 | 5 31 | 2 | 2 30 | 5 33 | 3 | 1 30 |
| 4 | 5 39 | 1 04 | 2 | 5 20 | 2 51 | 1 12 | 5 41 | 1 45 | 3 | | 3 | 1 42 | 5 32 | 2 | 3 | 5 35 | 3 | 1 45 |
| 5 | 5 40 | 0 | 0 | 5 21 | 0 | 45 | 5 42 | 1 21 | 3 | | 3 | 1 06 | 5 34 | 2 34 | 1 45 | 5 36 | 1 | 57 |
| 6 | 5 42 | 1 43 | 3 | 5 23 | 3 | 1 30 | 5 43 | 2 43 | 3 | | 3 | 2 43 | 5 35 | 2 35 | 3 | 5 38 | 3 | 2 38 |
| 7 | 5 43 | 0 | 0 | 5 24 | 36 | 0 | 5 44 | 0 | 57 | | 2 48 | 36 | 5 37 | 1 10 | 2 30 | 5 39 | 2 27 | 1 36 |
| 8 | 5 44 | 1 23 | 2 43 | 5 25 | 1 57 | 09 | 5 46 | 0 | 2 06 | | 1 | 2 06 | 5 38 | 1 40 | 1 33 | 5 40 | 0 | 1 15 |
| 9 | 5 46 | 1 57 | 2 39 | 5 27 | 1 28 | 1 01 | 5 47 | 1 27 | 48 | | 06 | 1 15 | 5 39 | 36 | 2 45 | 5 42 | 1 18 | 1 03 |
| 10 | 5 47 | 0 | 51 | 5 28 | 1 39 | 0 | 5 49 | 1 39 | 3 | | 3 | 36 | 5 41 | 2 41 | 2 48 | 5 43 | 3 | 2 21 |
| 11 | 5 48 | 1 41 | 3 | 5 30 | 3 | 58 | 5 50 | 2 30 | 2 35 | | 1 42 | 1 | 5 42 | 2 12 | 2 54 | 5 45 | 1 18 | 1 39 |
| 12 | 5 50 | 2 09 | 1 41 | 5 31 | 49 | 45 | 5 51 | 2 51 | 3 | | 3 | 2 03 | 5 43 | 2 18 | 3 | 5 46 | 2 48 | 2 42 |
| 13 | 5 51 | 2 13 | 3 | 5 32 | 3 | 2 15 | 5 52 | 2 52 | 3 | | 3 | 2 52 | 5 45 | 2 45 | 3 | 5 47 | 3 | 2 47 |
| 14 | 5 53 | 1 34 | 2 50 | 5 34 | 2 55 | 2 15 | 2 53 | 2 53 | 3 | | 3 | 2 53 | 5 46 | 2 46 | 3 | 5 48 | 3 | 2 48 |
| 15 | 5 54 | 2 18 | 3 | 5 35 | 3 | 2 15 | 5 55 | 2 55 | 3 | | 3 | 2 55 | 5 47 | 2 47 | 3 | 5 50 | 3 | 2 50 |
| 16 | 5 55 | 1 | 1 32 | 5 37 | 3 | 45 | 5 56 | 2 56 | 3 | | 3 | 2 56 | 5 49 | 2 49 | 3 | 5 51 | 3 | 2 51 |
| 17 | 5 56 | 1 32 | 2 18 | 5 39 | 1 10 | 1 03 | 5 57 | 2 57 | 48 | | 2 06 | 1 33 | 5 50 | 2 50 | 2 30 | 5 52 | 3 | 1 54 |
| 18 | 5 58 | 1 30 | 2 46 | 5 40 | 2 02 | 1 12 | 5 58 | 1 50 | 1 18 | | 1 12 | 42 | 5 51 | 1 51 | 1 | 5 53 | 1 03 | 36 |
| 19 | 5 59 | 0 | 1 23 | 5 41 | 2 51 | 1 52 | 6 00 | 24 | 1 18 | | 36 | 30 | 5 52 | 0 | 0 | 5 54 | 45 | 24 |
| 20 | 6 00 | 1 28 | 2 50 | 5 43 | 1 21 | 2 01 | 6 01 | 0 | 1 03 | | 27 | 54 | 5 54 | 0 | 0 | 5 56 | 1 30 | 0 |
| 21 | 6 02 | 14 | 2 32 | 5 45 | 3 | 2 42 | 6 02 | 3 02 | 3 | | 3 | 3 02 | 5 55 | 2 55 | 3 | 5 57 | 3 | 2 57 |
| 22 | 6 03 | 0 | 1 48 | 5 46 | 2 42 | 0 | 6 03 | 3 03 | 3 | | 3 | 45 | 5 57 | 2 57 | 3 | 5 58 | 2 03 | 33 |
| 23 | 6 04 | 2 09 | 3 | 5 47 | 3 | 2 24 | 6 04 | 3 01 | 18 | | 1 12 | 36 | 5 58 | 2 15 | 1 03 | 5 59 | 3 | 2 59 |
| 24 | 6 06 | 2 40 | 3 | 5 49 | 3 | 2 33 | 6 05 | 3 05 | 3 | | 3 | 3 05 | 5 59 | 2 59 | 3 | 6 01 | 3 | 3 01 |
| 25 | 6 07 | 2 40 | 3 | 5 50 | 1 43 | 1 39 | 6 06 | 3 06 | 2 48 | | 0 | 1 12 | 6 01 | 3 01 | 2 15 | 6 02 | 2 30 | 25 |
| 26 | 6 09 | 2 40 | 3 | 5 51 | 3 | 54 | 6 08 | 3 08 | 30 | | 30 | 2 45 | 6 02 | 1 42 | 35 | 6 03 | 2 45 | 1 10 |
| 27 | 6 10 | 2 02 | 3 | 5 52 | 3 | 2 42 | 6 09 | 2 24 | 3 | | 2 55 | 2 | 6 03 | 3 03 | 3 | 6 05 | 3 | 3 05 |
| 28 | 6 11 | 2 40 | 3 | 3 54 | 3 | 2 38 | 6 10 | 3 10 | 3 | | 3 | 3 10 | 6 05 | 3 05 | 3 | 6 06 | 3 | 1 |
| 29 | 6 13 | 2 25 | 3 | 5 55 | 2 10 | 09 | 6 11 | 3 09 | 2 39 | | 36 | 3 | 6 06 | 3 06 | 3 | 6 07 | 2 | 2 05 |
| 30 | 6 14 | 0 | 0 | 5 56 | 0 | 0 | 6 13 | 0 | 1 21 | | 3 | 1 06 | 6 08 | 2 39 | 3 | 6 08 | 3 | 3 08 |
| 31 | 6 16 | 0 | 0 | 5 58 | 0 | 0 | 6 14 | 0 | 0 | | 0 | 0 | 6 09 | 1 15 | 1 40 | 6 10 | 0 | 0 |
| | 183 29 | 44 42 | 69 00 | 174 06 | 66 13 | 36 34 | 183 43 | 65 14 | 69 53 | | 66 10 | 56 57 | 180 08 | 69 20 | 73 48 | 181 06 | 47 18 | 56 52 |
| Per cent. | | 49.4 | 74.2 | ..... | 71.2 | 45.1 | ..... | 71.90 | 74 78 | | 71.14 | 62.78 | ..... | 79.57 | 79.85 | ..... | 50.80 | 64.54 |

## SUNSHINE, IN HOURS AND MINUTES, FOR APRIL, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 6 17 | 09 | 2 32 | 5 59 | 3 | 2 37 | 6 15 | 0 | 0 | | 0 | 09 | 6 10 | 0 | 1 18 | 6 11 | 1 36 | 3 11 |
| 2 | 6 18 | 0 | 2 36 | 6 | 3 | 1 48 | 6 16 | 1 57 | 3 | | 3 | 3 15 | 6 12 | 3 12 | 2 27 | 6 12 | 3 | 3 12 |
| 3 | 6 20 | 2 48 | 3 | 6 02 | 3 | 2 56 | 6 17 | 3 17 | 3 | | 3 | 3 17 | 6 13 | 3 13 | 3 | 6 13 | 36 | 1 06 |
| 4 | 6 21 | 2 46 | 3 | 6 03 | 2 15 | 18 | 6 19 | 3 | 2 39 | | 1 51 | 09 | 6 14 | 3 14 | 2 27 | 6 15 | 2 36 | 3 15 |
| 5 | 6 22 | 0 | 1 11 | 6 05 | 41 | 1 03 | 6 20 | 24 | 1 59 | | 3 | 1 39 | 6 15 | 3 10 | 3 | 6 16 | 2 06 | 2 15 |
| 6 | 6 23 | 2 47 | 3 | 6 06 | 2 46 | 3 05 | 6 21 | 3 21 | 2 51 | | 1 45 | 2 24 | 6 17 | 3 06 | 2 27 | 6 17 | 2 27 | 3 17 |
| 7 | 6 25 | 2 46 | 3 | 6 07 | 3 | 1 05 | 6 22 | 3 22 | 3 | | 3 | 2 06 | 6 18 | 3 18 | 3 | 6 18 | 3 | 3 18 |
| 8 | 6 26 | 2 55 | 2 18 | 6 09 | 2 01 | 1 08 | 9 23 | 2 54 | 1 39 | | 3 | 2 48 | 6 19 | 3 19 | 3 | 6 19 | 3 | 3 19 |
| 9 | 6 27 | 2 50 | 3 | 6 10 | 3 | 3 10 | 6 25 | 3 25 | 3 | | 3 | 3 25 | 6 20 | 3 20 | 3 | 6 21 | 3 | 3 21 |
| 10 | 6 29 | 2 55 | 3 | 6 12 | 3 | 3 05 | 6 26 | 3 26 | 3 | | 3 | 3 26 | 6 21 | 3 21 | 3 | 6 22 | 30 | 1 48 |
| 11 | 6 30 | 2 59 | 3 | 6 13 | 3 | 2 38 | 6 27 | 3 27 | 3 | | 1 42 | 03 | 6 22 | 10 | 0 | 6 23 | 1 15 | 2 23 |
| 12 | 6 31 | 2 59 | 2 13 | 6 14 | 49 | 22 | 6 28 | 3 28 | 3 | | 3 | 1 33 | 6 24 | 2 50 | 2 18 | 6 24 | 3 | 3 24 |
| 13 | 6 32 | 2 04 | 1 43 | 6 15 | 0 | 0 | 6 29 | 0 | 2 06 | | 3 | 3 29 | 6 25 | 3 25 | 3 | 6 24 | 1 27 | 3 24 |
| 14 | 6 34 | 0 | 0 | 6 17 | 0 | 0 | 6 31 | 0 | 0 | | 09 | 1 51 | 6 26 | 27 | 1 30 | 6 25 | 18 | 0 |
| 15 | 6 35 | 0 | 0 | 6 18 | 05 | 0 | 6 32 | 0 | 0 | | 0 | 0 | 6 27 | 3 12 | 1 03 | 6 25 | 1 57 | 2 21 |
| 16 | 6 36 | 3 22 | 3 | 6 19 | 3 | 3 | 6 33 | 0 | 0 | | 0 | 0 | .... | | | 6 26 | 3 | 1 26 |
| 17 | 6 37 | 3 13 | 3 | 6 20 | 3 | 2 46 | 6 34 | 3 34 | 3 | | 3 | 2 45 | .... | | | 6 26 | 1 26 | 0 |
| 18 | 6 38 | 3 06 | 3 | 6 21 | 3 | 3 | 6 35 | 3 35 | 2 33 | | 3 | 42 | .... | | | 6 27 | 3 | 27 |
| 19 | 6 40 | 1 55 | 2 13 | 6 23 | 1 01 | 1 14 | 6 37 | 0 | 15 | | 1 27 | 0 | .... | | | 6 27 | 2 36 | 48 |
| 20 | 6 41 | 0 | 0 | 6 24 | 0 | 22 | 6 38 | 0 | 2 15 | | 2 54 | 1 18 | .... | | | 6 28 | 3 | 3 28 |
| 21 | 6 42 | 0 | 2 13 | 6 25 | 31 | 0 | 6 39 | 3 39 | 2 42 | | 2 12 | 2 21 | .... | | | 6 28 | 3 | 3 28 |
| 22 | 6 43 | 3 09 | 3 | 6 26 | 1 37 | 0 | 6 40 | 3 40 | 2 42 | | 1 06 | 3 40 | .... | | | 6 29 | 2 51 | 2 03 |
| 23 | 6 44 | 0 | 14 | 6 27 | 31 | 0 | 6 41 | 0 | 0 | | 0 | 0 | .... | | | 6 31 | 0 | .... |
| 24 | 6 46 | 0 | 0 | 6 29 | 0 | 0 | 6 42 | 0 | 0 | | 0 | 0 | .... | | | 6 32 | 0 | .... |
| 25 | 6 47 | 0 | 0 | 6 30 | 0 | 0 | 6 43 | 0 | 0 | | 0 | 0 | .... | | | 6 33 | 3 | .... |
| 26 | 6 48 | 1 48 | 3 | 6 31 | 2 51 | 54 | 6 44 | 21 | 42 | | 18 | 2 36 | .... | | | 6 34 | 0 | .... |
| 27 | 6 49 | 2 50 | 3 | 6 32 | 3 | 1 43 | 6 45 | 3 45 | 2 33 | | 2 48 | 3 12 | .... | | | 6 35 | 2 24 | .... |
| 28 | 6 50 | 2 50 | 3 | 6 33 | 2 38 | 3 | 6 46 | 3 46 | 2 30 | | 1 39 | 3 46 | .... | | | 6 36 | 2 48 | .... |
| 29 | 6 52 | 3 09 | 3 | 6 35 | 3 | 2 51 | 6 47 | 3 47 | 2 39 | | 2 30 | 3 47 | .... | | | .... | .... | .... |
| 30 | 6 53 | 3 09 | 2 23 | 6 36 | 38 | 1 30 | 6 48 | 3 48 | 1 30 | | 2 15 | 3 18 | .... | | | .... | .... | .... |
| | 197 36 | 56 29 | 64 36 | 189 01 | 54 24 | 43 35 | 196 03 | 61 76 | 55 35 | Same as forenoons, as there are no mountains on horizon. | 55 56 | 57 20 | 94 13 | 38 57 | 34 30 | 172 17 | 54 45 | 53 14 |
| Per cent. | | 52.5 | 71.8 | ..... | 60.4 | 44 | ..... | 58.1 | 61 76 | | 63 26 | 54.06 | ..... | 78.34 | 76 66 | ..... | 65.18 | 72.0 |

## SUNSHINE, IN HOURS AND MINUTES, FOR MAY, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 6 54 | 0 | 0 | 6 37 | 0 | 0 | 6 49 | 3 49 | 3 | | | | 6 41 | 12 | 1 33 | 6 38 | 1 42 | 69 |
| 2 | 6 55 | 32 | 1 41 | 6 38 | 0 | 36 | 6 50 | 3 50 | 3 | | | | 6 42 | 3 33 | 2 15 | 6 40 | 57 | 2 42 |
| 3 | 6 56 | 2 13 | 2 30 | 6 40 | 1 52 | 13 | 6 51 | 15 | 36 | 3 | 27 | 15 | 6 43 | 3 43 | 3 | 6 41 | 1 54 | 2 27 |
| 4 | 6 57 | 2 32 | 34 | 6 41 | 1 16 | 1 30 | 6 52 | 1 48 | 3 | 3 | 30 | 1 42 | 6 44 | 1 57 | 1 30 | 6 42 | 1 54 | 3 09 |
| 5 | 6 58 | 3 | 2 | 6 42 | 1 57 | 2 42 | 6 53 | 3 53 | 3 | 3 | | 3 53 | 6 45 | 2 30 | 3 | 6 43 | 1 48 | 2 42 |
| 6 | 6 59 | 3 18 | 3 | 6 44 | 3 | 2 28 | 6 54 | 3 54 | 3 | 3 | | 2 24 | 9 46 | 3 46 | 3 | 6 44 | 3 | 3 24 |
| 7 | 7 01 | 3 36 | 3 | 6 45 | 2 55 | 2 51 | 6 55 | 3 55 | 3 | 2 | 21 | 3 55 | 6 47 | 3 47 | 3 | 6 45 | 2 39 | 1 42 |
| 8 | 7 02 | 3 27 | 1 46 | 6 46 | 1 07 | 0 | 6 56 | 3 56 | 3 | 3 | | 57 | 6 48 | 3 39 | 2 56 | 6 46 | 2 51 | 2 42 |
| 9 | 7 03 | 1 55 | 2 07 | 6 47 | 36 | 20 | 6 57 | 0 | 3 | 2 | | 0 | 6 49 | 3 19 | 2 39 | 6 47 | 2 33 | 3 24 |
| 10 | 7 04 | 0 | 0 | 6 49 | 23 | 2 15 | 6 58 | 1 51 | 2 24 | 2 | 45 | 3 43 | 6 50 | 3 50 | 2 48 | 6 48 | 36 | 1 57 |
| 11 | 7 05 | 1 55 | 14 | 6 50 | 3 | 1 32 | 6 59 | 3 | 3 | 3 | | 3 59 | 6 51 | 3 03 | 3 | 6 48 | | 3 48 |
| 12 | 7 06 | 3 11 | 2 13 | 6 51 | 2 24 | 2 33 | 7 00 | 3 59 | 3 | 3 | | 1 51 | 6 52 | 3 52 | 3 | 6 49 | | 3 15 |
| 13 | 7 07 | 2 13 | 2 36 | 6 52 | 3 | 2 38 | 7 00 | 1 48 | 2 15 | 3 | 69 | 3 12 | 6 53 | 3 53 | 3 | 6 50 | 36 | 2 24 |
| 14 | 7 08 | 3 22 | 3 | 6 53 | 3 | 1 21 | 7 01 | 4 | 3 | 3 | | 4 01 | 6 53 | 3 53 | 3 | 6 51 | 18 | 3 36 |
| 15 | 7 09 | 05 | 1 30 | 6 54 | 49 | 2 38 | 7 02 | 0 | 03 | 3 | 36 | 06 | 6 54 | 1 42 | 2 54 | 6 52 | 1 50 | 69 |
| 16 | 7 10 | 1 50 | 3 | 6 54 | 3 | 1 21 | 7 03 | 4 03 | 3 | 3 | | 3 51 | 6 55 | 3 55 | 48 | 6 52 | 39 | 18 |
| 17 | 7 10 | 2 27 | 3 | 6 55 | 2 57 | 36 | 7 04 | 1 03 | 3 | 2 | 18 | 1 45 | 6 56 | 3 09 | 2 | 6 52 | 12 | 3 18 |
| 18 | 7 11 | 3 22 | 2 36 | 6 56 | 1 34 | 78 | 7 05 | 3 45 | 3 | 3 | | 4 05 | 6 57 | 3 57 | 3 | 6 54 | 2 | 3 54 |
| 19 | 7 12 | 3 06 | 2 51 | 6 57 | 1 25 | 27 | 7 06 | 4 05 | 3 | 3 | | 1 06 | 6 58 | 2 57 | 2 | 6 55 | 2 57 | 2 24 |
| 20 | 7 13 | 1 46 | 2 55 | 6 58 | 2 50 | 3 01 | 7 07 | 2 39 | 3 | 1 | 36 | 12 | 6 59 | 3 50 | 3 | 6 56 | 2 57 | 3 56 |
| 21 | 7 14 | 3 13 | 3 | 6 59 | 3 | 3 32 | 7 08 | 4 07 | 2 54 | 3 | | 4 08 | 6 59 | 3 59 | 2 | 6 56 | | 3 56 |
| 22 | 7 15 | 3 22 | 2 41 | 7 00 | 31 | 0 | 7 08 | 27 | 36 | 0 | | 45 | 7 00 | 4 | 2 03 | 6 57 | 18 | 3 45 |
| 23 | 7 15 | 3 01 | 1 46 | 7 01 | 1 12 | 3 13 | 7 09 | 1 36 | 3 | 3 | 12 | 2 45 | 7 01 | 1 01 | 2 18 | 6 58 | 2 57 | 3 33 |
| 24 | 7 16 | 1 50 | 3 | 7 01 | 3 | 2 37 | 7 10 | 4 06 | 2 27 | 2 | 54 | 4 10 | 7 01 | 4 01 | 3 | 6 58 | | 3 57 |
| 25 | 7 17 | 3 36 | 3 | 7 02 | 2 28 | 54 | 7 10 | 2 03 | 3 | 3 | | 4 10 | 7 02 | 4 02 | 3 | 6 59 | 2 33 | 1 54 |
| 26 | 7 18 | 37 | 2 32 | 7 03 | 3 | 3 32 | 7 11 | 0 | 0 | 1 | 24 | 4 11 | 7 03 | 4 03 | 3 | 6 59 | 2 21 | 3 21 |
| 27 | 7 18 | 3 32 | 2 23 | 7 04 | 54 | 1 34 | 7 11 | 4 11 | 3 | 2 | 51 | 1 11 | 7 03 | 3 48 | 1 36 | 7 00 | 2 33 | 2 57 |
| 28 | 7 19 | 2 23 | 2 13 | 7 05 | 2 16 | 2 33 | 7 12 | 0 | 0 | 0 | | 0 | 7 04 | 4 04 | 3 | 7 00 | 3 | 4 |
| 29 | 7 20 | 3 27 | 2 50 | 7 05 | .... | .... | 7 12 | 3 45 | 3 | 2 | 09 | 0 | 7 04 | 4 04 | 57 | 7 01 | 42 | 1 45 |
| 30 | 7 20 | 3 27 | 3 | 7 06 | 3 | 3 41 | 7 13 | 4 13 | 3 | 3 | | 4 13 | 7 05 | 4 05 | 3 | 7 01 | 3 | 1 03 |
| 31 | 7 21 | 2 55 | 3 | 7 07 | 2 02 | 2 56 | 7 14 | 2 48 | 2 21 | | 36 | 4 14 | 7 06 | 4 06 | 3 | 7 02 | 2 45 | 4 02 |
| | 221 23 | 75 16 | 69 58 | 213 42 | 58 28 | 54 35 | 218 21 | 85 49 | 73 36 | Same as for forenoons, as there are no mountains on horizon. | 63 18 | 81 38 | 214 10 | 109 19 | 78 57 | 212 45 | 73 12 | 84 33 |
| Per cent... | | 58.1 | 75.2 | ..... | 65.0 | 46.8 | ..... | 68.46 | 79.14 | | 68.06 | 65.12 | ..... | 90.22 | 84 89 | ..... | 78.71 | 70.61 |

## SUNSHINE, IN HOURS AND MINUTES, FOR JUNE, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 7 21 | 4 21 | 3 | 7 08 | 2 52 | 54 | 7 14 | 4 14 | 3 | Same as forenoons, as there are no mountains on horizon. | 3 | 1 27 | 7 06 | .... | .... | 7 02 | .... | .... |
| 2 | 7 22 | 4 22 | 3 | 7 08 | 2 42 | 3 31 | 7 15 | 4 15 | 3 | | 3 | 2 45 | 7 06 | .... | .... | 7 03 | .... | .... |
| 3 | 7 22 | 1 28 | 2 25 | 7 09 | 28 | 46 | 7 15 | 4 15 | 3 | | 3 | 4 12 | 7 06 | .... | .... | 7 03 | .... | .... |
| 4 | 7 23 | 2 15 | 2 57 | 7 09 | 2 52 | 3 10 | 7 16 | 4 16 | 3 | | 2 57 | 4 12 | 7 07 | .... | .... | 7 04 | .... | .... |
| 5 | 7 23 | 4 23 | 2 51 | 7 10 | 1 | 2 37 | 7 16 | 1 54 | 1 15 | | 3 | 4 16 | 7 07 | .... | .... | 7 04 | .... | .... |
| 6 | 7 24 | 2 51 | 39 | 7 10 | 24 | 0 | 7 17 | 06 | 1 06 | | 21 | 0 | 7 08 | .... | .... | 7 04 | .... | .... |
| 7 | 7 24 | 4 24 | 3 | 7 11 | 1 48 | 3 50 | 7 17 | 4 17 | 3 | | 2 21 | 3 45 | 7 08 | .... | .... | 7 05 | .... | .... |
| 8 | 7 24 | 3 27 | 3 | 7 11 | 3 | 4 11 | 7 17 | 4 17 | 3 | | 3 | 4 17 | 7 08 | .... | .... | 7 05 | .... | .... |
| 9 | 7 25 | 4 09 | 2 57 | 7 12 | 49 | 1 16 | 7 17 | 4 17 | 3 | | 45 | 54 | 7 09 | .... | .... | 7 06 | .... | .... |
| 10 | 7 25 | 2 21 | 36 | 7 13 | 22 | 1 05 | 7 18 | 4 18 | 3 | | 1 18 | 15 | 7 09 | .... | .... | 7 06 | .... | .... |
| 11 | 7 26 | 3 19 | 2 09 | 7 13 | 1 13 | 1 05 | 7 18 | 4 18 | 3 | | 3 | 3 21 | 7 09 | .... | .... | 7 06 | .... | .... |
| 12 | 7 26 | 0 | 1 31 | 7 13 | 2 28 | 3 07 | 7 18 | 3 12 | 1 48 | | 12 | 2 27 | 7 09 | .... | .... | 7 06 | .... | .... |
| 13 | 7 26 | 4 09 | 2 18 | 7 13 | 03 | 0 | 7 18 | 3 03 | 3 | | 3 | 3 48 | 7 10 | .... | .... | 7 07 | .... | .... |
| 14 | 7 26 | 4 | 3 | 7 14 | 2 18 | 2 18 | 7 18 | 4 12 | 3 | | 3 | 4 18 | 7 10 | .... | .... | 7 07 | .... | .... |
| 15 | 7 26 | 4 26 | 3 | 7 14 | 1 56 | 1 26 | 7 19 | 4 19 | 3 | | 1 06 | 3 48 | 7 10 | .... | .... | 7 07 | .... | .... |
| 16 | 7 26 | 4 26 | 3 | 7 14 | 2 29 | 3 50 | 7 19 | 4 19 | 3 | | 3 | 1 30 | 7 10 | .... | .... | 7 07 | .... | .... |
| 17 | 7 27 | 3 55 | 1 17 | 7 14 | 2 10 | 4 12 | 7 19 | 4 19 | 3 | | 2 42 | 1 54 | 7 10 | .... | .... | 7 07 | .... | .... |
| 18 | 7 27 | 4 27 | 3 | 7 14 | 2 37 | 2 45 | 7 19 | 4 19 | 3 | | 3 | 3 06 | 7 10 | .... | .... | 7 07 | .... | .... |
| 19 | 7 27 | 4 27 | 3 | 7 15 | 3 | 3 20 | 7 19 | 2 15 | 3 | | 3 | 4 19 | 7 10 | .... | .... | 7 07 | .... | .... |
| 20 | 7 27 | 1 59 | 3 | 7 15 | 2 54 | 3 20 | 7 19 | 4 19 | 3 | | 3 | 4 19 | 7 10 | .... | .... | 7 07 | .... | .... |
| 21 | 7 27 | 4 23 | 3 | 7 15 | 3 | 3 47 | 7 19 | 4 19 | 3 | | 3 | 4 19 | 7 11 | .... | .... | 7 08 | .... | .... |
| 22 | 7 27 | 4 27 | 3 | 7 15 | 3 | 1 45 | 7 19 | 4 19 | 2 30 | | 1 57 | 1 54 | 7 11 | .... | .... | 7 08 | .... | .... |
| 23 | 7 27 | 4 27 | 3 | 7 14 | 3 | 3 41 | 7 19 | 3 09 | 3 | | 1 39 | 2 21 | 7 11 | .... | .... | 7 08 | .... | .... |
| 24 | 7 27 | 1 45 | 33 | 7 11 | 1 42 | 1 06 | 7 19 | 4 19 | 2 57 | | 2 18 | 3 15 | 7 11 | .... | .... | 7 07 | .... | .... |
| 25 | 7 27 | 4 27 | 3 | 7 11 | 2 24 | 11 | 7 18 | 4 18 | 3 | | 2 33 | 1 33 | 7 10 | .... | .... | 7 07 | .... | .... |
| 26 | 7 27 | 4 27 | 3 | 7 14 | 1 26 | 33 | 7 18 | 3 54 | 3 | | 2 51 | 2 03 | 7 10 | .... | .... | 7 07 | .... | .... |
| 27 | 7 26 | 4 26 | 3 | 7 14 | 1 06 | 20 | 7 18 | 4 18 | 3 | | 2 12 | 1 21 | 7 10 | .... | .... | 7 07 | .... | .... |
| 28 | 7 26 | 4 26 | 3 | 7 13 | 2 15 | 1 59 | 7 18 | 2 | 3 | | 3 | 4 18 | 7 10 | .... | .... | 7 07 | .... | .... |
| 29 | 7 26 | 4 14 | 3 | 7 13 | 3 | 3 02 | 7 18 | 4 18 | 3 | | 2 | 1 15 | 7 10 | .... | .... | 7 07 | .... | .... |
| 30 | 7 26 | 4 06 | 2 48 | 7 13 | 2 48 | 3 39 | 7 18 | 3 24 | 2 57 | | 1 05 | 57 | 7 10 | .... | .... | 7 06 | .... | .... |
| | 222 44 | 110 17 | 77 04 | 216 18 | 61 36 | 66 46 | 219 52 | 113 12 | 84 33 | | 72 18 | 82 03 | 214 34 | .... | .... | 213 02 | .... | .... |
| Per cent. | | 82.96 | 85.63 | | 68.44 | 52.83 | | 87.65 | 93.94 | | 80.33 | 63.18 | | .... | .... | | .... | .... |

## SUNSHINE, IN HOURS AND MINUTES, FOR JULY, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 7 26 | 2 15 | 3 | 7 13 | 2 02 | 57 | 7 18 | 4 18 | 2 18 | Same as for forenoons, as there are no mountains on horizon. | 1 42 | 1 30 | 7 09 | 45 | 1 42 | 7 06 | 1 30 | 18 |
| 2 | 7 25 | 4 25 | 2 26 | 7 12 | 2 23 | 2 34 | 7 17 | 4 17 | 1 18 | | 1 30 | 4 17 | 7 09 | 3 39 | 3 | 7 06 | 2 36 | 1 21 |
| 3 | 7 25 | 4 25 | 3 | 7 12 | 2 10 | 1 56 | 7 17 | 4 17 | 3 | | 2 57 | 3 36 | 7 09 | 4 | 3 | 7 05 | 1 | 1 06 |
| 4 | 7 24 | 4 24 | 3 | 7 11 | 2 40 | 3 23 | 7 16 | 4 16 | 3 | | | 4 06 | 7 08 | 4 08 | 3 | 7 05 | 3 | 15 |
| 5 | 7 24 | 2 18 | 1 51 | 7 11 | 03 | 16 | 7 16 | 3 30 | 2 51 | | | 4 06 | 7 08 | 3 39 | 3 | 7 05 | 12 | 2 03 |
| 6 | 7 23 | 3 05 | 2 29 | 7 11 | 1 35 | 35 | 7 16 | 3 33 | 2 45 | | | 3 03 | 7 07 | 4 07 | 2 45 | 7 01 | 0 | 57 |
| 7 | 7 23 | 1 18 | 2 53 | 7 10 | 41 | 1 48 | 7 15 | 3 | | | 2 42 | 2 45 | 7 07 | 4 07 | 1 54 | 7 01 | 2 12 | 0 |
| 8 | 7 22 | 2 29 | 3 | 7 10 | 3 | 06 | 7 15 | 4 15 | 3 | | | 4 09 | 7 07 | 4 07 | 3 | 7 03 | 24 | 1 24 |
| 9 | 7 22 | 3 14 | 3 | 7 09 | 3 | 1 53 | 7 14 | 2 09 | 3 | | 2 39 | 3 09 | 7 06 | 3 18 | 1 | 7 03 | 1 15 | 3 12 |
| 10 | 7 22 | 4 22 | 1 18 | 7 09 | 06 | 08 | 7 14 | 3 36 | 2 06 | | 1 30 | 45 | 7 06 | 2 54 | 1 39 | 7 02 | 0 | 0 |
| 11 | 7 21 | 4 21 | 3 | 7 08 | 3 | 4 | 7 13 | 4 13 | 3 | | 3 | 1 06 | 7 05 | 2 51 | 2 39 | 7 02 | 1 21 | 27 |
| 12 | 7 20 | 4 20 | 3 | 7 07 | 3 | 3 52 | 7 13 | 4 13 | 3 | | 3 | 2 21 | 7 05 | 4 05 | 2 18 | 7 01 | 33 | 2 24 |
| 13 | 7 20 | 1 20 | 2 46 | 7 06 | 1 48 | 2 51 | 7 12 | 3 12 | 3 | | 3 | 33 | 7 01 | 4 01 | 2 30 | 6 01 | 2 | 54 |
| 14 | 7 19 | 47 | 1 50 | 7 05 | 06 | 2 15 | 7 12 | 1 33 | 39 | | 1 51 | 51 | 7 04 | 4 01 | 2 36 | 7 00 | 2 | 2 |
| 15 | 7 18 | 1 18 | 3 | 7 05 | 3 | 1 50 | 7 11 | 3 27 | 2 51 | | 2 54 | 3 | 7 03 | 3 33 | 3 | 7 00 | 71 | 1 15 |
| 16 | 7 18 | 1 56 | 1 01 | 7 04 | 52 | 3 02 | 7 11 | 3 39 | 3 | | 2 54 | 4 11 | 7 02 | 4 02 | 2 33 | 6 59 | 3 | 1 27 |
| 17 | 7 17 | 3 32 | 2 06 | 7 03 | 14 | 19 | 7 10 | 3 57 | 3 | | 2 57 | 3 57 | 7 02 | 4 02 | 2 57 | 6 58 | 1 48 | 24 |
| 18 | 7 16 | 3 30 | 2 46 | 7 02 | 2 04 | 0 | 7 09 | 4 09 | 3 | | | 4 09 | 7 01 | 3 | 2 57 | 6 58 | 1 30 | 3 48 |
| 19 | 7 16 | 3 14 | 2 03 | 7 01 | 1 32 | 0 | 7 08 | 3 03 | 2 51 | | 2 39 | 1 18 | 7 01 | 3 48 | 1 18 | 6 57 | 42 | 2 36 |
| 20 | 7 15 | 4 15 | 3 | 7 00 | 2 54 | 0 | 7 08 | 4 08 | 3 | | | 3 39 | 7 00 | 4 | 2 18 | 6 56 | 1 06 | 2 54 |
| 21 | 7 14 | 1 15 | 2 51 | 6 59 | 22 | 19 | 7 07 | 3 30 | 3 | | | 2 42 | 6 59 | 3 59 | 3 | 6 56 | 1 27 | 1 39 |
| 22 | 7 13 | 3 54 | 1 45 | 6 58 | 1 45 | 3 04 | 7 06 | 2 12 | 2 36 | | 1 57 | 0 | 6 58 | 3 58 | 2 54 | 7 55 | 30 | 1 36 |
| 23 | 7 12 | 4 12 | 3 | 6 57 | 3 | 2 59 | 7 06 | 4 06 | 2 42 | | 2 12 | 1 51 | 6 58 | 3 45 | 2 57 | 6 54 | 1 57 | 51 |
| 24 | 7 11 | 4 11 | 2 57 | 6 56 | 3 | 3 44 | 7 05 | 2 33 | 2 30 | | 2 24 | 21 | 6 57 | 3 42 | 3 | 6 54 | 21 | 2 15 |
| 25 | 7 11 | 2 46 | 3 | 6 55 | 3 | 1 05 | 7 01 | 33 | 2 27 | | 2 12 | 4 01 | 6 56 | 3 56 | 3 | 6 53 | 2 24 | 2 51 |
| 26 | 7 10 | 4 10 | 3 | 6 55 | 3 | 1 42 | 7 03 | 1 06 | 1 27 | | 2 27 | 1 27 | 6 55 | 3 55 | 2 15 | 6 52 | 2 12 | 33 |
| 27 | 7 09 | 1 09 | 2 51 | 6 54 | 3 | 3 35 | 7 02 | 2 15 | 1 57 | | 1 36 | 0 | 6 54 | 1 | 2 57 | 6 51 | 2 36 | 1 54 |
| 28 | 7 08 | 3 58 | 2 54 | 6 53 | 22 | 38 | 7 02 | 0 | 1 30 | | 1 12 | 3 09 | 6 54 | 3 54 | 3 | 6 50 | 1 03 | 45 |
| 29 | 7 07 | 55 | 1 12 | 6 52 | 27 | 1 40 | 7 01 | 3 06 | 3 | | 2 54 | 1 57 | 6 53 | 3 45 | 1 15 | 6 50 | 06 | 33 |
| 30 | 7 06 | 3 58 | 47 | 6 51 | 0 | 24 | 7 00 | 1 24 | 2 21 | | 2 15 | 3 18 | 6 52 | 1 33 | 24 | 6 49 | 1 24 | 0 |
| 31 | 7 05 | 1 05 | 3 | 6 50 | 3 | 3 26 | 6 59 | 33 | 30 | | 0 | 0 | 6 51 | 2 | 2 | 6 48 | 3 | 1 57 |
| | 225 45 | 107 21 | 77 46 | 248 29 | 57 06 | 57 21 | 222 00 | 91 54 | 77 39 | | 75 21 | 75 20 | 217 50 | 107 10 | 77 18 | 216 07 | 44 33 | 42 36 |
| Per cent... | | 80.86 | 83.62 | ..... | 61.4 | 45.7 | ..... | 73.56 | 83.5 | | 81.07 | 58.39 | ..... | 85.84 | 83.12 | ..... | 47.90 | 34.60 |

* Measurements of sunshine uncertain, on account of dimness of record.

## SUNSHINE, IN HOURS AND MINUTES, FOR AUGUST, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 to 3 p. m. | After 3 p. m. |
| 1 | 7 04 | 1 37 | 2 26 | 6 49 | 1 16 | 1 05 | 6 58 | 2 12 | 2 54 | | 2 48 | 2 21 | 6 50 | 3 50 | 2 | | 30 | 0 |
| 2 | 7 03 | 3 29 | 3 | 6 48 | 3 | 1 29 | 6 58 | 3 58 | 3 | | 3 | 2 21 | 6 49 | 3 49 | 3 | | 2 48 | 2 27 |
| 3 | 7 02 | 1 31 | 2 48 | 6 46 | 2 01 | 2 26 | 6 56 | 3 48 | 3 | | 3 | 1 12 | 6 48 | 2 54 | 1 57 | | 27 | 12 |
| 4 | 7 01 | 0 | 0 | 6 45 | 1 42 | 3 17 | 6 55 | 3 55 | 3 | | 3 | 3 55 | 6 47 | 3 48 | 2 57 | | 1 48 | 2 51 |
| 5 | 7 00 | 3 49 | 3 | 6 44 | 1 53 | 3 14 | 6 55 | 3 55 | 3 | | 1 57 | 3 55 | 6 46 | 3 46 | 3 | | 2 18 | 2 45 |
| 6 | 6 59 | 3 19 | 3 | 6 42 | 3 48 | 1 32 | 6 54 | 3 54 | 3 | | 0 | 33 | 6 45 | 3 45 | 3 | | 3 | 3 43 |
| 7 | 6 58 | 3 55 | 2 04 | 9 41 | 1 26 | 41 | 6 53 | 1 30 | 2 45 | | 3 | 3 53 | 6 44 | 3 44 | 3 | | 3 | 2 27 |
| 8 | 6 57 | 3 10 | 3 | 6 40 | 41 | 0 | 6 52 | 3 39 | 3 | | 3 | 3 52 | 6 43 | 3 43 | 3 | | 42 | 45 |
| 9 | 6 56 | 1 59 | 1 45 | 6 39 | 1 24 | 52 | 6 51 | 2 45 | 3 | | 3 | 3 21 | 6 42 | 3 42 | 3 | | 1 48 | 2 03 |
| 10 | 6 55 | 3 55 | 3 | 6 38 | 1 13 | 0 | 6 50 | 3 50 | 3 | | 3 | 3 12 | 6 41 | 3 41 | 3 | | 3 | 24 |
| 11 | 6 54 | 53 | 1 15 | 6 37 | 57 | 39 | 6 49 | 2 24 | 2 51 | | 3 | 3 49 | 6 40 | 3 40 | 3 | | 1 57 | 39 |
| 12 | 6 52 | 42 | 1 43 | 6 35 | 24 | 1 08 | 6 47 | 2 09 | 1 | | 2 39 | 0 | 6 40 | 3 40 | 2 18 | | 1 36 | 1 |
| 13 | 6 51 | 0 | 1 06 | 6 34 | 1 24 | 24 | 6 46 | 0 | 0 | | 3 | 2 06 | 6 39 | 2 15 | 1 33 | | 03 | 06 |
| 14 | 6 50 | 3 52 | 3 | 6 33 | 14 | 1 54 | 6 46 | 3 46 | 3 | | 2 36 | 03 | 6 38 | 2 39 | 3 | | 2 24 | 1 54 |
| 15 | 6 49 | 0 | 0 | 6 32 | 1 18 | 14 | 6 45 | 3 21 | 3 | | 3 | 1 09 | 6 37 | 1 24 | 1 30 | | 15 | 0 |
| 16 | 6 48 | 0 | 0 | 6 31 | 1 08 | 2 37 | 6 43 | 2 36 | 3 | | 2 36 | 48 | 6 36 | 3 15 | 2 54 | | 54 | 36 |
| 17 | 6 46 | 1 20 | 3 | 6 29 | 2 42 | 3 29 | 6 42 | 2 21 | 2 36 | | 2 54 | 3 03 | 6 36 | 3 36 | 3 | | 1 54 | 57 |
| 18 | 6 45 | 1 31 | 1 01 | 6 28 | 11 | 0 | 6 41 | 36 | 2 30 | | 2 57 | 21 | 6 35 | 2 15 | 2 48 | | 06 | 1 36 |
| 19 | 6 44 | 0 | 0 | 6 27 | 0 | 0 | 6 40 | 51 | 2 48 | | 2 36 | 12 | 6 34 | 3 34 | 3 | | 6 31 | 24 | 1 45 |
| 20 | 6 43 | 3 43 | 3 | 6 26 | 3 | 3 25 | 6 39 | 2 39 | 2 48 | | 3 | 3 39 | 6 33 | 3 24 | 2 24 | | 6 30 | 2 03 | 1 |
| 21 | 6 41 | 3 41 | 3 | 6 24 | 3 | 3 24 | 6 38 | 3 38 | 3 | | 3 | 3 30 | 6 32 | 3 32 | 3 | | 6 29 | 3 | 3 27 |
| 22 | 6 40 | 3 21 | 2 23 | 6 23 | 14 | 30 | 6 37 | 2 03 | 2 30 | | 2 36 | 1 48 | 6 30 | 2 06 | 27 | | 6 28 | 21 | 48 |
| 23 | 6 39 | 1 48 | 3 | 6 22 | 2 48 | 2 42 | 6 35 | 2 21 | 2 30 | | 2 45 | 3 21 | 6 29 | 3 03 | 2 30 | | 6 28 | 3 | 3 28 |
| 24 | 6 38 | 3 38 | 3 | 6 21 | 3 | 2 59 | 6 34 | 45 | 0 | | 2 54 | 3 33 | 6 28 | 3 28 | 2 39 | | 6 27 | 1 48 | 15 |
| 25 | 6 36 | 1 42 | 1 56 | 6 19 | 2 42 | 1 26 | 6 33 | 2 42 | 3 | | 1 57 | 2 48 | 6 27 | 54 | 51 | | 6 26 | 42 | 45 |
| 26 | 6 35 | 3 35 | 3 | 6 18 | 3 | 3 17 | 6 32 | 1 06 | 1 54 | | 3 | 3 32 | 6 26 | 3 15 | 3 | | 6 26 | 2 09 | 48 |
| 27 | 6 34 | 3 34 | 3 | 6 17 | 3 | 2 15 | .... | .... | .... | | 2 | 2 15 | 6 24 | 1 15 | 1 27 | | 5 25 | 1 39 | 51 |
| 28 | 6 33 | 3 09 | 3 | 6 15 | 1 40 | 2 29 | .... | .... | .... | | 2 29 | 3 30 | 6 23 | 2 30 | 3 | | 6 24 | 2 24 | 2 21 |
| 29 | 6 32 | 3 32 | 3 | 6 14 | 2 42 | 36 | .... | .... | .... | | 3 | 3 29 | 6 22 | 3 22 | 3 | | 6 23 | 3 | 3 03 |
| 30 | 6 30 | 3 30 | 3 | 6 13 | 2 18 | 2 15 | .... | .... | .... | | 3 | 3 28 | 6 21 | 3 21 | 2 27 | | 6 23 | 2 03 | 2 27 |
| 31 | 6 29 | 1 51 | 1 15 | 6 12 | 1 48 | 11 | .... | .... | .... | | 1 51 | 39 | 6 20 | 0 | 1 33 | | 6 21 | 48 | 2 |
| | 210 24 | 72 05 | 67 42 | 201 41 | 55 24 | 70 21 | 175 41 | 66 44 | 66 15 | Same as for forenoons, as there are no mountains on horizon. | 82 45 | 75 38 | 204 25 | 93 10 | 77 15 | 203 31 | 52 21 | 47 23 |
| Per Cent. | | 61 26 | 72 79 | | 48 81 | 46 33 | | 85 75 | 81 93 | | 88 98 | 61 47 | | 83 62 | 83 06 | | 76 29 | 42 87 |

## SUNSHINE, IN HOURS AND MINUTES, FOR SEPTEMBER, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 6 28 | 3 19 | 2 32 | 6 10 | 05 | 1 13 | .... | .... | .... | Same as for forenoon, as there are no mountains on horizon. | 3 | 1 15 | 6 19 | 3 12 | 2 54 | 6 20 | 1 | 1 12 |
| 2 | 6 26 | 3 19 | 1 01 | 6 09 | 3 | 2 48 | 6 24 | 3 24 | 3 | | 3 | 1 | 6 18 | 3 18 | 2 39 | 6 19 | 1 39 | 21 |
| 3 | 6 25 | 3 25 | 3 | 6 07 | 3 | 3 07 | 6 23 | 1 45 | 1 57 | | 3 | 3 21 | 6 18 | 3 18 | 3 | 6 18 | 1 15 | 06 |
| 4 | 6 24 | 3 24 | 3 | 6 06 | 2 15 | 2 45 | 6 22 | 3 24 | 3 | | 2 35 | 3 18 | 6 17 | 3 17 | 3 | 6 17 | 2 57 | 2 21 |
| 5 | 6 22 | 0 | 2 35 | 6 05 | 0 | 06 | 6 21 | 3 24 | 3 | | 2 54 | 1 45 | 6 16 | 3 16 | 3 | 6 16 | 2 33 | 38 |
| 6 | 6 21 | 1 28 | 28 | 6 03 | 0 | 0 | 6 19 | 2 27 | 21 | | 57 | 36 | 6 15 | 0 | 36 | 6 15 | 0 | 27 |
| 7 | 6 20 | 1 42 | 2 57 | 6 02 | 3 | 3 02 | 6 18 | 3 06 | 1 09 | | 1 39 | 2 54 | 6 14 | 3 | 3 | 6 14 | 1 57 | 57 |
| 8 | *6 18 | *3 18 | *3 | 6 01 | 3 | 3 01 | 6 17 | 3 17 | 3 | | 3 | 3 17 | 6 13 | 3 13 | 3 | 6 13 | 3 | 3 13 |
| 9 | *6 17 | *3 16 | *2 46 | 5 59 | 2 56 | 1 10 | 6 16 | 3 16 | 3 | | 2 51 | 2 33 | 6 12 | 3 12 | 3 | 6 12 | 2 30 | 1 54 |
| 10 | 6 16 | 3 16 | 2 49 | 5 58 | 2 18 | 9 | 6 15 | 3 15 | 3 | | 3 | 3 15 | 6 10 | 3 10 | 3 | 6 11 | 2 03 | 33 |
| 11 | 6 15 | 2 15 | 3 | 5 57 | 1 49 | 2 31 | 6 13 | 3 13 | 3 | | 3 | 3 03 | 6 09 | 3 09 | 3 | 6 09 | 2 | 3 09 |
| 12 | 6 13 | 3 13 | 3 | 5 55 | 3 | 2 55 | 6 12 | 3 12 | 3 | | 3 | 3 12 | 6 08 | 3 08 | 3 | 6 08 | 2 33 | 3 08 |
| 13 | 6 12 | 3 12 | 3 | 5 54 | 2 21 | 2 12 | 6 11 | 3 11 | 3 | | 3 | 2 48 | 6 06 | 3 06 | 3 | 6 07 | 3 | 2 51 |
| 14 | 6 11 | 3 11 | 3 | 5 53 | 2 25 | 1 56 | 6 10 | 2 09 | 3 | | 2 42 | 1 45 | 6 05 | 3 05 | 3 | 6 06 | 2 42 | 2 18 |
| 15 | 6 09 | 3 09 | 3 | 5 52 | 3 | 2 51 | 6 09 | 3 09 | 2 57 | | 3 | 3 09 | 6 04 | 3 04 | 3 | 6 05 | 3 | 3 05 |
| 16 | 6 08 | 3 03 | 3 | 5 50 | 2 57 | 1 45 | 6 07 | 3 07 | 3 | | 2 18 | 57 | 6 02 | 18 | 2 45 | 6 03 | 1 | 0 |
| 17 | 6 07 | 0 | 1 30 | 5 49 | 1 16 | 08 | 6 06 | 1 33 | 3 | | 3 | 2 30 | 6 01 | 1 24 | 2 36 | 6 02 | 30 | 15 |
| 18 | 6 05 | 0 | 1 57 | 5 48 | 41 | 0 | 6 05 | 2 51 | 06 | | 0 | 0 | 6 00 | 2 27 | 1 09 | 6 01 | 1 48 | 1 21 |
| 19 | 6 04 | 1 31 | 3 | 5 45 | 3 | 1 48 | 6 04 | 3 04 | 3 | | 3 | 2 30 | 5 58 | 2 58 | 2 15 | 6 00 | 03 | 12 |
| 20 | 6 03 | 22 | 1 24 | 5 45 | 1 35 | 41 | 6 03 | 1 30 | 1 06 | | 24 | 24 | 5 57 | 1 27 | 1 21 | 5 59 | 0 | 0 |
| 21 | 6 01 | 3 01 | 3 | 5 43 | 2 50 | 57 | 6 01 | 2 42 | 0 | | 1 57 | 3 01 | 5 55 | 1 45 | 3 | 5 57 | 2 54 | 42 |
| 22 | 6 00 | 3 | 3 | 5 42 | 3 | 2 34 | 6 00 | 3 | 3 | | 3 | 3 | 5 54 | 2 54 | 2 57 | 5 56 | 3 | 2 09 |
| 23 | 5 59 | 25 | 2 59 | 5 41 | 2 43 | 1 24 | 5 59 | 2 39 | 3 | | 3 | 2 59 | 5 53 | 2 53 | 3 | 5 55 | 3 | 15 |
| 24 | 5 57 | 2 21 | 3 | 5 39 | 3 | 2 25 | 5 58 | 2 27 | 2 45 | | 3 | 1 24 | 5 51 | 2 36 | 2 39 | 5 54 | 2 06 | 1 48 |
| 25 | 5 56 | 2 17 | 2 37 | 5 38 | 2 33 | 1 | 5 57 | 2 12 | 3 | | 3 | 2 57 | 5 50 | 2 50 | 2 57 | 5 53 | 3 | 18 |
| 26 | 5 55 | 2 14 | 2 50 | 5 37 | 1 59 | 1 20 | 5 55 | 1 54 | 3 | | 3 | 1 42 | 5 48 | 2 48 | 3 | 5 51 | 2 18 | 2 |
| 27 | 5 53 | 2 53 | 3 | 5 35 | 3 | 2 12 | 5 54 | 2 20 | 2 48 | | 3 | 2 54 | 5 47 | 2 47 | 3 | 5 50 | 1 48 | 1 27 |
| 28 | 5 52 | 2 52 | 3 | 5 34 | 2 35 | 1 54 | 5 53 | 2 53 | 3 | | 3 | 2 53 | 5 46 | 2 46 | 3 | 5 49 | 2 57 | 2 49 |
| 29 | 5 51 | 2 51 | 3 | 5 33 | 3 | 2 33 | 5 52 | 2 21 | 3 | | 3 | 2 52 | 5 44 | 2 44 | 3 | 5 48 | 3 | 2 27 |
| 30 | 5 49 | 2 49 | 3 | 5 31 | 3 | 2 31 | 5 51 | 1 48 | 3 | | 3 | 2 51 | 5 43 | 2 42 | 2 27 | 5 46 | 30 | 0 |
| | 181 18 | 71 14 | 79 07 | 175 01 | 69 21 | 52 59 | 177 35 | 78 27 | 73 09 | | 78 21 | 70 02 | 181 11 | 79 47 | 81 15 | 181 55 | 60 03 | 42 06 |
| Per cent... | 75.89 | | 87 90 | ..... | 77.06 | 60.11 | ..... | 89.57 | 81.28 | | 87.05 | 74.50 | ..... | 87.49 | 88.43 | ..... | 66.72 | 45.80 |

* Record of both days fell in same line.

## SUNSHINE, IN HOURS AND MINUTES, FOR OCTOBER, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 5 48 | 1 09 | 05 | 5 30 | 1 51 | 46 | 5 50 | 45 | 3 | Same as for forenoons, as there are no mountains on horizon. | 1 30 | 2 45 | 5 42 | 2 42 | 3 | 5 45 | 1 54 | 1 24 |
| 2 | 5 47 | 1 17 | 3 | 5 28 | 2 23 | 2 20 | 5 48 | 42 | 45 | | 3 | 2 48 | 5 41 | 2 41 | 2 48 | 5 45 | 45 | 2 43 |
| 3 | 5 45 | 2 45 | 3 | 5 27 | 1 59 | 33 | 5 47 | 0 | 0 | | 1 33 | 57 | 5 40 | 05 | 2 21 | 5 42 | 1 51 | 0 |
| 4 | 5 44 | 0 | 0 | 5 26 | 0 | 0 | 5 46 | 2 27 | 3 | | 3 | 2 46 | 5 38 | 57 | 1 51 | 5 40 | 27 | 1 09 |
| 5 | 5 43 | 2 43 | 3 | 5 24 | 2 39 | 2 24 | 5 45 | 2 30 | 3 | | 3 | 2 30 | 5 37 | 3 37 | 3 | 5 39 | 3 | 2 39 |
| 6 | 5 41 | 2 04 | 3 | 5 23 | 1 35 | 14 | 5 43 | 50 | 2 24 | | | 15 | 1 12 | 5 36 | 3 36 | 3 | 3 | 2 37 |
| 7 | 5 40 | 44 | 08 | 5 21 | 27 | 49 | 5 42 | 1 27 | 2 42 | | 1 15 | 0 | | 5 35 | 3 24 | 2 48 | 5 38 | 2 36 |
| 8 | 5 39 | 1 31 | 17 | 5 20 | 25 | 0 | 5 41 | 0 | 0 | | 24 | 03 | | 5 33 | 0 | 0 | 5 35 | 12 | 0 |
| 9 | 5 37 | 0 | 0 | 5 19 | 0 | 0 | 5 40 | 0 | 1 45 | | 1 57 | 39 | | 5 33 | 3 33 | 3 | 5 33 | 1 24 | 33 |
| 10 | 5 36 | 14 | 2 21 | 5 17 | 3 | 1 40 | 5 39 | 1 49 | 1 49 | | 1 40 | 1 24 | | 5 32 | 3 03 | 1 09 | 5 32 | 33 | 15 |
| 11 | 5 35 | 0 | 0 | 5 16 | 27 | 08 | 5 37 | 2 12 | 3 | | 3 | 2 24 | | 5 31 | 0 | 1 | 5 30 | 57 | 42 |
| 12 | 5 33 | 1 39 | 3 | 5 14 | 1 05 | 51 | 5 36 | 1 35 | 3 | | 3 | 2 36 | | 5 30 | 2 30 | 3 | 5 29 | 2 35 | 2 29 |
| 13 | 5 32 | 2 32 | 3 | 5 13 | 3 | 2 13 | 5 35 | 1 42 | 3 | | 2 12 | 45 | | 5 29 | 3 29 | 3 | 5 27 | 3 | 2 27 |
| 14 | 5 31 | 39 | 2 10 | 5 11 | 1 56 | 1 | 5 34 | 1 15 | 3 | | 2 42 | 2 34 | | 5 28 | 1 12 | 3 | 5 25 | 3 | 2 26 |
| 15 | 5 30 | 1 23 | 3 | 5 10 | 2 55 | 2 10 | 5 33 | 0 | 2 07 | | 3 | 2 33 | | 5 27 | 3 27 | 3 | 5 24 | 3 | 2 24 |
| 16 | 5 28 | 53 | 1 20 | 5 08 | 3 | 2 08 | 5 31 | 1 30 | 3 | | 3 | 2 31 | | 5 26 | 3 26 | 3 | 5 23 | 3 | 2 23 |
| 17 | 5 27 | 2 27 | 3 | 5 07 | 3 | 2 07 | 5 30 | 1 30 | 3 | | 3 | 2 30 | | 5 25 | 3 25 | 3 | 5 21 | 3 | 2 24 |
| 18 | 5 26 | 2 26 | 3 | 5 06 | 3 | 2 06 | 5 29 | 1 25 | 3 | | 3 33 | 0 | | 5 24 | 3 24 | 3 | 5 20 | 3 | 2 20 |
| 19 | 5 24 | 2 24 | 3 | 5 04 | 3 | 2 04 | 5 28 | 0 | 0 | | 0 | 03 | | 5 23 | 3 23 | 3 | 5 18 | 2 45 | 1 30 |
| 20 | 5 23 | 0 | 0 | 5 03 | 1 32 | 1 59 | 5 27 | 24 | 0 | | 42 | 0 | | 5 22 | 1 40 | 3 | 5 17 | 2 10 | 1 21 |
| 21 | 5 22 | 2 22 | 2 51 | 5 02 | 2 57 | 1 21 | 5 25 | 2 22 | 3 | | 3 | 2 25 | | 5 22 | 3 22 | 3 | 5 16 | 3 | 2 16 |
| 22 | 5 20 | 1 39 | 3 | 5 00 | 3 | 1 27 | 5 24 | 2 09 | 3 | | 3 | 2 24 | | 5 21 | 3 21 | 3 | 5 15 | 3 | 2 15 |
| 23 | 5 19 | 03 | 3 | 4 59 | 2 50 | 1 35 | 5 23 | 2 06 | 3 | | 3 | 2 23 | | 5 20 | 3 20 | 3 | 5 13 | 3 | 2 13 |
| 24 | 5 18 | 2 18 | 3 | 4 58 | 3 | 1 58 | 5 22 | 2 15 | 3 | | 3 | 2 22 | | 5 19 | 3 19 | 3 | 5 12 | 3 | 2 12 |
| 25 | 5 17 | 2 17 | 3 | 4 57 | 3 | 1 57 | 5 20 | 2 23 | 3 | | 3 | 2 20 | | 5 18 | 3 18 | 2 45 | 5 10 | 3 | 2 10 |
| 26 | 5 16 | 2 12 | 3 | 4 56 | 3 | 1 56 | 5 19 | 2 19 | 3 | | 3 | 2 19 | | 5 17 | 3 17 | 3 | 5 09 | 3 | 2 09 |
| 27 | 5 14 | 1 37 | 2 15 | 4 54 | 2 34 | 41 | 5 18 | 2 18 | 3 | | 2 12 | 0 | | 5 16 | 3 16 | 3 | 5 08 | 3 | 45 |
| 28 | 5 13 | 50 | 1 23 | 4 53 | 2 02 | 1 48 | 5 17 | 2 17 | 3 | | 3 | 2 17 | | 5 15 | 3 15 | 3 | 5 07 | 3 | 2 07 |
| 29 | 5 12 | 2 12 | 3 | 4 52 | 3 | 1 21 | 5 16 | 2 16 | 3 | | 3 | 2 16 | | 5 14 | 3 14 | 3 | 5 05 | 3 | 2 05 |
| 30 | 5 11 | 2 11 | 3 | 4 51 | 3 | 1 51 | 5 15 | 2 15 | 2 42 | | 2 42 | 2 15 | | 5 13 | 3 13 | 3 | 5 04 | 3 | 2 04 |
| 31 | 5 09 | 2 09 | 3 | 4 50 | 3 | 1 50 | 5 14 | 2 14 | 3 | | 3 | 2 14 | | 5 12 | 3 12 | 3 | 5 03 | 3 | 2 03 |
| | 169 50 | 46 40 | 66 50 | 159 37 | 68 37 | 43 17 | 171 14 | 46 46 | 74 01 | | 72 37 | 54 15 | 168 37 | 63 42 | 83 42 | 167 00 | 75 58 | 56 38 |
| Per cent. | ..... | 60.73 | 71.83 | ..... | 73.78 | 64.97 | ..... | 59.77 | 79.58 | | 78.08 | 69.11 | ..... | 84 24 | 90 | ..... | 81.68 | 79.19 |

## SUNSHINE, IN HOURS AND MINUTES, FOR NOVEMBER, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 5 08 | 2 08 | 3 | 4 49 | 3 | 1 49 | 5 13 | .... | .... | Same as for forenoons, as there are no mountains on horizon. | 2 39 | 2 13 | 5 11 | 1 40 | 3 | 5 02 | 3 | 2 02 |
| 2 | 5 07 | 28 | 25 | 4 48 | 30 | 1 48 | 5 11 | 2 11 | 3 | | 3 | 2 11 | 5 09 | 2 09 | 3 | 5 01 | 3 | 2 01 |
| 3 | 5 06 | 2 06 | 3 | 4 46 | 3 | 1 46 | 5 10 | 48 | 2 17 | | 2 34 | 2 10 | 5 08 | 2 08 | 3 | 5 00 | 3 | 2 |
| 4 | 5 05 | 2 05 | 3 | 4 45 | 3 | 1 45 | 5 09 | 0 | 0 | | 0 | 0 | 5 07 | 2 07 | 3 | 4 59 | 3 | 1 59 |
| 5 | 5 03 | 0 | 1 42 | 4 44 | 2 22 | 06 | 5 08 | 2 08 | 3 | | 3 | 2 08 | 5 05 | 2 05 | 3 | 4 58 | 2 54 | 36 |
| 6 | 5 02 | 0 | 33 | 4 43 | 03 | 22 | 5 07 | 2 07 | 3 | | 3 | 2 07 | 5 04 | 48 | 1 15 | 4 57 | 2 33 | 45 |
| 7 | 5 01 | 0 | 03 | 4 42 | 08 | 10 | 5 06 | 2 06 | 2 15 | | 2 45 | 0 | 5 03 | 0 | 0 | 4 56 | 0 | 0 |
| 8 | 5 00 | 0 | 0 | 4 41 | 0 | 0 | 5 05 | 0 | 45 | | 2 15 | 0 | 5 02 | 1 51 | 3 | 4 55 | 2 33 | 33 |
| 9 | 4 59 | 58 | 3 | 4 40 | 3 | 1 40 | 5 04 | 0 | 1 56 | | 3 | 2 01 | 5 01 | 1 | 2 45 | 4 54 | 2 06 | 1 15 |
| 10 | 4 58 | 25 | 3 | 4 39 | 3 | 1 39 | 5 04 | 0 | 38 | | 3 | 2 01 | 5 00 | 2 | 3 | 4 53 | | 1 53 |
| 11 | 4 57 | 1 57 | 3 | 4 38 | 2 12 | 0 | 5 03 | 2 03 | 3 | | 3 | 2 03 | 4 59 | 1 59 | 3 | 4 52 | | 1 52 |
| 12 | 4 56 | 0 | 1 31 | 4 37 | 3 | 41 | 5 02 | 2 02 | 3 | | 3 | 2 02 | 4 58 | 1 58 | 3 | 4 51 | | 1 51 |
| 13 | 4 55 | 1 55 | 3 | 4 36 | 2 02 | 1 36 | 5 00 | 0 | 09 | | 2 02 | 2 | 4 57 | 1 24 | 2 40 | 4 50 | 1 12 | 0 |
| 14 | 4 54 | 0 | 2 01 | 4 35 | 1 08 | 0 | 4 59 | 0 | 1 53 | | 2 57 | 34 | 4 56 | 21 | 0 | 4 49 | 0 | 0 |
| 15 | 4 53 | 1 53 | 3 | 4 34 | 3 | 1 34 | 4 59 | 1 56 | 2 15 | | 29 | 0 | 4 55 | 1 12 | 3 | 4 48 | 2 36 | 1 48 |
| 16 | 4 52 | 30 | 1 28 | 4 33 | 32 | 1 10 | 4 58 | 1 08 | 2 10 | | 29 | 0 | 4 55 | 0 | 1 36 | 4 47 | 3 | 1 47 |
| 17 | 4 51 | 1 51 | 3 | 4 32 | 2 48 | 1 32 | 4 57 | 1 57 | 3 | | 1 02 | 1 57 | 4 54 | 1 54 | 3 | 4 46 | 3 | 1 46 |
| 18 | 4 50 | 1 50 | 3 | 4 32 | 3 | 1 32 | 4 56 | 1 56 | 3 | | 3 | 1 56 | 4 53 | 1 53 | 3 | 4 46 | 3 | 1 46 |
| 19 | 4 49 | 1 49 | 3 | 4 31 | 3 | 1 31 | 4 55 | 1 22 | 3 | | 3 | 1 55 | 4 52 | 36 | 1 57 | 4 45 | 1 24 | 03 |
| 20 | 4 48 | 1 48 | 2 57 | 4 31 | 3 | 1 31 | 4 54 | 1 54 | 3 | | 3 | 1 54 | 4 51 | 24 | 3 | 4 44 | 3 | 1 44 |
| 21 | 4 47 | 1 47 | 3 | 4 30 | 3 | 1 30 | 4 54 | 57 | 3 | | 3 | 1 54 | 4 50 | 1 50 | 3 | 4 43 | 3 | 1 43 |
| 22 | 4 46 | 1 46 | 3 | 4 30 | 3 | 1 30 | 4 53 | 1 53 | 3 | | 3 | 1 53 | 4 49 | 1 26 | 3 | 4 43 | 3 | 1 43 |
| 23 | 4 45 | 1 45 | 3 | 4 29 | 3 | 1 29 | 4 52 | 1 52 | 3 | | 3 | 1 52 | 4 49 | 1 49 | 3 | 4 42 | 3 | 1 42 |
| 24 | 4 44 | 1 44 | 3 | 4 29 | 3 | 59 | 4 52 | 1 52 | 3 | | 3 | 1 52 | 4 48 | 1 33 | 3 | 4 41 | 3 | 1 41 |
| 25 | 4 44 | 30 | 1 14 | 4 28 | 2 45 | 1 28 | 4 51 | 1 08 | 3 | | 1 48 | 41 | 4 47 | 1 24 | 3 | 4 40 | 3 | 1 40 |
| 26 | 4 43 | 1 43 | 3 | 4 28 | 3 | 1 28 | 4 50 | 1 50 | 3 | | 3 | 1 50 | .... | .... | .... | 4 39 | 3 | 1 39 |
| 27 | 4 42 | 1 27 | 1 | 4 27 | 2 34 | 1 27 | 4 49 | 1 49 | 3 | | 3 | 1 49 | .... | .... | .... | 4 39 | 3 | 1 39 |
| 28 | 4 41 | 0 | 1 40 | 4 27 | 1 45 | 1 27 | 4 48 | 29 | 42 | | 05 | 0 | .... | .... | .... | 4 38 | 3 | 1 38 |
| 29 | 4 41 | 1 41 | 3 | 4 26 | 3 | 54 | 4 48 | 1 48 | 3 | | 3 | 1 48 | .... | .... | .... | 4 37 | 3 | 1 37 |
| 30 | 4 40 | 1 40 | 3 | 4 25 | 3 | 1 25 | 4 47 | 1 47 | 3 | | 3 | 1 47 | .... | .... | .... | 4 37 | 3 | 1 37 |
| | 146 25 | 35 46 | 68 34 | 137 38 | 69 49 | 35 44 | 149 24 | 39 03 | 69 00 | | 73 35 | 47 14 | 124 06 | 36 11 | 64 13 | 144 15 | 78 18 | 42 20 |
| Per cent... | | 63.3 | 76.1 | ..... | 77.6 | 75.3 | ..... | 78.1 | 79.2 | | 82.8 | 79.1 | ..... | 79.06 | 85.62 | ..... | 87.00 | 78.03 |

## SUNSHINE, IN HOURS AND MINUTES, FOR DECEMBER, 1890.

| Date. | COLLEGE, FORT COLLINS. | | | | | | BENT, ROCKY FORD. | | | | | SAN LUIS, DEL NORTE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Forenoon. | | | Afternoon. | | | Forenoon. | | | Afternoon. | | Forenoon. | | | Afternoon. | | |
| | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | | Comp. | Observed. | Comp. | Observed. | | Comp. | Observed. | |
| | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. | Before 9 a. m. | 9 a. m. to 12 m. | | 12 m. to 3 p. m. | After 3 p. m. |
| 1 | 4 40 | 1 40 | 3 | 4 25 | 3 | 1 25 | 4 47 | 54 | 2 | Same as for forenoon, as there are no mountains on horizon. | 2 45 | 1 47 | 4 43 | 1 43 | 3 | 4 36 | 3 | 1 36 |
| 2 | 4 39 | 41 | 2 48 | 4 25 | 0 | 51 | 4 47 | 27 | 1 48 | | 1 57 | 1 48 | 4 43 | 1 | 1 42 | 4 36 | 2 54 | 1 27 |
| 3 | 4 38 | 0 | 0 | 4 24 | 0 | 0 | 4 46 | 36 | 3 | | 1 15 | 0 | 4 42 | 1 | 2 12 | 4 35 | 1 12 | 0 |
| 4 | 4 38 | 1 28 | 3 | 4 23 | 1 48 | 0 | 4 45 | 0 | 0 | | 3 | 36 | 4 42 | 1 27 | 1 18 | 4 35 | 2 21 | 57 |
| 5 | 4 37 | 0 | 0 | 4 23 | 0 | 0 | 4 45 | 0 | 0 | | 0 | 0 | 4 41 | 21 | 2 06 | 4 34 | 1 54 | 12 |
| 6 | 4 37 | 0 | 2 26 | 4 23 | 3 | 1 23 | 4 44 | 0 | 0 | | 0 | 1 15 | 4 41 | 57 | 57 | 4 34 | 30 | 24 |
| 7 | 4 36 | 1 36 | 3 | 4 22 | 3 | 1 22 | 4 44 | 1 06 | 2 30 | | 3 | 06 | 4 40 | 1 40 | 3 | 4 33 | 3 | 1 33 |
| 8 | 4 36 | 1 36 | 3 | 4 22 | 3 | 1 22 | 4 44 | 1 44 | 3 | | 3 | 1 44 | 4 40 | 1 40 | 3 | 4 33 | 3 | 1 33 |
| 9 | 4 35 | 41 | 3 | 4 21 | 3 | 1 21 | 4 43 | 1 43 | 3 | | 3 | 1 43 | 4 40 | 26 | 2 30 | 4 32 | 3 | 1 32 |
| 10 | 4 35 | 1 35 | 2 07 | 4 21 | 2 42 | 1 21 | 4 43 | 57 | 2 27 | | 1 42 | 0 | 4 39 | 0 | 0 | 4 32 | 1 30 | 1 30 |
| 11 | 4 35 | 1 35 | 3 | 4 21 | 3 | 30 | 4 43 | 0 | 0 | | 0 | 0 | 4 39 | 0 | 0 | 4 32 | 2 35 | 1 24 |
| 12 | 4 35 | 1 35 | 3 | 4 20 | 3 | 1 20 | 4 43 | 1 43 | 3 | | 3 | 1 43 | 4 39 | 1 06 | 3 | 4 32 | 2 21 | 1 30 |
| 13 | 4 34 | 0 | 0 | 4 20 | 0 | 0 | 4 42 | 1 42 | 1 48 | | 1 30 | 1 | 4 38 | 12 | 1 30 | 4 32 | 0 | 0 |
| 14 | 4 34 | 1 34 | 1 42 | 4 20 | 32 | 0 | 4 42 | 1 42 | 3 | | 2 45 | 0 | 4 38 | 0 | 0 | 4 31 | 3 | 1 31 |
| 15 | 4 34 | 1 34 | 3 | 4 20 | 3 | 1 20 | 4 42 | 1 42 | 3 | | 3 | 1 42 | 4 38 | 05 | 1 06 | 4 31 | 54 | 0 |
| 16 | 4 33 | 1 33 | 3 | 4 19 | 3 | 1 19 | 4 41 | 1 41 | 3 | | 3 | 1 41 | 4 38 | 1 38 | 2 39 | 4 31 | 2 48 | 1 31 |
| 17 | 4 33 | 1 33 | 3 | 4 19 | 3 | 1 19 | 4 41 | 1 41 | 3 | | 3 | 1 41 | 4 38 | 1 35 | 2 57 | 4 30 | 30 | 12 |
| 18 | 4 33 | 1 33 | 3 | 4 19 | 2 10 | 1 10 | 4 41 | 1 41 | 2 42 | | 3 | 1 30 | 4 37 | 1 37 | 2 20 | 4 30 | 1 57 | 15 |
| 19 | 4 33 | 1 33 | 3 | 4 19 | 51 | 54 | 4 41 | 1 41 | 2 36 | | 1 48 | 1 15 | 4 37 | 1 06 | 3 | 4 30 | 2 24 | 1 18 |
| 20 | 4 32 | 1 32 | 3 | 4 18 | 43 | 0 | 4 41 | 0 | 0 | | 33 | 1 | 4 37 | 30 | 3 | 4 30 | 3 | 1 30 |
| 21 | 4 32 | 1 32 | 3 | 4 18 | 3 | 1 18 | 4 40 | 1 40 | 3 | | 3 | 1 40 | 4 36 | 1 36 | 3 | 4 29 | 3 | 1 29 |
| 22 | 4 32 | 1 32 | 3 | 4 19 | 2 31 | 1 19 | 4 40 | 1 40 | 3 | | 3 | 1 40 | 4 37 | 1 37 | 3 | 4 30 | 3 | 1 30 |
| 23 | 4 33 | 03 | 1 15 | 4 19 | 0 | 17 | 4 41 | 1 41 | 3 | | 3 | 1 41 | 4 37 | 1 37 | 3 | 4 30 | 2 57 | 1 24 |
| 24 | 4 33 | 06 | 47 | 4 19 | 0 | 0 | 4 41 | 24 | 3 | | 2 20 | 20 | 4 37 | 1 37 | 3 | 4 30 | 2 30 | 1 18 |
| 25 | 4 33 | 52 | 28 | 4 19 | 2 19 | 11 | 4 41 | 1 06 | 3 | | 3 | 1 41 | 4 37 | 1 30 | 2 15 | 4 31 | 3 | 1 31 |
| 26 | 4 33 | 41 | 2 32 | 4 19 | 3 | 1 19 | 4 41 | 0 | 1 20 | | 1 10 | 1 41 | 4 38 | 1 18 | 3 | 4 31 | 3 | 1 15 |
| 27 | 4 33 | 1 33 | 3 | 4 20 | 3 | 1 20 | 4 41 | 1 41 | 3 | | 3 | 1 41 | 4 38 | 1 38 | 3 | 4 31 | 1 45 | 1 31 |
| 28 | 4 34 | 1 34 | 3 | 4 20 | 2 02 | 06 | 4 41 | 1 41 | 3 | | 3 | 1 | 4 38 | 21 | 1 | 4 31 | 3 | 1 |
| 29 | 4 34 | 28 | 2 46 | 4 20 | 2 10 | 1 20 | 4 42 | 1 03 | 3 | | 3 | 1 42 | 4 39 | 1 39 | 2 57 | 4 32 | 2 48 | 0 |
| 30 | 4 34 | 0 | 1 17 | 4 21 | 2 55 | 1 21 | 4 42 | 1 42 | 3 | | 0 | 0 | 4 39 | 1 39 | 3 | 4 32 | 21 | 1 27 |
| 31 | 4 35 | 0 | 09 | 4 21 | 3 | 1 21 | 4 42 | 1 42 | 2 06 | | 2 25 | 1 42 | 4 39 | 0 | 0 | 4 33 | 0 | 0 |
| | 141 52 | 31 50 | 69 17 | 134 38 | 62 43 | 26 49 | 145 58 | 40 20 | 70 17 | | 68 40 | 35 19 | 144 05 | 32 45 | 66 39 | 140 28 | 67 12 | 32 20 |
| Per cent. | | 65.1 | 74.5 | | 67.4 | 64.4 | | 76.1 | 75.55 | | 73.83 | 66.68 | | 64.11 | 71.67 | | 72.26 | 68.12 |

## ACTINOMETRY—SOLAR RADIATION.

One of the most important series of measures from an agricultural standpoint, is the measure of the intensity of the solar radiation. From the sun comes the energy which the plants utilize, and a study of the amount and variations cannot but give added insight eventually into those differences of climates and altitudes which are shown in the different qualities and properties of plants and flowers under different conditions of insolation.

For several years we have had solar maximum thermometers made by Green, but the results have not been satisfactory. Their readings side by side were not comparable, which is a fault common to all instruments of this type. But of all those which we have had, none has possessed a scale long enough to measure the radiation of our elevation. Sooner or later the expansion of the mercury broke the bulb.

These instruments are not as satisfactory as they would be without the maximum registering feature. It is supposed that the excess of their reading above the maximum air thermometer gives the measure of the solar radiation. But as the maximum radiation is usually about noon, while the maximum air temperature is about 2 o'clock, it requires but a moment's consideration to see that the difference between these two readings is less than the actual radiation. The difference, if known, is not in proportion to the radiation, as has been shown by Ferrel.

A year since, we imported two sets of the conjugate thermometers of the Arago-Davy pattern, as used in the Montsouris Observatory of Paris. These have many more convenient features, as they may be read as readily as any ordinary thermometers and at any desired times.

These instruments consist of two thermometers constructed alike, each surrounded by a glass envelope, with a sphere surrounding and concentric with the bulb of the thermometer. The bulb of one thermometer is bright, of the other covered with lampblack. The difference of the readings of the two thermometers of one set gives a measure of the solar radiation, but the constant of each instrument needs to be determined by an appropriate series of observations, in order to have the basis for a table for evaluating the readings of the instruments.

Occasional high winds have proved that these are fragile. At present both sets are withdrawn for new envelopes. The opportunity will be taken to more carefully study the peculiarities of the thermometers composing the pairs.

The readings for a portion of the year are here given, with a third column which gives numbers which are in proportion to the actual radiation. The constant by which these numbers are to be multiplied to give the actual radiation has not as yet been satisfactorily enough determined to complete the reduction :

## ACTINOMETER READINGS, 12 M., 1890.

| Date. | APRIL. | | | | MAY. | | | | AUGUST. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Black Bulb. | Bright Bulb. | Difference. | Relative Radiation. | Black Bulb. | Bright Bulb. | Difference. | Relative Radiation. | Black Bulb | Bright Bulb. | Difference. | Relative Radiation. |
| 1 | 23.8 | 9.45 | 14.35 | 0.57 | 19.6 | 13.4 | 6.2 | 0.46 | ..... | ..... | ..... | .... |
| 2 | 34.6 | 19.1 | 15.5 | 0.67 | 31.4 | 24.3 | 7.1 | 0.31 | ..... | ..... | ..... | .... |
| 3 | 42.8 | 28.1 | 14.7 | 0.68 | 26.0 | 21.3 | 4.7 | 0.20 | ..... | ..... | ..... | .... |
| 4 | 42.3 | 29.5 | 12.8 | 0.59 | 36.9 | 22.5 | 14.4 | 0.64 | ..... | ..... | ..... | .... |
| 5 | 49.1 | 33.5 | 15.6 | 0.75 | 21.8 | 15.3 | 6.5 | 0.27 | ..... | ..... | ..... | .... |
| 6 | 47.5 | 32.6 | 14.9 | 0.72 | 44.5 | 29.6 | 14.9 | 0.70 | ..... | ..... | ..... | .... |
| 7 | 44.7 | 28.8 | 15.9 | 0.74 | 42.8 | 30 1 | 12.7 | 0.59 | ..... | ..... | ..... | .... |
| 8 | 24.8 | 13.75 | 11.05 | 0.44 | 46.3 | 32.3 | 14.0 | 0.80 | ..... | ..... | ..... | .... |
| 9 | 39.0 | 24.2 | 14.8 | 0.67 | 33.2 | 23.2 | 10.0 | 0.45 | ..... | ..... | ..... | .... |
| 10 | 48.5 | 34.3 | 14.2 | 0.68 | 14.7 | 10.3 | 4.4 | 0.17 | 51.7 | 37.2 | 14.5 | 0.72 |
| 11 | 47.85 | 33.85 | 14.0 | 0.68 | 44.1 | 30.4 | 13.7 | 0.64 | 50.2 | 36.6 | 13.6 | 0.42 |
| 12 | 31.7 | 20.7 | 11.0 | 0.67 | 42.0 | 26.5 | 15.5 | 0.71 | 53.3 | 38.7 | 14.6 | 0.60 |
| 13 | 12.2 | 8.5 | 3.7 | 0.14 | 40.3 | 25.5 | 14.8 | 0.67 | 42.6 | 31.5 | 11.1 | 0.52 |
| 14 | 16.0 | 8.8 | 7.2 | 0.18 | 45.3 | 30.9 | 14.4 | 0.68 | 39.5 | 29.5 | 10.0 | 0.46 |
| 15 | 10.5 | 5.3 | 5.2 | 0.20 | 34.0 | 19.6 | 14.4 | 0.62 | ..... | ..... | ..... | .... |
| 16 | 35.65 | 20.5 | 15.15 | 0.66 | 42.4 | 28.4 | 14.0 | 0.65 | 34.0 | 22.4 | 11.6 | 0.51 |
| 17 | 42.6 | 33.1 | 9.5 | 0.41 | 49.0 | 35.0 | 14.0 | 0.68 | 50.0 | 35.2 | 14.8 | 0.72 |
| 18 | 45.2 | 31.0 | 14.2 | 0.66 | 40.7 | 27.5 | 13.2 | 0.61 | 37.7 | 27.7 | 10 0 | 0.45 |
| 19 | 35.0 | 25.3 | 9.7 | 0.43 | 45.9 | 30.5 | 15.4 | 0.73 | 18.4 | 14.7 | 3.7 | 0.15 |
| 20 | 11.0 | 8.0 | 3.0 | 0.11 | 50.5 | 37.0 | 13.5 | 0.67 | ..... | ..... | ..... | .... |
| 21 | 34.2 | 22.55 | 11.65 | 0.52 | 45.5 | 31.7 | 13.8 | 0.65 | 48.6 | 34.6 | 14.0 | 0.68 |
| 22 | 40.1 | 26.15 | 13.95 | 0.68 | 49.4 | 32.7 | 16.7 | 0.81 | 43.9 | 32.9 | 11.0 | 0.52 |
| 23 | 38.2 | 22.5 | 15.7 | 0.69 | 36.2 | 26.9 | 9.3 | 0.42 | 49.3 | 35.7 | 13.6 | 0.56 |
| 24 | 11.1 | 6.8 | 4.3 | 0.19 | 42.4 | 28.2 | 14.2 | 0.66 | 47.3 | 33.3 | 14.0 | 0.81 |
| 25 | 10.6 | 4.8 | 5.8 | 0.17 | 39.0 | 29.2 | 9.8 | 0.45 | 31.9 | 25.4 | 6.5 | 0.29 |
| 26 | 36.2 | 21.5 | 14.7 | 0.44 | 42.7 | 28.9 | 13.8 | 0.64 | ..... | ..... | ..... | .... |
| 27 | 43.0 | 28.6 | 14.4 | 0.44 | 43.5 | 33.2 | 10.3 | 0.49 | 48.5 | 34.5 | 14.0 | 0.68 |
| 28 | 45.0 | 30.6 | 14.4 | 0.43 | 49.0 | 34.7 | 14.3 | 0.70 | 50.2 | 35.4 | 14.8 | 0.73 |
| 29 | 47.45 | 33.2 | 14.25 | 0.69 | 36.0 | 28.0 | 8.0 | 0.36 | 49.9 | 36.3 | 13.6 | 0.67 |
| 30 | 30.45 | 24.50 | 5.95 | 0.26 | 48.2 | 34.3 | 13.9 | 0.67 | 51.6 | 38.2 | 13.4 | 0.67 |
| 31 | ..... | ..... | ..... | .... | 48.0 | 34.1 | 13.9 | 0.67 | 30.5 | 25.8 | 4.7 | 0.21 |
| Sum | 1021.10 | 669.55 | 351.55 | 15.16 | 1231.30 | 855.50 | 375.80 | 17.77 | 829.10 | 605.60 | 223.50 | 10.37 |
| Mean | 34.036 | 22.318 | 11.718 | 0.505 | 39.71 | 27.597 | 12.122 | 0.573 | 43.63 | 31.87 | 11.76 | 0.546 |

**ACTINOMETER READINGS—Continued.**

| Date. | SEPTEMBER. | | | | OCTOBER. | | | | NOVEMBER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Black Bulb. | Bright Bulb. | Difference. | Relative Radiation. | Black Bulb. | Bright Bulb. | Difference. | Relative Radiation. | Black Bulb. | Bright Bulb. | Difference. | Relative Radiation. |
| 1 | 47.4 | 35.3 | 12.1 | 0.59 | 25.7 | 19.2 | 6.5 | 0.27 | 41.8 | 28 3 | 13.5 | 0.62 |
| 2 | 39.4 | 30.9 | 8.5 | 0.39 | 50.6 | 34.4 | 16.2 | 0.79 | 21.9 | 17.0 | 4.9 | 0.20 |
| 3 | 47.3 | 34.0 | 13.3 | 0 64 | 39.7 | 25.6 | 14.1 | 0.64 | 43.7 | 30.7 | 13.0 | 0.61 |
| 4 | 46.7 | 33.2 | 13.5 | 0.65 | ..... | ..... | ..... | .... | 43.0 | 34.7 | 8.3 | 0.39 |
| 5 | 55.5 | 40.2 | 15.3 | 0.78 | 37.8 | 24.8 | 13.0 | 0.58 | 40.9 | 27.4 | 13.5 | 0.62 |
| 6 | 28.0 | 23.4 | 4.6 | 0.20 | 41.9 | 27.5 | 14.4 | 0.67 | 19.5 | 10.2 | 9.3 | 0.37 |
| 7 | 40.2 | 26.0 | 14.2 | 0.65 | 34.1 | 26.2 | 7.9 | 0.36 | 21.3 | 9.9 | 11.4 | 0.46 |
| 8 | 45.5 | 31.5 | 14.0 | 0.66 | 16.7 | 12.0 | 4.7 | 0.18 | 18.6 | 5.4 | 13.2 | 0.51 |
| 9 | 49.0 | 35.1 | 13.9 | 0.68 | 15.6 | 8.2 | 7.4 | 0.29 | 30.3 | 15.4 | 14.9 | 0.63 |
| 10 | 51.0 | 37.0 | 14.0 | 0.69 | 37.0 | 23.0 | 14.0 | 0.62 | 30.5 | 16.8 | 13.7 | 0.58 |
| 11 | 51.2 | 37.6 | 13.6 | 0.58 | 22.2 | 16.7 | 5.5 | 0.23 | 34.7 | 21.0 | 13.7 | 0.60 |
| 12 | 38.5 | 23.8 | 14.7 | 0.64 | 41.2 | 25.3 | 15.9 | 0.72 | 20.3 | 9.9 | 10.4 | 0.41 |
| 13 | ..... | ..... | ..... | .... | 34.8 | 20.0 | 14.8 | 0.65 | ..... | ..... | ..... | .... |
| 14 | 47.5 | 38.2 | 9.3 | 0.46 | 26.7 | 18.2 | 8.5 | 0.36 | ..... | ..... | ..... | .... |
| 15 | 46.1 | 32.3 | 13.8 | 0.66 | 30.3 | 17.6 | 12.7 | 0.54 | ..... | .... | ..... | .... |
| 16 | 52.4 | 37.9 | 14.5 | 0.72 | 46.2 | 31.3 | 14.9 | 0.71 | ..... | ..... | ..... | .... |
| 17 | 50.7 | 38.0 | 12.7 | 0.63 | 42.5 | 28.5 | 14.0 | 0.65 | ..... | ..... | ..... | .... |
| 18 | 33.8 | 25.4 | 8.4 | 0.37 | 36.6 | 22.4 | 14.2 | 0.63 | ..... | ..... | ..... | .... |
| 19 | 42.9 | 29.1 | 13.8 | 0.64 | 44.4 | 30.4 | 14.0 | 0.66 | ..... | ... .. | ..... | .... |
| 20 | 45.1 | 31.8 | 13.3 | 0.64 | 19.3 | 12.6 | 6.7 | 0.27 | ..... | ..... | ..... | .... |
| 21 | 39.4 | 27.8 | 11.6 | 0 53 | 37.7 | 23.5 | 13.2 | 6.63 | ..... | ..... | ..... | .... |
| 22 | 47.4 | 34.6 | 12.8 | 0.62 | 43.2 | 29.3 | 13.9 | 0.65 | ..... | ..... | ..... | .... |
| 23 | 48.5 | 34.2 | 14.3 | 0.69 | 45.6 | 28.5 | 11.1 | 0.80 | ..... | ..... | ..... | .... |
| 24 | 45.1 | 31.2 | 13.9 | 0.66 | 43.0 | 30.0 | 13.0 | 0.61 | ..... | ..... | ..... | .... |
| 25 | 49.6 | 34.5 | 15.1 | 0.74 | 36.5 | 22.7 | 13.8 | 0.61 | ..... | ..... | ..... | .... |
| 26 | 45.8 | 32.0 | 13.8 | 0.66 | 40.0 | 25.2 | 14.8 | 0.67 | ..... | ..... | ..... | .... |
| 27 | 44.5 | 31.9 | 12.6 | 0.59 | 45.0 | 30.7 | 14.3 | 0.67 | ..... | ..... | ..... | .... |
| 28 | 49.3 | 35.5 | 13 8 | 0.67 | 44.7 | 31.5 | 13.2 | 0.62 | ..... | ..... | ..... | .... |
| 29 | 49.9 | 36.4 | 13.5 | 0.66 | 44.6 | 31.5 | 13.1 | 0.62 | ..... | ..... | ..... | .... |
| 30 | 46.0 | 32.2 | 13.8 | 0.66 | 40.6 | 27.2 | 13.4 | 0.62 | ..... | ..... | ..... | .... |
| 31 | ..... | ..... | ..... | ..... | 44.3 | 30.8 | 13.5 | 0.63 | ..... | ..... | ..... | .... |
| Sum | 1323.70 | 951.00 | 372.70 | 17.75 | 1108.50 | 734.80 | 373.70 | 16.95 | 366.50 | 226.70 | 139.80 | 6.00 |
| Mean | 45.64 | 32.79 | 12.85 | 0.612 | 36.95 | 24.493 | 12.456 | 0.565 | 30.54 | 18.89 | 11.65 | 0.50 |

## TEMPERATURE.

In the latter part of 1889, a Normal thermometer was ordered of Green, of New York, but before being forwarded it was tested by our direction at the Yale Thermometric Bureau. Gen. Greeley also kindly consented to have it tested at the Weather Service, where Prof. Marvin gave it a thorough examination. Afterwards Prof. W. A. Rogers, formerly of Harvard College, so well known for his accuracy and for his series of careful measurements, expressed a desire to test the thermometer, and it was accordingly sent him. He has given a very thorough examination during some months, so that with the tests made by these various standards, the errors and peculiarities of our thermometer are as well known as those of any in the country.

The temperatures here given are corrected for the errors at freezing point of the various thermometers, the Normal Standard above referred to not having been received in time to make comparisons.

## TEMPERATURE, 1800.

| Date. | JANUARY. | | | | | | FEBRUARY. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. |
| 1.... | 9.2 | 25.9 | 17.6 | 37.2 | 5.0 | 21.1 | 16.2 | 36.8 | 26.5 | 50.0 | 11.5 | 30.7 |
| 2.... | 00.0 | 7.0 | 3.5 | 20.2 | -2.2 | 11.2 | 48.0 | 44.0 | 46.0 | 68.3 | 33.0 | 50.6 |
| 3.... | 5.8 | 14.9 | 10.4 | 24.0 | 4.5 | 14.2 | 33.0 | 57.3 | 45.2 | 64.5 | 32.9 | 48.7 |
| 4.... | 6.1 | 15.0 | 10.5 | 34.5 | 8.0 | 21.2 | 42.8 | 47.5 | 45.1 | 66.9 | 37.5 | 52.2 |
| 5.... | 12.2 | 19.8 | 16.0 | 27.0 | 8.5 | 17.7 | 36 2 | 36.5 | 36.4 | 54.8 | 31.0 | 42.9 |
| 6.... | 13.3 | 24.0 | 18.6 | 32.0 | 8.5 | 20.3 | 33.0 | 41.2 | 37.1 | 49.5 | 26.5 | 38.0 |
| 7.... | 2.2 | 13.7 | 8.0 | 35.0 | 2.2 | 18.6 | 15.0 | 28.2 | 21.6 | 52.0 | 15.0 | 33.5 |
| 8.... | 11.9 | 20.5 | 16.2 | 48.5 | 9.0 | 28.7 | 19.1 | 45.5 | 32.3 | 57.5 | 14.0 | 35.7 |
| 9.... | 21.0 | 33.5 | 30.2 | 56.5 | 15.2 | 35.9 | 22.0 | 29.6 | 25 8 | 52.9 | 19.0 | 35.9 |
| 10.... | 20.1 | 34.0 | 27.1 | 45.0 | 21.0 | 33.0 | 21.5 | 27.8 | 24.6 | 47.8 | 18.8 | 33.3 |
| 11.... | 16 7 | 5.3 | 11.0 | 16.0 | 15.0 | 15.5 | 16.8 | 24.0 | 20.4 | 41.7 | 16.0 | 28.9 |
| 12.... | -8.0 | 2.3 | -2.8 | 17.0 | -13.0 | 2.0 | 8.0 | 29.0 | 18.5 | 53.9 | 6.0 | 30.0 |
| 13.... | 6.9 | 16.2 | 11.6 | 29.1 | -7.0 | 11.1 | 22.1 | 35.0 | 28.5 | 51.2 | 14.0 | 32.6 |
| 14.... | 7.8 | 9.6 | 8.7 | 22.0 | 4.0 | 31.0 | 17.0 | 21.0 | 21.0 | 52.9 | 13.9 | 32.9 |
| 15.... | -3.5 | 12.0 | 4.3 | 23.0 | -6.0 | 8.5 | 14.7 | *38.5 | 26.6 | 58.2 | 12.9 | 35.5 |
| 16.... | 4.2 | 32.8 | 18.5 | 49.0 | -1.7 | 16.0 | 19.4 | 51.0 | 35.2 | 55.3 | 16.0 | 35.7 |
| 17.... | 12.1 | 24.0 | 18.1 | 39.4 | 8.8 | 24.1 | 46.5 | 32.0 | 39.3 | 53.7 | 41.0 | 47.3 |
| 18.... | 41.0 | 40.2 | 40.6 | 52.7 | 14.0 | 33.4 | 17.7 | 34.5 | 26.1 | 41.0 | 16.0 | 28.5 |
| 19.... | 21.2 | 12.0 | 16.6 | 36.8 | 12.6 | 24.7 | 14.0 | 29.0 | 21.5 | 36.0 | 13.5 | 24.7 |
| 20.... | 1.8 | 17.8 | 9.8 | 31.9 | -1.2 | 15.4 | 17.2 | 33.2 | 25.2 | 37.6 | 12.8 | 25.2 |
| 21.... | -4.0 | 16.7 | 6.3 | 29.9 | -4.0 | 12.8 | 24.5 | 32.4 | 28.4 | 42.8 | 22.8 | 32.8 |
| 22.... | 5.5 | 25.0 | 15.2 | 41.8 | -1.0 | 20.4 | 22.0 | 33.4 | 27.7 | 46.1 | 17.5 | 31.8 |
| 23.... | 14.4 | 28.0 | 21.2 | 44.5 | 10.5 | 27.3 | 21.9 | 32.5 | 27.2 | 42.0 | 16.5 | 29.3 |
| 24.... | 15.5 | 48.0 | 31.8 | 59.3 | 9.0 | 31.2 | 14.1 | 35.5 | 24.8 | 41.3 | 7.5 | 24.4 |
| 25.... | 54.6 | 60.9 | 57.7 | 65.6 | 43.0 | 54.3 | .2 | 5.0 | 2.6 | 16.0 | 0.00 | 8.0 |
| 26.... | 50.5 | 38.0 | 44.2 | 54.5 | 42.0 | 48.3 | -6.0 | -3.8 | -4.9 | -1.5 | -7.0 | 4.3 |
| 27.... | 31.8 | 32.6 | 32.2 | 48.2 | 28.0 | 38.1 | -19.8 | -11.8 | -15.8 | 7.0 | -20.0 | -6.5 |
| 28.... | 18.0 | 42.1 | 30.1 | 55.0 | 16.0 | 35.5 | -9.2 | 14.3 | 2.6 | 22.0 | -19.0 | 1.5 |
| 29.... | 22.7 | 35.0 | 28.8 | 52.9 | 18.0 | 35.4 | ..... | ..... | ..... | ..... | ..... | ..... |
| 30.... | 55.0 | 47.6 | 51.3 | 61.5 | 16.0 | 38.7 | ..... | ..... | ..... | ..... | ..... | ..... |
| 31.... | 23.8 | 36.8 | 30.3 | 44.4 | 16.0 | 30.2 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sum. | 489.8 | 797.2 | 643.5 | 1231.4 | 298.7 | 766.55 | 527.9 | 869.1 | 698.5 | 1260.5 | 419.6 | 840.1 |
| Mean | 15.8 | 25.72 | 20.76 | 39.82 | 9.64 | 24.73 | 18.85 | 31.04 | 24.94 | 45.02 | 14.99 | 30.00 |

* From Thermograph.

## TEMPERATURE, 1890.

| Date. | MARCH. | | | | | | APRIL. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. |
| 1.... | -8.3 | 25.0 | 8.3 | 31.1 | -9.0 | 11.0 | 18.6 | 36.0 | 27.3 | 40.9 | 13.8 | 27.4 |
| 2.... | 35.2 | 41.8 | 38.5 | 50.2 | 16.8 | 33.5 | 23.6 | 45.8 | 34.7 | 57.0 | 17.2 | 37.1 |
| 3.... | 20.0 | 38.2 | 29.1 | 54.8 | 18.0 | 36.4 | 51.3 | 56.0 | 53.7 | 67.5 | 32.5 | 50.0 |
| 4.... | 31.3 | 47.0 | 39.2 | 56.2 | 29.0 | 42.6 | 38.5 | 61.0 | 49.7 | 71.0 | 26.3 | 48.7 |
| 5.... | 34.3 | 32.0 | 33.1 | 35.3 | 32.8 | 34.1 | 47.5 | 61.4 | 54.4 | 70.8 | 46.2 | 58.5 |
| 6.... | 42.5 | 46.0 | 44.3 | 56.0 | 22.0 | 39.0 | 46.8 | 55.8 | 51.3 | 75.3 | 38.1 | 56.7 |
| 7.... | 30.0 | 38.3 | 34.1 | 44.0 | 24.0 | 34.0 | 56.3 | 55.8 | 56.1 | 67.5 | 41.0 | 54.2 |
| 8.... | 29.2 | 43.5 | 36.4 | 57.3 | 20.0 | 38.6 | 33.5 | 40.0 | 36.7 | 49.3 | 29.0 | 39.1 |
| 9.... | 50.1 | 43.3 | 46.7 | 60.9 | 23.2 | 42.1 | 29.0 | 55.8 | 42.4 | 65.2 | 18.8 | 42.0 |
| 10.... | 24.4 | 31.2 | 27.8 | 35.0 | 22.5 | 28.8 | 43.5 | 61.0 | 52.2 | 78.0 | 29.3 | 53.6 |
| 11.... | 20.8 | 24.4 | 22.6 | 35.7 | 18.8 | 27.3 | 53.0 | 62.0 | 57.5 | 76.8 | 33.0 | 54.9 |
| 12.... | 16.2 | 25.0 | 20.6 | 36.4 | 15.5 | 25.9 | 39.0 | 46.7 | 42.8 | 60.0 | 35.2 | 47.6 |
| 13.... | 19.5 | 37.2 | 28.3 | 46.8 | 12.5 | 29.6 | 33.1 | 33.4 | 33.3 | 45.8 | 32.0 | 38.9 |
| 14.... | 27.5 | 40.0 | 33.8 | 55.9 | 17.5 | 36.7 | 33.2 | 36.3 | 34.7 | 38.0 | 31.8 | 34.9 |
| 15.... | 21.2 | 49.8 | 35.5 | 62.3 | 15.8 | 39.0 | 33.5 | 35.0 | 34.3 | 36.8 | 32.6 | 34.7 |
| 16.... | 29.5 | 52.0 | 40.7 | 70.1 | 21.0 | 45.5 | 32.0 | 44.0 | 38.0 | 52.0 | 27.3 | 39.7 |
| 17.... | 41.0 | 52.0 | 46.5 | 67.8 | 33.5 | 50.7 | 39.5 | 52.2 | 45.9 | 66.5 | 28.0 | 47.3 |
| 18.... | 44.1 | 57.0 | 50.6 | 65.2 | 34.0 | 49.6 | 42.0 | 57.9 | 49.9 | 69.6 | 30.0 | 49.8 |
| 19.... | 32.6 | 54.2 | 43.4 | 66.9 | 27.9 | 47.4 | 45.0 | 56.9 | 50.9 | 69.6 | 38.2 | 53.9 |
| 20.... | 44.8 | 46.8 | 45.8 | 64.4 | 32.9 | 48.6 | 44.7 | 47.0 | 45.9 | 49.2 | 43.3 | 46.3 |
| 21.... | 34.9 | 50.3 | 42.6 | 64.7 | 28.0 | 46.4 | 43.0 | 46.0 | 44.5 | 57.1 | 41.0 | 49.0 |
| 22.... | 36.0 | 48.8 | 42.4 | 57.0 | 33.2 | 45.1 | 44.5 | 49.0 | 46.8 | 62.4 | 34.7 | 48.6 |
| 23.... | 34.2 | 52.0 | 43.1 | 69.0 | 27.8 | 48.4 | 44.1 | 45.5 | 44.8 | 53.0 | 42.5 | 47.7 |
| 24.... | 43.0 | 45.2 | 44.1 | 55.4 | 40.0 | 47.7 | 41.8 | 33.7 | 37.8 | 41.8 | 41.0 | 41.4 |
| 25.... | 29.4 | 40.8 | 35.1 | 51.3 | 19.6 | 35.5 | 32.6 | 33.8 | 33.2 | 35.0 | 32.5 | 33.7 |
| 26.... | 34.1 | 50.2 | 42.1 | 68.6 | 20.0 | 44.3 | 39.0 | 45.0 | 42.0 | 54.0 | 31.0 | 42.5 |
| 27.... | 38.3 | 40.0 | 39.2 | 54.5 | 35.8 | 45.1 | 39.0 | 57.0 | 48.0 | 69.0 | 31.6 | 50.3 |
| 28.... | 29.6 | 44.0 | 36.8 | 61.5 | 20.0 | 40.7 | 52.8 | 56.9 | 54.8 | 70.0 | 37.8 | 53.9 |
| 29.... | 29.8 | 40.9 | 35.4 | 48.5 | 22.8 | 35.7 | 50.0 | 61.0 | 55.5 | 75.2 | 36.0 | 55.6 |
| 30.... | 28.8 | 31.0 | 29.9 | 31.0 | 26.0 | 28.5 | 54.5 | 57.8 | 55.9 | 74.7 | 41.6 | 58.2 |
| 31.... | 18.4 | 23.0 | 20.7 | 25.5 | 18.0 | 21.8 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sums. | 942.4 | 1290.9 | 1116.65 | 1639.5 | 719.9 | 1179.7 | 1224.9 | 1485.2 | 1355.0 | 1799.0 | 993.3 | 1396.2 |
| Mean. | 30.4 | 41.64 | 36.02 | 52.89 | 23.22 | 38.03 | 40.83 | 49.84 | 45.17 | 59.97 | 33.11 | 46.54 |

## TEMPERATURE, 1890.

| Date. | MAY. | | | | | | JUNE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. |
| 1.... | 43.3 | 51.9 | 47.6 | 52.3 | 42.5 | 47.4 | 59.5 | 71.2 | 65.3 | 84.8 | 47.2 | 66.0 |
| 2.... | 46.8 | 51.0 | 48.9 | 66.0 | 39.8 | 52.9 | 61.0 | 73.2 | 67.1 | 84.0 | 42.2 | 63.1 |
| 3.... | 50.5 | 57.0 | 53.8 | 70.1 | 39.1 | 54.6 | 62.9 | 57.0 | 59.9 | 74.0 | 57.0 | 62.5 |
| 4.... | 48.6 | 48.2 | 48.4 | 57.3 | 42.4 | 49.8 | 50.9 | 58.8 | 54.9 | 65.2 | 43.8 | 54.5 |
| 5.... | 45.0 | 51.0 | 48.0 | 59.5 | 36.0 | 47.7 | 56.2 | 62.6 | 59.4 | 71.0 | 50.0 | 60.5 |
| 6.... | 43.0 | 55.6 | 49.3 | 69.0 | 29.1 | 49.1 | 52.3 | 51.3 | 51.8 | 63.1 | 42.0 | 52.6 |
| 7.... | 44.5 | 66.5 | 55.5 | 74.1 | 34.3 | 54.2 | 47.2 | 57.6 | 52.4 | 67.1 | 32.7 | 49.9 |
| 8.... | 56.2 | 52.5 | 54.4 | 74.6 | 43.2 | 58.9 | 50.1 | 59.3 | 54.7 | 74.7 | 37.0 | 55.9 |
| 9.... | 46.0 | 48.0 | 47.0 | 62.8 | 37.2 | 50.0 | 51.7 | 67.6 | 59.7 | 77.0 | 38.0 | 57.5 |
| 10.... | 40.4 | 54.3 | 47.3 | 59.0 | 39.3 | 49.2 | 64.9 | 63.9 | 64.4 | 81.4 | 43.4 | 62.4 |
| 11.... | 49.0 | 68.7 | 58.9 | 76.0 | 41.0 | 58.5 | 59.2 | 69.7 | 64.4 | 82.0 | 43.3 | 62.6 |
| 12.... | 47.3 | 45.0 | 46.1 | 62.0 | 40.8 | 51.4 | 50.8 | 69.5 | 60.2 | 86.4 | 44.0 | 65.2 |
| 13.... | 47.0 | 56.0 | 51.5 | 63.0 | 35.0 | 49.0 | 60.5 | 51.9 | 56.2 | 73.4 | 51.9 | 62.7 |
| 14.... | 48.6 | 65.2 | 56.9 | 72.2 | 32.0 | 52.1 | 57.9 | 65.1 | 61.5 | 72.2 | 41.0 | 56.6 |
| 15.... | 34.8 | 47.3 | 41.0 | 72.1 | 31.8 | 51.9 | 56.5 | 64.9 | 60.7 | 85.0 | 41.9 | 63.5 |
| 16.... | 48.0 | 60.0 | 54.0 | 69.2 | 35.5 | 52.4 | 54.4 | 65.6 | 60.0 | 77.6 | 40.9 | 59.2 |
| 17.... | 59.0 | 67.8 | 63.4 | 80.7 | 43.2 | 61.9 | 59.6 | 72.0 | 65.8 | 85.0 | 41.0 | 63.0 |
| 18.... | 56.6 | 50.0 | 53.3 | 65.0 | 46.2 | 55.6 | 65.5 | 73.4 | 69.4 | 88.1 | 43.0 | 65.6 |
| 19.... | 46.9 | 63.0 | 54.9 | 73.9 | 35.9 | 54.9 | 65.5 | 70.0 | 67.7 | 86.3 | 54.0 | 70.2 |
| 20.... | 60.5 | 66.7 | 63.6 | 84.0 | 48.8 | 66.4 | 59.1 | 74.9 | 67.0 | 88.8 | 51.0 | 69.9 |
| 21.... | 54.7 | 74.3 | 64.5 | 82.2 | 40.8 | 61.5 | 69.7 | 69.6 | 69.6 | 85.4 | 56.0 | 70.7 |
| 22.... | 61.0 | 52.8 | 56.9 | 71.0 | 53.8 | 62.4 | 55.9 | 74.0 | 64.9 | 88.1 | 52.4 | 70.3 |
| 23.... | 53.3 | 66.8 | 60.1 | 73.9 | 38.5 | 56.2 | 67.1 | 71.0 | 69.1 | 92.1 | 53.1 | 72.6 |
| 24.... | 48.7 | 62.6 | 55.6 | 68.2 | 45.2 | 56.7 | 64.9 | 76.2 | 70.5 | 92.2 | 55.4 | 73.8 |
| 25.... | 64.1 | 64.3 | 64.2 | 75.5 | 54.9 | 65.2 | 68.8 | 72.1 | 70.4 | 91.7 | 58.8 | 75.2 |
| 26.... | 51.2 | 67.0 | 59.1 | 74.2 | 48.6 | 61.4 | 69.4 | 66.7 | 68.1 | 85.5 | 50.0 | 67.8 |
| 27.... | 58.8 | 72.3 | 65.6 | 85.0 | 40.8 | 62.9 | 66.6 | 71.1 | 68.8 | 84.1 | 50.0 | 67.1 |
| 28.... | 61.2 | 67.0 | 64.1 | 81.2 | 45.8 | 63.5 | 64.8 | 66.5 | 65.7 | 82.1 | 51.5 | 66.8 |
| 29.... | 56.2 | 59.5 | 57.9 | 76.0 | 41.0 | 58.5 | 63.0 | 71.0 | 67.0 | 84.0 | 47.9 | 65.9 |
| 30.... | 56.0 | 64.6 | 60.3 | 79.3 | 41.0 | 60.2 | 63.1 | 71.9 | 67.5 | 84.7 | 50.2 | 67.5 |
| 31.... | 57.8 | 70.5 | 64.1 | 78.2 | 48.0 | 63.1 | ..... | ..... | ..... | ..... | ..... | ..... |
| Sum. | 1585.0 | 1847.4 | 1716.2 | 2207.5 | 1271.5 | 1739.5 | 1799.0 | 2009.6 | 1904.2 | 2436.9 | 1404.6 | 1920.75 |
| Mean | 51.13 | 59.66 | 55.36 | 71.21 | 41.02 | 57.98 | 59.97 | 66.97 | 63.47 | 81.23 | 46.82 | 64.03 |

## TEMPERATURE, 1890.

| | JULY. | | | | | | AUGUST. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. |
| 1.... | 65.0 | 69.5 | 67.2 | 85.1 | 53.5 | 69.3 | 65.2 | 71.8 | 68.5 | 90.3 | 53.0 | 71.6 |
| 2.... | 62.7 | 66.2 | 64.4 | 85.7 | 46.9 | 66.3 | 63.9 | 76.7 | 70.3 | 89.1 | 52.9 | 71.0 |
| 3.... | 62.0 | 71.0 | 66.5 | 80.2 | 52.0 | 66.1 | 66.2 | 66.9 | 66.5 | 87.0 | 59.8 | 73.4 |
| 4.... | 63.9 | 73.9 | 68.9 | 85.8 | 54.5 | 70.2 | 60.0 | 68.0 | 64.0 | 79.3 | 57.9 | 68.6 |
| 5.... | 63.5 | 72.3 | 67.9 | 88.1 | 51.1 | 69.6 | 61.8 | 71.2 | 66.5 | 89.1 | 50.0 | 69.6 |
| 6.... | 67.2 | 71.3 | 69.3 | 92.0 | 60.0 | 76.0 | 60.9 | 77.6 | 69.3 | 95.3 | 46.0 | 70.6 |
| 7.... | 72.3 | 75.1 | 73.7 | 90.1 | 53.1 | 71.6 | 77.1 | 73.9 | 75.5 | 92.5 | 50.1 | 71.3 |
| 8.... | 65.2 | 74.1 | 69.6 | 90.0 | 55 1 | 72.5 | 65.8 | 64.2 | 65.0 | 78.2 | 61.7 | 69.9 |
| 9 ... | 68.7 | 76.8 | 72.7 | 88.7 | 55.0 | 71.9 | 62.8 | 73.8 | 68.3 | 86.0 | 57.8 | 71.9 |
| 10.... | 70.2 | 70.9 | 70.6 | 85.4 | 56.4 | 70.9 | 61.0 | 69.7 | 65.3 | 84.0 | 54.0 | 69.0 |
| 11.... | 64.2 | 77.9 | 71.0 | 86.2 | 57.1 | 71.6 | 64.1 | 68.8 | 66.5 | 83.5 | 52.0 | 67.7 |
| 12.... | 66.2 | 77.8 | 72.0 | 90.0 | 50.0 | 70.0 | 59.8 | 66.0 | 62.9 | 82.2 | 53.3 | 67.8 |
| 13.... | 73.5 | 77.8 | 75.6 | 93.1 | 51.8 | 72.5 | 60.0 | 63.0 | 61.5 | 76.6 | 55.0 | 65.8 |
| 14.... | 66.1 | 71.7 | 68.9 | 77.9 | 65.2 | 71.6 | 62.9 | 70.0 | 66.4 | 75.8 | 60.1 | 67.9 |
| 15.... | 61.8 | 79.2 | 70.5 | 89.0 | 51.2 | 70.1 | 63.1 | 65.0 | 64.0 | 85.8 | 55.1 | 70.5 |
| 16.... | 68.8 | 79.4 | 74.1 | 91.1 | 60.1 | 75.6 | 60.1 | 60.8 | 60.4 | 66.8 | 57.0 | 61.9 |
| 17.... | 70.1 | 76.1 | 73.1 | 85.8 | 61.9 | 73.8 | 55.0 | 68.0 | 61.5 | 79.5 | 47.2 | 63.3 |
| 18.... | 67.8 | 67.8 | 67.8 | 84.9 | 59.1 | 72.0 | 62.5 | 55.2 | 58.9 | 68.0 | 53.2 | 60.6 |
| 19.... | 70.5 | 73.9 | 72.2 | 89.0 | 59.9 | 74.5 | 50.6 | 54.1 | 52.3 | 56.0 | 49.0 | 52.5 |
| 20.... | 68.6 | 63.8 | 66.2 | 93.0 | 57.3 | 75.1 | 56.5 | 66.8 | 61.7 | 79.0 | 48.1 | 63.6 |
| 21.... | 69.7 | 69.9 | 69.8 | 85.9 | 57.0 | 71.5 | 57.0 | 67.0 | 63.5 | 80.8 | 45.0 | 62.9 |
| 22.... | 69.2 | 73.8 | 71.5 | 80.5 | 60.0 | 70.2 | 60.0 | 63.2 | 61.6 | 80.0 | 49.0 | 64.5 |
| 23.... | 63.1 | 70.2 | 66.7 | 86.9 | 51.8 | 69.4 | 59.0 | 70.8 | 64.9 | 84.0 | 52.0 | 68.0 |
| 24.... | 67.5 | 70.6 | 69.1 | 84.0 | 57.5 | 70.8 | 63.5 | 65.3 | 64.4 | 73.9 | 50.4 | 62.1 |
| 25.... | 64.8 | 76.5 | 70.6 | 89.0 | 50.8 | 69.9 | 57.1 | 53.8 | 55.4 | 75.5 | 46.5 | 61.0 |
| 26.... | 67.0 | 74.1 | 70.6 | 89.9 | 53.3 | 71.6 | 54.0 | 66.5 | 60.3 | 75.8 | 39.5 | 57.7 |
| 27.... | 69.9 | 79.2 | 74.5 | 92.0 | 50.6 | 71.3 | 59.0 | 65.0 | 62.0 | 82.0 | 43.6 | 62.8 |
| 28.... | 69.4 | 63.1 | 66.3 | 93.4 | 53.0 | 73.2 | 56.7 | 62.6 | 59.6 | 81.6 | 44.0 | 62.8 |
| 29.... | 64.8 | 75.1 | 69.9 | 84.9 | 58.0 | 71.5 | 56.7 | 66.2 | 61.5 | 85.2 | 50.9 | 68.1 |
| 30.... | 65.1 | 67.9 | 66.5 | 77.0 | 58.0 | 67.5 | 56.1 | 69.0 | 62.5 | 87.7 | 42.5 | 65.1 |
| 31.... | 62.1 | 76.1 | 69.1 | 85.6 | 49.6 | 67.3 | 61.8 | 65.0 | 63.4 | 78.0 | 51.9 | 64.9 |
| Sum. | 2070.9 | 2263.0 | 2166.8 | 2700.2 | 1710.2 | 2205.4 | 1880.2 | 2065.9 | 1974.0 | 2508.5 | 1588.5 | 2048.5 |
| Mean | 66.8 | 73.0 | 69.9 | 87.1 | 55.17 | 71.14 | 60.65 | 66.64 | 63.69 | 80.92 | 51.24 | 66.08 |

## TEMPERATURE, 1800.

| Date. | SEPTEMBER. | | | | | | OCTOBER. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. |
| 1.... | 64.6 | 62.7 | 63.6 | 85.3 | 46.9 | 66.1 | 48.6 | 50.5 | 49.5 | 68.9 | 36.1 | 52.5 |
| 2.... | 62.9 | 66.6 | 64.8 | 78.0 | 51.8 | 64.9 | 43.9 | 60.0 | 51.9 | 75.1 | 34.9 | 55.0 |
| 3.... | 62.8 | 59.5 | 61.1 | 77.9 | 46.9 | 62.4 | 43.9 | 47.0 | 45.5 | 62.7 | 37.8 | 50.2 |
| 4.... | 53.0 | 61.9 | 57.4 | 79.0 | 41.3 | 60.2 | 40.0 | 32.8 | 36.4 | 47.4 | 35.5 | 41.5 |
| 5.... | 52.8 | 67.0 | 59.9 | 84.0 | 45.5 | 64.8 | 26.0 | 53.4 | 39.7 | 63.8 | 15.7 | 39.7 |
| 6.... | 63.1 | 50.4 | 56.3 | 70.8 | 45.0 | 57.9 | 47.0 | 54.0 | 50.5 | 65.8 | 43.0 | 54.4 |
| 7.... | 42.2 | 50.0 | 46.1 | 64.1 | 34.7 | 49.4 | 38.4 | 54.1 | 46.3 | 69.6 | 35.9 | 52.8 |
| 8.... | 44.2 | 57.1 | 50.6 | 74.0 | 30.1 | 52.1 | 35.9 | 41.8 | 38.9 | 53.2 | 33.0 | 43.1 |
| 9.... | 50.0 | 67.9 | 58.9 | 82.0 | 32.5 | 57.2 | 33.2 | 39.0 | 36.1 | 38.7 | 32.0 | 35.3 |
| 10.... | 53.2 | 71.0 | 62.1 | 83.7 | 35.5 | 59.6 | 42.4 | 54.5 | 48.5 | 62.0 | 38.0 | 50.0 |
| 11.... | 61.1 | 69.2 | 65.1 | 83.0 | 52.0 | 67.5 | 49.6 | 51.8 | 50.7 | 57.9 | 47.0 | 52.4 |
| 12.... | 43.0 | 48.8 | 45.9 | 61.0 | 34.9 | 47.9 | 36.2 | 46.8 | 41.5 | 57.0 | 33.0 | 45.0 |
| 13.... | 50.0 | 65.5 | 57.8 | 78.8 | 28.0 | 53.4 | 35.6 | 37.9 | 36.7 | 54.3 | 35.5 | 44.9 |
| 14.... | 48.1 | 62.0 | 55.5 | 78.0 | 31.8 | 54.9 | 28.5 | 38.4 | 33.5 | 60.1 | 21.4 | 40.8 |
| 15.... | 46.4 | 60.4 | 53.4 | 77.7 | 31.0 | 54.3 | 35.0 | 47.7 | 41.3 | 51.0 | 34.6 | 42.8 |
| 16.... | 53.6 | 65.4 | 59.5 | 85.0 | 39.1 | 62.0 | 27.4 | 53.2 | 40.3 | 68.9 | 23.0 | 45.9 |
| 17.... | 71.6 | 70.0 | 70.8 | 84.7 | 45.0 | 64.9 | 32.6 | 47.0 | 39.8 | 67.1 | 26.9 | 47.0 |
| 18.... | 64.9 | 56.5 | 60.7 | 68.2 | 61.5 | 64.9 | 28.2 | 38.1 | 33.2 | 61.8 | 23.5 | 42.7 |
| 19.... | 43.7 | 63.4 | 53.5 | 79.0 | 37.9 | 58.5 | 35.0 | 48.6 | 41.8 | 71.9 | 21.9 | 46.9 |
| 20.... | 69.0 | 58.9 | 63.9 | 73.1 | 51.0 | 62.0 | 49.5 | 41.4 | 45.4 | 51.6 | 39.0 | 45.3 |
| 21.... | 44.4 | 57.7 | 51.1 | 72.2 | 34.1 | 53.1 | 30.0 | 44.1 | 32.1 | 61.7 | 17.9 | 39.8 |
| 22.... | 45.9 | 56.1 | 51.0 | 78.0 | 34.9 | 56.5 | 29.4 | 65.0 | 47.2 | 75.0 | 26.0 | 50.5 |
| 23.... | 47.1 | 61.7 | 54.4 | 75.0 | 45.0 | 60.0 | 44.9 | 47.4 | 46.2 | 68.0 | 31.9 | 49.9 |
| 24.... | 45.6 | 55.3 | 50.5 | 73.0 | 38.7 | 55.9 | 43.4 | 54.3 | 48.8 | 73.0 | 35.0 | 54.0 |
| 25.... | 44.8 | 61.1 | 52.9 | 75.7 | 37.9 | 56.8 | 36.8 | 37.4 | 37.1 | 57.9 | 31.5 | 44.7 |
| 26.... | 44.8 | 49.9 | 47.4 | 73.2 | 35.1 | 54.2 | 29.0 | 47.4 | 38.2 | 68.0 | 22.9 | 45.5 |
| 27.... | 39.4 | 52.9 | 46.1 | 74.8 | 34.0 | 54.4 | 37.9 | 44.9 | 41.4 | 70.8 | 34.6 | 52.7 |
| 28.... | 47.5 | 60.7 | 54.1 | 80.1 | 35.0 | 57.5 | 32.8 | 62.1 | 47.5 | 77.0 | 29.4 | 53.2 |
| 29.... | 46.9 | 59.9 | 53.4 | 82.8 | 35.9 | 59.4 | 34.0 | 51.1 | 42.5 | 76.0 | 31.0 | 53.5 |
| 30.... | 46.2 | 60.6 | 53.4 | 77.9 | 36.0 | 56.9 | 29.1 | 41.0 | 35.1 | 67.0 | 26.8 | 46.9 |
| 31.... | ..... | ..... | ..... | ..... | ..... | ..... | 29.2 | 37.0 | 33.1 | 73.9 | 27.0 | 50.4 |
| Sum. | 1552.8 | 1810.1 | 1681.2 | 2310.0 | 1189.0 | 1749.5 | 1123.4 | 1469.7 | 1296.7 | 1977.1 | 961.7 | 1469.4 |
| Mean | 51.76 | 60.34 | 56.04 | 77.00 | 39.63 | 58.32 | 36.24 | 47.41 | 41.83 | 63.78 | 31.02 | 47.4 |

## TEMPERATURE, 1890.

| Date. | NOVEMBER. | | | | | | DECEMBER. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. | 7 a. m. | 7 p. m. | Mean. | Max. | Min. | Mean. |
| 1.... | 31.0 | 56.0 | 43.5 | 70.0 | 26.9 | 48.4 | 20.2 | 52.0 | 36.1 | 61.8 | 24.2 | 43.0 |
| 2.... | 48.0 | 41.0 | 44.5 | 60.4 | 36.0 | 48.2 | 22.7 | 45.8 | 34.25 | 51.9 | 24.9 | 38.4 |
| 3.... | 26.3 | 53.0 | 39.6 | 75.7 | 22.9 | 49.3 | 26.2 | 35.2 | 30.7 | 37.2 | 29.0 | 33.1 |
| 4.... | 34.9 | 56.5 | 45.7 | 74.0 | 27.0 | 50.5 | 29.9 | 33.3 | 31.6 | 57.9 | 15.6 | 36.75 |
| 5.... | 47.0 | 44.0 | 45.5 | 65.0 | 35.9 | 50.4 | 22.2 | 35.8 | 29.0 | 29.7 | 22.7 | 26.2 |
| 6.... | 24.4 | 28.0 | 26.2 | 42.0 | 19.8 | 30.9 | 23.0 | 23.1 | 23.05 | 34.0 | 20.4 | 26.2 |
| 7.... | 22.0 | 30.9 | 26.5 | 36.0 | 20.0 | 28.0 | 23.8 | 21.0 | 22.4 | 32.7 | 12.0 | 22.35 |
| 8.... | 24.0 | 18.9 | 21.4 | 25.2 | 23.6 | 24.4 | 4.1 | 20.0 | 12.05 | 44.1 | 5.8 | 24.95 |
| 9.... | 10.8 | 23.0 | 16.9 | 38.0 | 6.5 | 22.3 | 23.2 | 34.5 | 28.85 | 62.9 | 14.8 | 38.85 |
| 10.... | 21.7 | 29.2 | 25.5 | 45.6 | 19.8 | 32.7 | 24.3 | 49.8 | 36.55 | 61.7 | 22.7 | 42.20 |
| 11.... | 23.9 | 39.9 | 31.9 | 52.0 | 20.1 | 36.1 | 23.3 | 38.0 | 30.65 | 44.9 | 24.4 | 34.65 |
| 12.... | 27.6 | 25.9 | 26.7 | 37.9 | 19.0 | 28.4 | 11.7 | 27.5 | 19.6 | 50.6 | 12.8 | 31.70 |
| 13.... | 20.9 | 35.0 | 27.9 | 55.5 | 17.0 | 36.3 | 38.4 | 40.1 | 39.25 | 31.7 | 20.0 | 25.85 |
| 14.... | 31.0 | 30.5 | 32.2 | 42.0 | 35.0 | 38.5 | 16.9 | 29.8 | 22.85 | 43.0 | 19.0 | 31.00 |
| 15.... | 13.1 | 27.5 | 20.3 | 41.9 | 13.9 | 27.9 | 38.7 | 35.7 | 37.2 | 48.1 | 18.1 | 33.10 |
| 16.... | 17.0 | 25.0 | 21.0 | 47.0 | 11.0 | 24.0 | 6.4 | 23.9 | 15.15 | 47.0 | 9.0 | 28.00 |
| 17.... | 25.3 | 35.3 | 30.3 | 60.0 | 19.3 | 39.6 | 18.2 | 23.0 | 20.6 | 50.9 | 11.3 | 31.10 |
| 18.... | 25.7 | 40.8 | 33.3 | 60.1 | 21.0 | 40.5 | 14.8 | 21.9 | 18.35 | 54.7 | 10.1 | 32.40 |
| 19.... | 20.6 | 29.0 | 24.8 | 59.3 | 19.0 | 39.1 | 18.1 | 28.4 | 23.25 | 54.0 | 17.0 | 35.50 |
| 20.... | 19.0 | 38.4 | 28.7 | 69.0 | 17.9 | 43.5 | 32.0 | 37.2 | 34.6 | 55.2 | 26.0 | 40.60 |
| 21.... | 36.0 | 34.2 | 35.1 | 52.0 | 34.5 | 43.2 | 8.0 | 25.8 | 16.9 | 49.8 | 10.0 | 29.9 |
| 22.... | 20.0 | 31.6 | 25.8 | 55.0 | 18.0 | 36.5 | 22.0 | 24.9 | 23 45 | 54.9 | 13.9 | 34.4 |
| 23.... | 20.7 | 43.9 | 32.3 | 63.0 | 20.2 | 41.6 | 18.7 | 21.2 | 19.95 | 34.8 | 12.2 | 23.5 |
| 24.... | 24.6 | 32.0 | 28.3 | 60.2 | 20.9 | 40.5 | 34.8 | 30.0 | 32.4 | 43.0 | 20.7 | 31.85 |
| 25.... | 36.5 | 33.8 | 35.2 | 54.5 | 26.3 | 40.4 | 11.9 | 38.8 | 20.35 | 51.8 | 10.9 | 31.35 |
| 26.... | 18.8 | 30.5 | 24.6 | 60.0 | 11.8 | 35.9 | 49.0 | 40.0 | 44.5 | 60.0 | 33.8 | 46.9 |
| 27.... | 28.0 | 36.0 | 32.0 | 61.8 | 18.8 | 40.3 | 14.1 | 23.0 | 18.55 | 45.1 | 12.0 | 28.55 |
| 28.... | 29.1 | 33.2 | 31.1 | 54.0 | 21.3 | 37.6 | 27.8 | 36.1 | 31.95 | 61.0 | 13.0 | 37.0 |
| 29.... | 23.5 | 38.2 | 30.9 | 57.4 | 16.2 | 36.8 | 26.1 | 33.8 | 28.95 | 59.0 | 24.2 | 41.6 |
| 30.... | 20.2 | 52.0 | 36.1 | 71.8 | 20 2 | 46.0 | 38.6 | 37.2 | 37.9 | 58.9 | 26.0 | 42.45 |
| 31.... | ..... | ..... | ..... | ..... | ..... | ..... | 39.3 | 29.9 | 34.60 | 45.8 | 32.0 | 38.90 |
| Sums | 774.6 | 1073.2 | 923.8 | 1646.3 | 639.8 | 1143.0 | 718.4 | 966.7 | 842.55 | 1538.1 | 568.5 | 1171.0 |
| Mean | 25.82 | 35.77 | 30.79 | 54.88 | 21.33 | 38.1 | 23.17 | 31.18 | 27.175 | 49.61 | 18.34 | 37.77 |

RANGE OF TEMPERATURE.

From an agricultural standpoint, at any rate, the range is of greater importance than the mean temperature. The range in a great part of Colorado is very great, and the temperature of day far above that of night. The average daily range, or the average difference between the highest and lowest temperatures of the day, is more than twice the corresponding ranges of New York. The cause is due to the dryness of our air, which allows radiation to proceed with extreme rapidity, so that immediately the sun is set, the cooling effect of radiation is felt. As our average temperature is near that of New York, and our range throughout the year so much greater, it follows that our nights of summer are much cooler and the days of winter much warmer. The range is due both to the great radiation from the earth and from the sun. In consequence, the average winter day seems warm in the sun, while the indication of the thermometer for the day shows what seems a surprisingly low register. For comparison, the average and greatest daily ranges for the College and the sub-stations are given, together with that of central New York.

In the table is given the daily range in full for the year at both the College and San Luis. The greatest amount for each month is printed in bold-faced type. In comparing the records of the two places, it should be remembered that the elevation of the station in the San Luis is about 7,800 feet; that at the College, 5,000 feet. The latitude of the former is 37° 40′ approximately, of the College, 40° 35′.

During most of the months of the year the range at San Luis has averaged greater than that at Fort Collins, as we might have expected, but the absolute range is

greater at the College for each month. The frequency with which the maximum ranges for the month fall on the same day at both places suggests that the causes of the great ranges are general over a considerable extent of territory.

AVERAGE DAILY RANGE.

| STATION. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Sums. | Average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| College, 1889..... | 28.2 | 27.2 | 28.8 | 27.5 | 25.2 | 29.6 | 33.1 | 34.2 | 34.9 | 28.7 | 25.4 | 28.6 | 351.4 | 29.28 |
| San Luis, " ..... | .... | .... | .... | .... | .... | .... | 37.0 | 35.6 | 37.7 | 36.6 | 38.6 | 29.0 | 212.0 | 35.66 |
| New York, " ..... | 13.8 | 17.6 | 13.8 | 19.5 | 19.9 | 20.0 | 19.5 | 20.3 | 18.7 | 15.1 | 12.5 | 16.0 | 206.7 | 17.23 |
| College, 1890..... | 30.2 | 30.0 | 29.7 | 26.8 | 30.2 | 34.4 | 31.9 | 29.7 | 37.4 | 32.7 | 33.6 | 30.4 | 376.0 | 31.33 |
| San Luis, " ..... | 31.8 | 28.4 | 30.7 | 29.1 | 34.3 | 36.6 | 33.5 | 32.7 | 34.9 | 35.6 | 28.6 | 28.8 | 385.4 | 32.12 |

GREATEST DAILY RANGE.

| STATION. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Sums. | Average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| College, 1889 ..... | 47.0 | 50.5 | 47.0 | 50.5 | 42.0 | 43.2 | 50.8 | 47.5 | 55.5 | 54.5 | 44.8 | 47.3 | 580.6 | 48.38 |
| College, 1890 ..... | 50.7 | 47.9 | 49.1 | 48.7 | 44.2 | 45.1 | 41.4 | 49.3 | 50.8 | 49.0 | 52.8 | 48.1 | 577.09 | 48.09 |
| San Luis, 1889..... | .... | .... | .... | .... | .... | .... | 46.0 | 45.0 | 52.0 | 50.0 | 57.0 | 49.0 | 299.0 | 49.8 |
| San Luis, 1890.... | 48.0 | 43.0 | 46.0 | 40.0 | 44.0 | 43.0 | 39.0 | 42.0 | 48.0 | 46.0 | 42.0 | .... | ..... | ..... |

## DAILY RANGE OF TEMPERATURE.

| Date. | JAN. | | FEB. | | MARCH. | | APRIL. | | MAY. | | JUNE. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | College. | San Luis. | College. | San Luis. | College. | San Luis. | College. | San Luis. | College. | San Luis. | College. | San Luis. |
| 1 | 32.2 | 38.0 | 38.5 | 30.0 | 40.1 | 30.0 | 27.1 | 26.0 | 9.8 | 28.0 | 37.6 | 38.0 |
| 2 | 22.4 | 41.0 | 35.3 | 35.0 | 33.4 | 35.0 | 39.8 | 22.0 | 26.2 | 24.0 | 41.8 | 32.0 |
| 3 | 19.5 | 37.0 | 31.6 | 32.0 | 36.8 | 30.0 | 35.0 | 34.0 | 31.0 | 34.0 | 23.0 | 35.0 |
| 4 | 26.5 | 33.0 | 29.4 | 41.0 | 27.2 | 32.0 | 44.7 | 32.0 | 14.9 | 26.0 | 21.4 | 37.0 |
| 5 | 18.5 | 20.0 | 23.8 | 32.0 | 2.5 | 40.0 | 24.6 | 29.0 | 23.5 | 30.0 | 21.0 | 36.0 |
| 6 | 23.5 | 31.0 | 23.0 | 24.0 | 34.0 | 34.0 | 37.2 | ..... | 39.9 | 39.9 | 21.1 | 29.0 |
| 7 | 32.8 | **48.0** | 37.0 | 40.0 | 20.0 | 28.0 | 26.5 | 15.0 | 29.8 | 32.0 | 34.4 | 36.0 |
| 8 | 39.5 | 26.0 | 43.5 | 29.0 | 37.3 | 24.0 | 20.3 | 28.0 | 31.4 | 31.0 | 37.7 | 36.0 |
| 9 | 41.3 | 25.0 | 33.9 | 34.0 | 37.7 | 28.0 | 46.4 | **40.0** | 25.6 | 30.0 | 39.0 | 36.0 |
| 10 | 24.0 | **48.0** | 29.0 | 28.0 | 12.5 | 22.0 | **48.7** | **40.0** | 19.7 | 32.0 | 38.0 | 37.0 |
| 11 | 1.0 | 30.0 | 25.7 | 24.0 | 16.9 | 25.0 | 43.8 | 34.0 | 35.0 | 37.0 | 38.7 | 39.0 |
| 12 | 30.0 | 34.0 | **47.9** | **43.0** | 21.1 | 25.0 | 24.8 | 31.0 | 21.2 | 36.0 | 42.4 | 37.0 |
| 13 | 36.1 | 32.0 | 37.2 | 29.0 | 34.3 | 31.0 | 13.8 | 28.0 | 28.0 | 33.0 | 21.5 | 34.0 |
| 14 | 18.0 | 38.0 | 38.1 | 41.0 | 33.4 | 35.0 | 6.2 | 36.0 | 40.2 | 27.0 | 31.2 | 40.0 |
| 15 | 29.0 | 40.0 | 45.3 | 36.0 | 46.5 | 40.0 | 4.2 | 26.0 | 40.3 | 35.0 | 43.1 | 40.0 |
| 16 | **50.7** | 38.0 | 39.3 | 20.0 | **49.1** | **46.0** | 24.7 | 33.0 | 33.7 | 34.0 | 36.7 | 37.0 |
| 17 | 30.6 | 18.0 | 12.7 | 18.0 | 34.3 | 36.0 | 38.5 | 34.0 | 37.5 | 38.0 | 44.0 | 33.0 |
| 18 | 38.7 | 15.0 | 25.0 | 26.0 | 31.2 | 28.0 | 39.6 | 26.0 | 18.8 | 35.0 | **45.1** | 40.0 |
| 19 | 24.2 | 32.0 | 22.5 | 15.0 | 39.0 | 19.0 | 31.4 | 26.0 | 28.0 | 28.0 | 32.3 | 37.0 |
| 20 | 33.1 | 34.0 | 24.8 | 28.0 | 31.5 | 32.0 | 5.9 | 32.0 | 35.2 | 40.0 | 37.8 | 41.0 |
| 21 | 33.9 | 28.0 | 20.0 | 20.0 | 26.7 | 35.0 | 16.1 | 28.0 | 41.4 | 37.0 | 29.4 | 39.0 |
| 22 | 42.8 | 38.0 | 28.6 | 22.0 | 23.8 | 28.0 | 27.7 | 30.0 | 17.2 | 35.0 | 35.7 | 34.0 |
| 23 | 34.0 | 34.0 | 25.5 | 21.0 | 41.2 | 30.0 | 10.5 | 34.0 | 35.4 | 37.0 | 38.9 | 35.0 |
| 24 | 50.3 | 31.0 | 33.8 | 19.0 | 15.4 | 37.0 | .8 | 19.0 | 23.0 | 30.0 | 36.8 | 40.0 |
| 25 | 22.6 | 19.0 | 16.0 | 21.0 | 31.7 | 26.0 | 2.5 | 32.0 | 20.6 | 42.0 | 32.9 | 36.0 |
| 26 | 12.5 | 24.0 | 5.5 | 18.0 | 48.6 | 33.0 | 23.0 | 20.0 | 25.6 | **44.0** | 35.5 | 34.0 |
| 27 | 20.2 | 26.0 | 27.0 | 27.0 | 18.7 | 33.0 | 37.4 | 26.0 | **44.2** | 40.0 | 34.1 | 38.0 |
| 28 | 39.0 | 30.0 | 41.0 | 33.0 | 41.5 | 33.0 | 32.2 | 32.0 | 35.4 | 32.0 | 30.6 | **48.0** |
| 29 | 34.9 | 31.0 | ..... | ..... | 25.7 | 27.0 | 39.2 | 26.0 | 35.0 | 26.0 | 36.1 | 38.0 |
| 30 | 45.5 | 34.0 | ..... | ..... | 5.0 | 25.0 | 33.1 | 24.0 | 38.3 | 40.0 | 34.5 | 32.0 |
| 31 | 28.4 | 33.0 | ..... | ..... | 7.5 | 26.0 | ..... | ..... | 30.2 | 42.0 | ..... | ..... |
| S'm | 935.7 | 986.0 | 840.9 | 796.0 | 919.6 | 953.0 | 805.7 | 843.0 | 936.0 | 1064.0 | 1032.3 | 1099.0 |
| M'n | 30.18 | 31.80 | 30.03 | 28.43 | 29.67 | 30.74 | 26.86 | 29.07 | 30.2 | 34.32 | 34.41 | 36.63 |

## DAILY RANGE OF TEMPERATURE.

| Date. | JULY. | | AUGUST. | | SEPT. | | OCT. | | NOV. | | DEC. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | College. | San Luis. | College. | San Luis. | College. | San Luis. | College. | San Luis. | College. | San Luis. | College. | San Luis. |
| 1 | 31.6 | 35.0 | 37.3 | 28.0 | 38.4 | 30.0 | 32.8 | 35.0 | 43.1 | 40.0 | **51.6** | 35.0 |
| 2 | 38.8 | 38.0 | 36.2 | 33.0 | 26.2 | 32.0 | 40.2 | 28.0 | 24.4 | 38.0 | 37.6 | 32.0 |
| 3 | 28.2 | 32.0 | 27.2 | 33.0 | 31.0 | 31.0 | 24.9 | 30.0 | **52.8** | 40.0 | 27.0 | 15.0 |
| 4 | 31.3 | 38.0 | 21.4 | 34.0 | 37.7 | 39.0 | 11.9 | 26.0 | 47.0 | **42.0** | 8.2 | 22.0 |
| 5 | 37.0 | 32.0 | 39.1 | 37.0 | 38.5 | 32.0 | 48.1 | 34 0 | 29.1 | 29.0 | 42.3 | 24.0 |
| 6 | 32.6 | 30.0 | **49.3** | **42.0** | 25.8 | 27.0 | 22.8 | 40.0 | 22.2 | 22.0 | 7.0 | 26.0 |
| 7 | 37.0 | 37.0 | 42.4 | 39.0 | 29.4 | 38.0 | 33.7 | 34.0 | 16.0 | 13.0 | 13.6 | 33.0 |
| 8 | 34.9 | 35.0 | 16.5 | 36.0 | 43.9 | 40.0 | 20.2 | 13.0 | 1.6 | 14.0 | 38.3 | 30.0 |
| 9 | 33.7 | 29.0 | 28.2 | 39.0 | 49.5 | ..... | 6.7 | 31.0 | 31.5 | 26.0 | 48.1 | 33.0 |
| 10 | 29.0 | 31.0 | 30.0 | 38.0 | 48.2 | 32.0 | 24.0 | 24.0 | 25.8 | 31.0 | 39.0 | 28.0 |
| 11 | 29.1 | 35.0 | 31.5 | 36.0 | 31.0 | 33.0 | 10.9 | 32.0 | 31.9 | 28.0 | 20.5 | 18.0 |
| 12 | 40.0 | 33.0 | 28.9 | 30.0 | 26.1 | **48.0** | 24.0 | 26.0 | 18.9 | 32.0 | 37.8 | 20.0 |
| 13 | 41.3 | 36.0 | 21.6 | 28.0 | **50.8** | 43.0 | 18.8 | 38.0 | 38.5 | 26.0 | 11.7 | 22.0 |
| 14 | 12.7 | 34.0 | 15.7 | 31.0 | 46.2 | 44.0 | 38.7 | 30.0 | **7.0** | 32.0 | 24.0 | 14.0 |
| 15 | 37.8 | 33.0 | 30.7 | 33.0 | 46.7 | 43.0 | 16.4 | 34.0 | 28.0 | 26.0 | 30.0 | 34.0 |
| 16 | 31.0 | 35.0 | 9.8 | 34.0 | 45.9 | 30.0 | 45.9 | 38.0 | 36.0 | 32.0 | 38.0 | 32.0 |
| 17 | 23.9 | 30.0 | 32.3 | 33.0 | 39.7 | 32.0 | 40.2 | 40.0 | 40.7 | 28.0 | 39.6 | 30.0 |
| 18 | 25.8 | 29.0 | 14.8 | 32.0 | 6.7 | 35.0 | 38.3 | 37.0 | 39.1 | 28.0 | 44.6 | 22.0 |
| 19 | 29.1 | 32.0 | 7.0 | 24.0 | 41.1 | 24.0 | **50.0** | 39.0 | 40.3 | 24.0 | 37.0 | 25.0 |
| 20 | 35.7 | 36.0 | 30.9 | 31.0 | 22.1 | 30.0 | 12.6 | 33.0 | 51.1 | 30.0 | 29.2 | 32.0 |
| 21 | 28.9 | 36.0 | 35.8 | 27.0 | 38.1 | 32.0 | 43.8 | 40.0 | 17.5 | 28.0 | 39.8 | 33.0 |
| 22 | 20.5 | 32.0 | 31.0 | 27.0 | 43.1 | 38.0 | 49.0 | 42.0 | 37.0 | 34.0 | 41.0 | 37.0 |
| 23 | 35.1 | 32.0 | 32.0 | 34.0 | 30.0 | 36.0 | 36.1 | 42.0 | 42.8 | 32.0 | 22.6 | 36.0 |
| 24 | 26.5 | 31.0 | 23.5 | 28.0 | 34.3 | 32.0 | 38.0 | 42.0 | 39.3 | 34.0 | 22.3 | 33.0 |
| 25 | 38.2 | 37.0 | 29.0 | 34.0 | 37.8 | 35.0 | 26.4 | 45.0 | 28.2 | 38 0 | 40.9 | 31.0 |
| 26 | 36.6 | 35.0 | 36.3 | 29.0 | 38.1 | 33.0 | 45.1 | 40.0 | 48.2 | 35.0 | 26.2 | 39.0 |
| 27 | **41.4** | **39.0** | 38.4 | 29.0 | 40.8 | 35.0 | 36.2 | 38.0 | 43.0 | 34.0 | 33.1 | 35.0 |
| 28 | 40.4 | 36.0 | 37.6 | 36.0 | 45.1 | 38.0 | 47.6 | 44.0 | 32.7 | 36.0 | 48.0 | 37.0 |
| 29 | 26.9 | 28.0 | 34.3 | 34.0 | 46.9 | 34.0 | 45.0 | 42.0 | 41.2 | 32.0 | 34.8 | 35.0 |
| 30 | 19.8 | 32.0 | 45.2 | 33.0 | 41.9 | 32.0 | 40.2 | 42.0 | 51.6 | 36.0 | 32.9 | 23.0 |
| 31 | 36.6 | 29.0 | 26.1 | 32.0 | ..... | ..... | 46.9 | **46.0** | ..... | ..... | 13.8 | 26.0 |
| S'm | 990.0 | 1038.0 | 920.0 | 1014.0 | 1121.0 | 1011.0 | 1015.4 | 1105.0 | 1006.5 | 857.0 | 942.5 | 892.0 |
| M'n | 31.93 | 33.48 | 29.68 | 32.71 | 37.37 | 34.86 | 32.75 | 35.64 | 33.55 | 28.57 | 30.4 | 28.78 |

## TERRESTRIAL RADIATION.

In addition to the terrestrial radiation thermometer placed as in previous years, we have placed two, one at 12 inches above the grass, another at 24 inches. The gradual change in the temperature of the air as we pass from the ground upward is noticeable. Near the ground the air usually becomes from 6 to 10 degrees colder than the air in the instrument shelter, six feet above. The thermometers have not been freely exposed to the sky, as the horizon on nearly every side has not been clear, otherwise the readings would have descended lower. The thermometers used have been the minimum registering used for that purpose, but without having the bulbs blackened. The minimum air temperatures given for comparison are those taken in the instrument shelter close by. The instrument is about 6 feet from the ground. The instruments are all above grass. The lower one is about 3 inches above the grass.

## TERRESTRIAL RADIATION THERMOMETERS.

| Date. | JANUARY. | | | | FEBRUARY. | | | | MARCH. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height Above Ground. | | | Minimum Air Tem'ture. | Height Above Ground. | | | Minimum Air Tem'ture. | Height Above Ground. | | | Minimum Air Tem'ture. |
| | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | |
| 1.... | -3.3 | -2.5 | -1.5 | 5.0 | 7.8 | 8.0 | 8.8 | 11.5 | -14.2 | -13.0 | -13.2 | -9.0 |
| 2.... | -8.5 | -8.0 | -8.3 | -2.2 | 25.5 | 28.0 | 28.0 | 33.0 | 13.7 | 15.8 | 16.0 | 16.8 |
| 3.... | -3.8 | -2.0 | -1.0 | 4.5 | 27.5 | 29.0 | 29.6 | 32.9 | 12.5 | 14.2 | 14.2 | 18.0 |
| 4.... | 0.5 | 1.0 | 2.0 | 8.0 | 33.0 | 34.0 | 34.5 | 37.5 | 28.0 | 28.0 | 27.6 | 29.0 |
| 5.... | 4.0 | 4.0 | 4.2 | 8.5 | 23.0 | 28.2 | 28.2 | 31.0 | 30.8 | 31.3 | 31.0 | 32.8 |
| 6.... | 3.5 | 3.0 | 4.0 | 8.5 | 20.6 | 21.5 | 21.7 | 26.5 | 19.0 | 20.0 | 19.6 | 22.0 |
| 7.... | -1.5 | 1.8 | 1.2 | 2.2 | 11.6 | 13.0 | 13.0 | 15.0 | 21.0 | 21.5 | 21.0 | 24.0 |
| 8.... | 3.0 | 2.5 | -1.0 | 9.0 | 9.0 | 9.3 | 10.2 | 14.0 | 16.0 | 11.7 | 17.0 | 20.0 |
| 9.... | 8.0 | 8.0 | 8.5 | 15.2 | 12.0 | 13.8 | 14.0 | 19.0 | 18.3 | 19.7 | 19.3 | 23.2 |
| 10.... | 12.8 | 12.0 | 12.8 | 21.0 | 13.0 | 15.0 | 15.0 | 18.8 | 19.0 | 20.0 | 19.5 | 22.5 |
| 11.... | 11.0 | 11.0 | 11.0 | 15.0 | 7.8 | 9.0 | 10.8 | 16.0 | 11.0 | 13.0 | 13.0 | 18.8 |
| 12.... | -16.2 | -16.0 | -16.0 | -13.0 | 0.0 | 1.5 | 1.5 | 6.0 | 8.0 | 11.5 | 11.2 | 15.5 |
| 13.... | -12.5 | -12.5 | -12.2 | -7.0 | 7.5 | 8.6 | 9.5 | 14.0 | 5.0 | 8.0 | 7.3 | 12.5 |
| 14.... | -0.5 | -1.0 | 0.0 | 4.0 | 6.8 | 8.3 | 8.7 | 13.9 | 11.0 | 13.7 | 13.0 | 17.5 |
| 15.... | -13.0 | -12.0 | -11.5 | -6.0 | 7.0 | 9.1 | 9.2 | 12.9 | 11.0 | 13.0 | 12.0 | 15.8 |
| 16.... | -6.5 | -7.0 | -6.3 | -1.7 | .... | .... | .... | 16.0 | 14.7 | 16.0 | 15.0 | 21.0 |
| 17.... | 4.0 | 3.3 | 4.0 | 8.8 | 33.8 | 36.8 | 37.0 | 41.0 | 23.2 | 23.2 | 23.8 | 33.5 |
| 18.... | 6.5 | 6.5 | 7.0 | 14.0 | 12.0 | 14.0 | 14.0 | 16.0 | 27.0 | 28.0 | 29.2 | 34.0 |
| 19.... | 9.0 | 9.0 | 9.6 | 12.6 | 11.0 | 11.0 | 11.5 | 13.5 | 24.2 | 25.3 | 25.0 | 27.9 |
| 20.... | -7.8 | -7.0 | -6.0 | -1.2 | 8.8 | 9.0 | 9.7 | 12.8 | 27.0 | 28.0 | 28.0 | 32.9 |
| 21.... | -9.0 | -9.5 | -8.7 | -4.0 | 21.5 | 22.0 | 21.5 | 22.8 | 21.0 | 22.9 | 23.0 | 28.0 |
| 22.... | -6.0 | -6.0 | -5.2 | -1.0 | 11.5 | 13.6 | 13.5 | 17.5 | 31.6 | 31.5 | 31.4 | 32.2 |
| 23.... | 2.5 | 2.5 | 3.0 | 10.5 | 10.0 | 10.5 | 11.3 | 16.5 | 24.0 | 25.4 | 25.0 | 27.8 |
| 24.... | 4.0 | 4.0 | 5.0 | 9.0 | 1.0 | 2.0 | 2.3 | 7.5 | 32.7 | 33.5 | 34.0 | 40.0 |
| 25.... | 34.5 | .... | .... | 43.0 | -1.2 | -1.0 | -1.0 | 0.0 | 11.8 | 13.7 | 13.8 | 19.6 |
| 26.... | 53.0 | .... | .... | .... | -7.8 | -7.3 | -8.0 | -7.0 | 15.8 | 17.5 | 17.3 | 20.0 |
| 27.... | 22.2 | .... | .... | 28.0 | -25.5 | -23.5 | -23.5 | -20.0 | 33.0 | 34.0 | 34.0 | 35.8 |
| 28.... | 12.0 | 12.9 | 12.9 | 16.0 | -24.0 | -22.5 | -22.5 | -19.0 | 14.0 | 16.5 | 16.5 | 20.0 |
| 29.... | 11.9 | 13.5 | 13.2 | 18.0 | .... | .... | .... | .... | 15.3 | 18.5 | 18.6 | 22.8 |
| 30.... | 10.8 | 13.0 | 13.0 | 16.0 | .... | .... | .... | .... | 24.5 | 25.5 | 25.3 | 26.0 |
| 31.... | 12.1 | 13.0 | .... | 16.0 | .... | .... | .... | .... | 17.8 | 17.8 | 17.5 | 18.0 |
| Sums | 136.7 | 37.5 | 33.7 | 256.7 | 257.2 | 290.9 | 308.5 | 419.6 | 570.7 | 616.7 | 610.9 | 718.9 |
| Mean | 4.41 | 1.34 | 1.25 | 8.56 | 9.896 | 10.77 | 11.43 | 14.99 | 18.41 | 19.89 | 19.71 | 23.19 |

## TERRESTRIAL RADIATION THERMOMETERS.

| Date. | APRIL. | | | | MAY. | | | | JUNE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height Above Ground. | | | Minimum Air Temp'ture. | Height Above Ground. | | | Minimum Air Temp'ture. | Height Above Ground. | | | Minimum Air Temp'ture. |
| | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | |
| 1.... | 10.0 | 11.5 | 11.0 | 13.8 | 41.3 | 41.5 | 40.8 | 42.5 | 40.9 | 43.0 | 43.8 | 47.2 |
| 2.... | 13.8 | 15.2 | 15.0 | 17.2 | 34.0 | 36.8 | 37.1 | 39.8 | 36.0 | 37.8 | 38.5 | 42.2 |
| 3.... | 27.3 | 29.0 | 28.8 | 32.5 | 33.0 | 36.0 | 36.2 | 39.1 | 40.2 | 43.8 | 45.7 | 57.0 |
| 4.... | 22.0 | 23.5 | 23.2 | 26.3 | 38.0 | 39.5 | 40.0 | 42.4 | 33.0 | 36.0 | 38.0 | 43.8 |
| 5.... | 40.8 | 42.8 | 40.3 | 46.2 | 23.3 | 33.0 | 33.2 | 36.0 | 41.0 | 43.0 | 45.0 | 50.0 |
| 6.... | 33.4 | 35.0 | 35.2 | 38.1 | 22.2 | 25.8 | 25.8 | 29.1 | 34.0 | 37.0 | 37.5 | 42.0 |
| 7.... | 38.4 | 36.5 | 36.6 | 41.0 | 29.2 | 31.5 | 31.5 | 34.3 | 24.9 | 27.6 | 28.5 | 32.7 |
| 8.... | 26.7 | 28.0 | 26.7 | 29.0 | 35.0 | 39.3 | 40.2 | 43.2 | 29.0 | 32.0 | 32.8 | 37.0 |
| 9.... | 12.0 | 14.0 | 14.3 | 18.8 | 31.8 | 35.1 | 35.3 | 37.2 | 31.4 | 33.9 | 34.6 | 38.0 |
| 10.... | 21.6 | 23.3 | 23.3 | 29.3 | 39.0 | 39.0 | 39.5 | 39.3 | 34.8 | 37.9 | 38.5 | 43.4 |
| 11.... | 24.0 | 26.3 | 26.9 | 33.0 | 34.6 | 38.2 | 38.3 | 41.0 | 34.9 | 38.3 | 39.0 | 43.3 |
| 12.... | 30.5 | 32.0 | 32.5 | 35.2 | .... | 38.5 | 39.0 | 40.8 | 36.2 | 39.8 | 40.6 | 44.0 |
| 13.... | 30.9 | 31.5 | 31.2 | 32.0 | .... | 30.1 | 30.6 | 35.0 | 39.0 | 46.1 | 48.7 | 51.9 |
| 14.... | 32.0 | 32.5 | 32.5 | 31.8 | 22.0 | 27.3 | 27.8 | 32.0 | 29.9 | 33.3 | 35.6 | 41.0 |
| 15.... | 32.0 | 32.0 | 31.6 | 32.6 | 31.5 | 31.9 | 31.5 | 31.8 | 33.7 | 37.0 | 38.1 | 41.9 |
| 16.... | .... | 25.0 | 24.5 | 27.3 | 27.3 | 32.5 | 31.0 | 35.5 | 30.7 | 38.8 | 41.0 | 40.9 |
| 17.... | 21.5 | 24.0 | .... | 28.0 | 35.5 | 39.0 | 40.2 | 43.2 | 34.1 | 38.0 | 38.2 | 41.0 |
| 18.... | 23.1 | 25.0 | 25.0 | 30.0 | 33.2 | 38.0 | 40.0 | 46.2 | 34.7 | 37.9 | 38.6 | 43.0 |
| 19.... | 33.3 | 34.3 | 34.5 | 38.2 | 28.5 | 32.5 | 33.0 | 35.9 | 44.8 | 47.8 | 44.5 | 54.0 |
| 20.... | 41.6 | 41.6 | 41.8 | 43.3 | 38.0 | 42.0 | 44.5 | 48.8 | 43.8 | 47.0 | 47.1 | 51.0 |
| 21.... | 38.6 | 39.0 | 39.3 | 41.0 | 32.0 | 35.3 | 36.9 | 40.8 | 40.5 | 48.0 | 46.0 | 56.0 |
| 22.... | 30.0 | 31.8 | 31.8 | 34.7 | 43.5 | 49.7 | 51.0 | 53.8 | 43.5 | 47.1 | 47.9 | 52.4 |
| 23.... | 41.5 | 41.8 | 41.5 | 42.5 | 31.8 | 35.8 | 36.5 | 38.5 | .... | .... | .. | 53.1 |
| 24.... | 41.0 | 41.0 | 40.8 | 41.0 | 35.0 | 38.8 | 40.5 | 45.2 | 45.0 | 49.5 | 50.0 | 55.4 |
| 25.... | 30.8 | 31.0 | 30.6 | 32.5 | 41.0 | 44.5 | 48.0 | 54.9 | 44.1 | 48.0 | 48.9 | 58.8 |
| 26.... | 29.5 | 29.6 | 29.3 | 31.0 | 38.5 | 43.0 | 45.0 | 48.6 | 40.1 | 44.3 | 45.2 | 50.0 |
| 27.... | 27.5 | 29.5 | 29.5 | 31.6 | 32.4 | 35.5 | 36.0 | 40.8 | 39.8 | 44.0 | 45.3 | 50.0 |
| 28.... | 30.2 | 33.0 | 33.8 | 37.8 | 36.3 | 38.8 | 40.8 | 45.8 | 41.3 | 45.9 | 47.0 | 51.5 |
| 29.... | 30.3 | 32.5 | 32.5 | 36.0 | 34.2 | 36.8 | 37.5 | 41.0 | 36.5 | 40.9 | 42.4 | 47.9 |
| 30.... | 32.0 | 36.5 | 37.2 | 41.6 | 34.0 | 36.0 | 37.0 | 41.0 | 39.0 | 43.2 | 45.3 | 50.2 |
| 31.... | .... | .... | .... | .... | 38.8 | 41.6 | 43.2 | 48.0 | .... | .... | .... | .... |
| Sums | 846.3 | 908.7 | 881.2 | 993.3 | 979.9 | 1143.3 | 1169.9 | 1271.5 | 1082.8 | 1186.9 | 1212.3 | 1404.6 |
| Mean | 29.2 | 30.3 | 30.4 | 33.11 | 33.8 | 36.9 | 37.7 | 41.02 | 37.3 | 40.9 | 41.8 | 46.82 |

## TERRESTRIAL RADIATION THERMOMETERS.

| Date. | JULY. | | | | AUGUST. | | | | SEPTEMBER | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height Above Ground. | | | Minimum Air Tem'ture. | Height Above Ground. | | | Minimum Air Tem'ture. | Height Above Ground. | | | Minimum Air Tem'ture. |
| | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | |
| 1.... | 46.6 | 49.9 | 50.1 | 53.5 | 44.0 | 50.1 | 50.7 | 53.0 | 35.2 | 42.5 | 43.0 | 46.9 |
| 2.... | 37.2 | 41.1 | 42.2 | 46.9 | 42.0 | 48.3 | 49.2 | 52.9 | 40.6 | 47.9 | 48.0 | 51.8 |
| 3.... | 44.1 | 47.9 | 48.2 | 52.0 | 49.0 | 55.1 | 56.1 | 59.8 | 35.5 | 42.5 | 43.0 | 46.9 |
| 4.... | 46.0 | 50.0 | 50.8 | 54.5 | 44.9 | 51.2 | 52.9 | 57.9 | 30.9 | 38.0 | 38.1 | 41.3 |
| 5.... | 43.6 | 47.4 | 47.8 | 51.1 | 39.9 | 46.0 | 46.2 | 50.0 | 34.4 | 42.0 | 42.5 | 45.5 |
| 6.... | 50.2 | 54.0 | 55.1 | 60.0 | 35.3 | 41.9 | 42.0 | 46.0 | ..... | 52.1 | 54.0 | ..... |
| 7.... | 42.9 | 47.1 | 48.6 | 53.1 | 40.0 | 41.0 | 41.3 | 50.1 | ..... | 31.0 | 31.0 | 34.7 |
| 8.... | 47.2 | 51.6 | 52.0 | 55.1 | 50.2 | 58.1 | 58.5 | 61.7 | ..... | 27.0 | 27.0 | 30.1 |
| 9.... | 47.0 | 51.5 | 51.8 | 55.0 | 48.0 | 54.0 | 55.0 | 57.8 | ..... | 27.8 | 28.1 | 32.5 |
| 10.... | 48.9 | 53.2 | 53.4 | 56.4 | 45.8 | 51.9 | 51.5 | 54.0 | ..... | 32.0 | 32.0 | 35.5 |
| 11.... | 47.0 | 52.0 | 52.5 | 57.1 | 48.0 | 54.0 | 54.2 | 52.0 | ..... | 43.0 | 46.0 | 52.0 |
| 12.... | 36.6 | 42.8 | 43.9 | 50.0 | 44.8 | 50.7 | 50.6 | 53.3 | ..... | 30.2 | 30.9 | 34.9 |
| 13.... | 39.8 | 45.7 | 46.5 | 51.8 | 47.0 | 53.0 | 52.9 | 55.0 | ..... | 24.6 | 24.1 | 28.0 |
| 14.... | 59.8 | 64.4 | 64.4 | 65.2 | 52.6 | 58.2 | 58.2 | 60.1 | ..... | 24.4 | 28.0 | 31.8 |
| 15.... | 42.8 | 48.5 | 48.5 | 51.2 | 45.2 | 52.0 | 52.1 | 55.1 | ..... | 27.4 | 28.0 | 31.0 |
| 16.... | 52.0 | 57.3 | 57.5 | 60.1 | 47.8 | 53.9 | 54.0 | 57.0 | ..... | 33.5 | 34.8 | 39.1 |
| 17.... | 52.4 | 58.0 | 58.7 | 61.9 | 39.9 | 46.0 | 46.0 | 47.2 | ..... | 39.0 | 40.7 | 45.0 |
| 18.... | 50.3 | 55.6 | 55.8 | 59.1 | 44.2 | 50.8 | 50.7 | 53.2 | ..... | 53.5 | 56.3 | 61.5 |
| 19.... | 55.0 | 57.1 | 57.2 | 59.9 | 42.4 | 48.3 | 48.0 | 49.0 | ..... | 33.4 | 34.7 | 37.9 |
| 20.... | 46.7 | 52.4 | 53.1 | 57.3 | 38.5 | 45.0 | 45.0 | 48.1 | ..... | 41.1 | 46.5 | 51.0 |
| 21.... | 48.8 | 53.9 | 54.1 | 57.0 | .... | ..... | ..... | 45.0 | ..... | 30.0 | 30.8 | 34.1 |
| 22.... | 51.4 | 56.7 | 57.0 | 60.0 | 35.0 | 42.0 | 42.1 | 49.0 | ..... | 30.0 | 31.1 | 34.9 |
| 23.... | 44.5 | 49.5 | 49.1 | 51.8 | 42.8 | 48.4 | 48.9 | 52.0 | ..... | 41.0 | 42.0 | 45.0 |
| 24.... | 47.7 | 53.1 | 54.0 | 57.5 | 36.5 | 43.0 | 44.0 | 50.4 | ..... | 34.9 | 35.1 | 38.7 |
| 25.... | 40.9 | 46.7 | 47.0 | 50.8 | 36.5 | 43.0 | 43.1 | 46.5 | ..... | 33.0 | 33.6 | 37.9 |
| 26.... | 44.0 | 49.9 | 50.0 | 53.8 | 30.0 | 36.0 | 36.8 | 39.5 | ..... | 32.0 | 32.4 | 35.1 |
| 27.... | 40.3 | 46.2 | 47.8 | 50.6 | 35.2 | 38.0 | 38.1 | 43.6 | ..... | 30.1 | 30.5 | 34.0 |
| 28.... | 41.9 | 47.9 | 48.5 | 53.0 | 31.9 | 40.0 | 40.9 | 44.0 | ..... | 31.0 | 31.0 | 35.0 |
| 29.... | 48.3 | 54.0 | 54.6 | 47.9 | 37.0 | 44.0 | 45.8 | 50.9 | ..... | 30.1 | 30.8 | 35.9 |
| 30.... | 47.0 | 52.9 | 53.9 | 58.0 | 31.7 | 38.1 | 38.8 | 42.5 | ..... | 30.3 | 30.6 | 36.0 |
| 31.... | 41.0 | 46.7 | 46.8 | 49.0 | 38.8 | 46.3 | 47.5 | 51.9 | ..... | ..... | ..... | ..... |
| Sums | 1431.9 | 1585.0 | 1598.3 | 1710.2 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Mean | 46.2 | 51.1 | 51.6 | 55.17 | 41.5 | 47.61 | 48.0 | 51.24 | ..... | 35.2 | 36.2 | 39.45 |

## TERRESTRIAL RADIATION THERMOMETERS.

| Day. | OCTOBER. | | | | NOVEMBER. | | | | DECEMBER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height Above Ground. | | | Minimum Air Temture. | Height Above Ground. | | | Minimum Air Temture. | Height Above Ground. | | | Minimum Air Temture. |
| | 6 In. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | | 6 in. | 12 in. | 24 in. | |
| 1.... | ..... | 31.7 | 32.1 | 36.1 | 17.9 | 20.0 | 20.5 | 26.9 | 12.5 | 17.0 | 17.5 | 24.2 |
| 2.... | ..... | 30.9 | 31.0 | 34.9 | 25.0 | 29.0 | 30.0 | 36.0 | 15.1 | 20.0 | 20.9 | 24.9 |
| 3.... | ..... | 32.0 | 33.0 | 37.8 | 17.0 | 19.0 | 19.5 | 22.9 | 23.0 | 28.0 | 28.4 | 29.0 |
| 4.... | ..... | 29.9 | 31.2 | 35.5 | 19.0 | 20.7 | 22.8 | 27.0 | 7.5 | 11.9 | 11.9 | 15.6 |
| 5.... | ..... | 11.8 | 12.8 | 15.7 | 26.1 | 29.0 | 30.5 | 35.9 | 18.8 | 22.0 | 22.0 | 22.7 |
| 6.... | ..... | 37.2 | 38.9 | 43.0 | 12.0 | 14.8 | 15.0 | 19.8 | 10.4 | 16.0 | 16.2 | 20.4 |
| 7.... | ..... | 30.6 | 31.8 | 35.9 | 13.3 | 15.0 | 17.5 | 20.0 | 1.6 | 7.5 | 7.9 | 12.0 |
| 8.... | ..... | 26.0 | 27.7 | 33.0 | 21.7 | 22.0 | 22.9 | 23.6 | -3.0 | 1.0 | 1.9 | 5.8 |
| 9.... | ..... | 31.9 | 31.5 | 32.0 | 1.2 | 3.0 | 3.5 | 6.5 | 6.2 | 11.1 | 11.4 | 14.8 |
| 10.... | ..... | 37.5 | 37.8 | 38.0 | 11.8 | 16.0 | 15.9 | 19.8 | 13.7 | 17.9 | 18.2 | 22.7 |
| 11.... | ..... | 42.0 | 43.7 | 47.0 | 11.0 | 15.5 | 15.9 | 20.1 | 13.0 | 19.8 | 20.2 | 24.4 |
| 12.... | ..... | 30.0 | 30.5 | 33.0 | 13.0 | 16.0 | 16.0 | 19.0 | 3.5 | 8.0 | 8.0 | 12.8 |
| 13.... | ..... | 32.0 | 32.5 | 35.5 | 10.0 | 13.4 | 13.6 | 17.0 | 9.0 | 14.8 | 15.0 | 20.0 |
| 14.... | ..... | 16.7 | 17.0 | 21.4 | 22.8 | 27.2 | 27.3 | 35.0 | 9.4 | 13.8 | 14.1 | 19.0 |
| 15.... | ..... | 31.0 | 32.1 | 34.6 | 4.0 | 8.0 | 8.2 | 13.9 | 12.7 | 12.9 | 13.5 | 18.1 |
| 16.... | ..... | 17.0 | 17.6 | 23.0 | 2.3 | 7.0 | 7.0 | 11.0 | -0.8 | 4.0 | 5.5 | 9.0 |
| 17.... | ..... | 21.0 | 22.0 | 26.9 | 10.2 | 13.8 | 14.0 | 19.3 | 0.0 | 4.8 | 6.1 | 11.3 |
| 18.... | ..... | 17.9 | 19.0 | 23.5 | 12.0 | 17.0 | 18.5 | 21.0 | -2.0 | 3.5 | 4.0 | 10.1 |
| 19.... | ..... | 16.9 | 17.8 | 21.9 | 9.5 | 13.9 | 14.6 | 19.0 | 7.1 | 12.9 | 13.1 | 17.0 |
| 20.... | ..... | 33.8 | 34.8 | 39.0 | 8.4 | 12.8 | 13.0 | 17.9 | 14.0 | 20.0 | 20.9 | 26.0 |
| 21.... | ..... | 13.4 | 13.9 | 17.9 | 22.0 | 27.0 | 28.1 | 34.5 | -0.3 | 44.0 | 56.0 | 10.0 |
| 22.... | ..... | 20.9 | 21.4 | 26.0 | 9.0 | 13.0 | 13.5 | 18.0 | 3.4 | 13.7 | 13.8 | 13.9 |
| 23.... | ..... | 31.0 | 32.0 | 31.9 | 10.5 | 15.1 | 16.0 | 20.2 | 1.2 | 7.7 | 7.9 | 12.2 |
| 24.... | ..... | 28.0 | 29.6 | 35.0 | 10.0 | 15.0 | 15.7 | 20.9 | 11.0 | 18.3 | 18.6 | 20.7 |
| 25.... | ..... | 27.0 | 27.3 | 31.5 | 14.5 | 21.0 | 21.5 | 26.3 | 1.0 | 7.2 | 7.5 | 10.9 |
| 26.... | ..... | 17.0 | 17.9 | 22.9 | 5.4 | 11.0 | 11.0 | 11.8 | 24.2 | 31.0 | 31.8 | 33.8 |
| 27.... | ..... | 28.0 | 28.2 | 34.6 | 7.6 | 14.6 | 14.0 | 18.8 | 2.9 | 8.9 | 9.5 | 12.0 |
| 28.... | ..... | 23.6 | 24.0 | 29.4 | 11.2 | 16.0 | 17.0 | 21.3 | 2.9 | 8.8 | 9.0 | 13.0 |
| 29.... | ..... | 24.4 | 24.5 | 31.0 | 7.0 | 12.6 | 12.8 | 16.2 | 11.9 | 19.0 | 19.5 | 24.2 |
| 30.... | ..... | 22.0 | 22.6 | 26.8 | 9.0 | 15.2 | 15.7 | 20.2 | 12.0 | 22.0 | 22.0 | 26.0 |
| 31.... | ..... | 21.2 | 22.0 | 27.0 | ..... | ..... | ..... | ..... | 20.6 | 27.9 | 28.9 | 32.0 |
| Sums | 319.9 | 814.3 | 838.2 | 961.7 | 384.4 | 493.6 | 521.4 | 639.8 | 262.5 | 475.4 | 501.2 | 568.4 |
| Mean | 10.3 | 26.3 | 27.0 | 31.0 | 12.81 | 16.45 | 17.35 | 21.33 | 8.4 | 14.9 | 16.2 | 18.3 |

## SOIL THERMOMETERS.

We have had three sets of soil thermometers in the ground during the greater portion of the season, and in the same locations as last year. Set A is placed near the instrument shelter for meteorological instruments, and has not been disturbed, except as some of the thermometers have been removed for limited times to test. Set B is in some low, damp ground, near a ditch, with the water table for a large portion of the year higher than the bulb of the deep thermometer, which is 54 inches below the surface. Set C is on a knoll, with a northerly exposure, near the College barn. Set A is in a soil with southern exposure, not directly irrigated, but close enough to the College lawn to share in its benefits, and sometimes receives some of the water which overflows. Set B not only derives moisture from the regular irrigations, but from the underlying water table which always keeps the soil there damp. It is a dark loam. Set C is in ground that has never been irrigated. It is a yellow clay, so hard and compact that it was only with great difficulty that the thermometers could be sunk to place.

Each set consists of the same thermometers as last year. Each was read in 1889 twice daily, but in 1890 the sets at the barn and at the ditch, at a considerable distance, were read weekly, and set A was read as usual, twice daily.

*Corrections*—By testing the thermometers when surrounded with melting snow, we find the following corrections necessary at 32°; position, vertical:

CORRECTIONS TO SOIL THERMOMETERS AT 32°.

| Thermometer, Size. | SET A. | | SET B. | | SET C. | |
|---|---|---|---|---|---|---|
| | Number. | Correction. | Number. | Correction. | Number. | Correction. |
| | | *Plus.* | | | | |
| 3 inches | 3267 | .3 | ..... | ..... | ..... | ..... |
| 6 inches. | 3338 | .05 | 3644 | —.4 | 3052 | —.3 |
| 12 inches. | 3255 | .2 | 3780 | —.1 | 3774 | —.4 |
| 24 inches. | 3335 | .05 | 3513 | .0 | 3785 | —.2 |
| 36 inches. | 3234 | .2 | 3821 | —.2 | 3823 | —.7 |
| 72 inches. | 3811 | .05 | 3813 | .0 | ..... | ..... |

These corrections have been applied to the readings of 1890, but were not applied to those of 1889.

Means were not at hand to give a satisfactory test at other temperatures. Some considerable time was spent with the means at hand, but the results were not consistent enough to give any confidence in the corrections. We hope to prepare later, before a discussion of these results is made, a satisfactory means of determining the corrections of these thermometers at all temperatures needed.

In the horizontal position the correction is much greater in each case, as is shown in the test given of the Green 3,811, 6-foot thermometer.

TEST OF GREEN SIX-FOOT SOIL THERMOMETER NO. 3,811, FEBRUARY AND MARCH, 1890.

| Inclination to the Horizontal. | Snow on Bulb and 6 inches of Stem. | With Snow on Bulb and 13 in. of Stem. | With Whole Stem in Snow. | |
|---|---|---|---|---|
| | | | 1st Trial. | 2nd Trial. |
| Vertical. | 32.6 | 32.6 | 31.95 | 31.95 |
| 60 degrees. | ..... | ..... | 32.00 | ..... |
| 45 degrees. | 33.0 | 32.9 | 32.10 | 32.05 |
| 30 degrees. | 33.1 | 33.9 | 32.25 | 32.25 |
| 25 degrees. | ..... | 33.05 | 32.40 | 32.40 |
| 20 degrees. | ..... | 33.10 | 32.45 | 32.45 |
| 15 degrees. | 33.25 | 33.15 | 32.50 | 32.50 |
| 10 degrees. | 33.40 | 33.30 | 32.55 | 32.55 |
| 5 degrees. | 33.45 | 33.40 | 32.60 | 32.60 |
| 0 degrees. | 33.50 | 33.50 | 32.60 | 32.60 |
| After 4 minutes. | 33.50 | ..... | ..... | ..... |
| After 10 minutes. | ..... ..... | 33.40 | ..... | ..... |
| After 5 minutes. | ..... | ..... | 32.60 | ..... |

In the second test, with snow covering 13 inches of the stem, the temperature of the stem at the 20° mark was 67°; 18 inches below this mark, 62°; 30 inches below, 61°. The partition confining the snow was 39 inches below this mark. The temperature of the air was between 60° and 70°.

In the longer thermometers, as in the 6-foot one whose test is given, there must necessarily be an appreciable quantity of mercury in the long stem above the bulb, and its temperature will affect the reading of the thermometer. The long thermometers consist of several tubes welded together, with minute secondary bulbs formed at the point of welding. In our instruments these bulbs are very small. The lower tubes are of smaller bore than the upper one, which carries the graduations.

The effect of the different temperatures of the stem is noticeable in comparing the readings when the stem was entirely covered with snow, and when only partially. When the stem was about two-thirds exposed to a temperature 30° higher than that of the bulb, the reading was increased by .65°. This difference gives the length of the stem as 275° from the bulb to the zero mark. The thermometer was subjected to cooling to determine the length of the column by direct measurement. The bulb and a small portion of the stem were surrounded by a freezing mixture, whose temperature, as well as that of the thermometer, was taken at intervals. The results were not considered good, as they were affected by the sluggishness of the thermometer which we had, at the time, no convenient means to measure. By platting the observations, and making a graphical measurement of the retard, the end of the column descended a distance of $4\frac{1}{4}$ inches for a cooling of 20°, which corresponds to a length of the stem between the bulb and zero of 310°. With the arrival of our Normal thermometer, these corrections will be more carefully determined. Assuming the length of the stem from these measures to be 290°, and taking 1-11,600 as the coefficient of the relative expansion of mercury and glass, we derive the following table of corrections. A more careful determination of the constants involved will not be apt to alter these much :

CORRECTION FOR TEMPERATURE OF STEM FOR SOIL THERMOMETER, NO. 3,811.

| READING. | Difference Between Mean Temperature of Stem and Temperature of Bulb. | | | | |
|---|---|---|---|---|---|
| | 5 degrees. | 10 degrees. | 15 degrees. | 20 degrees. | 30 degrees. |
| 30 degrees | .14 | .28 | .41 | .56 | .83 |
| 40 degrees | .14 | .28 | .43 | .57 | .84 |
| 50 degrees | .14 | .29 | .44 | .58 | .87 |
| 60 degrees | .15 | .30 | .45 | .60 | .90 |

This correction is subtractive if the mean temperature of the soil at less than 6 feet is greater than that at 6 feet, and is additive if it be less.

From April to September the readings will be slightly reduced from this cause, and from October to March slightly increased, thus having the effect of reducing the extremes of its temperature, or, in other words, to lessen its range. This correction has not been taken into account in the following tables of the weekly means of the temperatures of the soils:

The soil reached its extreme temperatures as follows, in 1890, sets B and C being read weekly:

| DEPTHS. | Set. | Max. | Date. | Min. | Date. | Range. |
|---|---|---|---|---|---|---|
| 3 inches | A | 87.7 | July 14. | 18.6 | January 22. | 71.1 |
| 6 inches | A | 81.65 | July 15. | 22.75 | January 22. | 58.9 |
| | B | 74.6 | July 24. | | | |
| | C | 80.7 | July 24. | | | |
| 12 inches | A | 74.1 | July 20. | 26.0 | January 22. | 48.1 |
| | B | 70.9 | July 17 | | | |
| | C | 76.6 | July 17. | | | |
| 24 inches | A | 69.45 | July 22. | 32.1 | January 24. | 37.35 |
| | B | 66.2 | July 24. | | | |
| | C | 72.6 | July 17. | | | |
| 36 inches | A | 67.6 | July 23. | 34.4 | January 27. | 33.2 |
| | B | 64.7 | August 7. | | | |
| | C | 68.5 | July 31. | | | |
| 72 inches | A | 63.1 | *August 14. | 40.25 | March 11. | 21.85 |
| | B | 60.0 | August 14. | | | |

* Water from irrigation flooded the plat where the thermometers are placed September 4, and raised the temperature above this

It will be noticed that set C, the set in soil almost entirely free from moisture, is the highest, and set B, in the low, damp ground, is the lowest. The case where the three inch thermometer of A reads higher than C, is due

to the fact that the two sets were not read at quite the same hour, and also that C was read weekly only.

In 1889 the extremes and their dates were as follows. In this year each set was read twice daily, at the same hours:

EXTREMES AND THEIR DATES.

| DEPTHS. | Set. | Max. | Date. | Min. | Date. | Range. |
|---|---|---|---|---|---|---|
| 3 inches | A | 86.2 | July 1. | 14.5 | January 2. | 71.7 |
| 6 inches | A | 81.2 | July 1. | 20.0 | January 2. | 61.2 |
| | B | 73.5 | July 1. | ..... | ..... | ..... |
| | C | 82.0 | July 1. | ..... | ..... | ..... |
| 12 inches | A | 72.5 | July 16. | 25.5 | January 24. | 47.0 |
| | B | 69.4 | July 16. | ..... | ..... | ..... |
| | C | 74.8 | August 8. | ..... | ..... | ..... |
| 24 inches | A | 66.9 | July 17, 27, 28 and Aug. 7. | 30.6 | February 11. | 36.3 |
| | B | 66.0 | July 27. | ..... | ..... | ..... |
| | C | 71.7 | July 16. | ..... | ..... | ..... |
| 36 inches | A | 64.6 | August 21. | 33.3 | January 29. | 31.3 |
| | B | 64.0 | August 26. | ..... | ..... | ..... |
| | C | 68.7 | August 30. | ..... | ..... | ..... |
| 72 inches | A | 60.0 | Sept 1 to 12. | 39.4 | February 18. | 20.6 |
| | B | 60.4 | September 6. | ..... | ..... | ..... |

COMPARISON OF SETS A, B, C, MAY 15 TO JUNE 2.

| SET. | 6 Inch. | 12 Inch. | 24 Inch. | 36 Inch. | 72 Inch. |
|---|---|---|---|---|---|
| A | 56.2 | 56.3 | 55.9 | 55.8 | 55.6 |
| B | 58.7 | 57.0 | 56.3 | 55.8 | 54.7 |
| C | 60.4 | 59.0 | 58.8 | 57.1 | ..... |

Set A read twice daily. Sets B and C read once weekly. Sets B and C, only, are strictly comparable.

## WEEKLY MEANS OF SOIL TEMPERATURES FROM SET A, 1890.

| WEEK ENDING. | DEPTH. | | | | | |
|---|---|---|---|---|---|---|
| | Three inches. | Six inches. | One foot. | Two feet. | Three feet. | Six feet. |
| January 4 | 28.66 | 31.06 | 33.51 | 36.27 | 38.59 | 44.31 |
| January 11 | 27.51 | 29.54 | 31.53 | 34.38 | 36.97 | 43.51 |
| January 18 | 25.56 | 27.22 | 30.02 | 33.43 | 35.91 | 42.61 |
| January 25 | 25.77 | 27.14 | 28.78 | 32.45 | 34.91 | 41.73 |
| February 1 | 32.67 | 32.23 | 31.49 | 32.37 | 34.47 | 41.08 |
| February 8 | 34.99 | 34.42 | 32.56 | 33.19 | 34.84 | 40.56 |
| February 15 | 31.52 | 32.51 | 33.32 | 34.61 | 35.90 | 40.54 |
| February 22 | 34.69 | 35.26 | 35.13 | 35.57 | 36.49 | 40.61 |
| March 1 | 28.96 | 31.16 | 33.34 | 35.24 | 36.66 | 40.73 |
| March 8 | 33.23 | 32.46 | 32.22 | 34.14 | 35.84 | 40.52 |
| March 15 | 34.45 | 35.26 | 35.33 | 35.84 | 36.66 | 40.32 |
| March 22 | 44.12 | 44.08 | 41.91 | 39.46 | 38.71 | 40.66 |
| March 29 | 45.06 | 46.04 | 45.13 | 43.34 | 42.17 | 41.89 |
| April 5 | 43.49 | 44.17 | 43.63 | 43.02 | 42.80 | 43.09 |
| April 12 | 51.17 | 51.43 | 49.65 | 46.78 | 45.01 | 43.97 |
| April 19 | 46.19 | 47.14 | 47.20 | 46.72 | 46.19 | 45.17 |
| April 26 | 47.63 | 48.29 | 48.69 | 47.80 | 46.98 | 45.84 |
| May 3 | 53.29 | 53.30 | 51.89 | 49.26 | 47.86 | 46.64 |
| May 10 | 53.34 | 53.75 | 53.08 | 51.17 | 49.62 | 47.64 |
| May 17 | 55.84 | 55.98 | 54.53 | 52.16 | 50.70 | 48.58 |
| May 24 | 60.39 | 60.35 | 58.29 | 54.77 | 52.46 | 49.57 |
| May 31 | 65.07 | 64.32 | 61.51 | 57.21 | 54.55 | 50.78 |
| June 7 | 64.11 | 64.58 | 63.24 | 59.52 | 56.61 | 52.02 |
| June 14 | 64.96 | 63.63 | 62.18 | 57.38 | 56.62 | 52.68 |
| June 21 | 72.37 | 70.38 | 66.50 | 61.33 | 58.19 | 53.60 |
| June 28 | 75.85 | 73.68 | 69.92 | 64.35 | 60.65 | 54.49 |

**WEEKLY MEANS OF SOIL TEMPERATURES, FROM SET A, 1890—Continued.**

| WEEK ENDING. | DEPTH. | | | | | |
|---|---|---|---|---|---|---|
| | Three inches. | Six inches. | One foot. | Two feet. | Three feet. | Six feet. |
| July 5 | 72.51 | 72.35 | 68.95 | 64.85 | 61.86 | 55.60 |
| July 12 | 75.23 | 74.55 | 70.08 | 65.73 | 63.23 | 56.71 |
| July 19 | 77.26 | 76.40 | 72.95 | 68.43 | 65.43 | 59.49 |
| July 26 | 74.79 | 75.18 | 72.98 | 69.06 | 66.63 | 60.88 |
| August 2 | 71.50 | 70.58 | 70.03 | 68.10 | 66.21 | 61.44 |
| August 9 | 71.44 | 71.48 | 69.78 | 67.30 | 65.55 | 61.49 |
| August 16 | 68.18 | 68.20 | 68.63 | 66.97 | 65.51 | 61.74 |
| August 23 | 63.90 | 65.25 | 65.50 | 65.15 | 64.65 | 61.85 |
| August 30 | 62.99 | 63.81 | 64.26 | 64.23 | 63.89 | 61.70 |
| September 6 | 61.76 | 62.73 | 63.66 | 63.66 | 63.49 | 62.55 |
| September 13 | 57.38 | 58.46 | 60.64 | 62.07 | 62.68 | 62.64 |
| September 20 | 56.65 | 57.66 | 58.96 | 60.20 | 61.07 | 61.95 |
| September 27 | 54.49 | 55.83 | 57.53 | 58.97 | 59.79 | 60.86 |
| October 4 | 52.80 | 54.18 | 56.15 | 57.94 | 58.76 | 60.09 |
| October 11 | 48.63 | 50.13 | 52.29 | 55.06 | 56.77 | 59.11 |
| October 18 | 44.14 | 46.14 | 49.05 | 52.28 | 54.33 | 57.81 |
| October 25 | 44.83 | 45.77 | 47.55 | 50.05 | 52.02 | 56.33 |
| November 1 | 44.69 | 45.98 | 47.68 | 49.71 | 51.19 | 55.04 |
| November 8 | 42.37 | 44.04 | 46.28 | 48.79 | 50.36 | 54.14 |
| November 15 | 36.54 | 38.34 | 40.96 | 44.94 | 47.88 | 53.08 |
| November 22 | 33.59 | 35.11 | 38.05 | 42.03 | 44.89 | 51.41 |
| November 29 | 34.14 | 35.47 | 37.88 | 41.03 | 43.66 | 49.83 |
| December 6 | 35.61 | 36.46 | 38.05 | 40.28 | 42.28 | 48.26 |
| December 13 | 32.12 | 33.36 | 35.96 | 38.67 | 41.31 | 47.32 |
| December 20 | 30.61 | 32.06 | 34.55 | 37.18 | 40.01 | 46.23 |
| December 27 | 30.05 | 31.23 | 33.42 | 35.95 | 38.57 | 45.07 |
| Sums | 2559.09 | 2590.13 | 2596.40 | 2590.39 | 2598.38 | 2645.76 |
| Means for year | 49.21 | 49.81 | 49.93 | 49.81 | 49.96 | 50.88 |

## WEEKLY READINGS OF SOIL THERMOMETERS, 1890.

| WEEKLY READINGS. | SET B, LOW GROUND. DEPTH. | | | | | SET C, UNIRRIGATED. DEPTH. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 6 in. | 1 ft. | 2 ft. | 3 ft. | 6 ft. | 6 in. | 1 ft. | 2 ft. | 3 ft. |
| May 15 | 53.6 | 52.4 | 50.1 | 49.2 | 47.6 | 54.9 | 53.6 | 52.0 | 49.7 |
| May 22 | 62.6 | 58.9 | 53.8 | 51.8 | 49.0 | 63.5 | 60.8 | 56.3 | 52.3 |
| May 29 | 63.6 | 60.4 | 66.3 | 53.4 | 50.5 | 66.7 | 63.1 | 59.6 | 55.5 |
| June 5 | 63.6 | 60.9 | 57.8 | 56.2 | 52.0 | 66.7 | 63.9 | 61.8 | 58.3 |
| June 12 | 63.3 | 60.0 | 57.4 | 56.2 | 53.0 | 68.7 | 64.4 | 61.9 | 58.5 |
| June 19 | 69.1 | 63.6 | 59.0 | 57.3 | 54.0 | 75.4 | 69.0 | 64.6 | 60.3 |
| June 26 | 71.8 | 67.2 | 61.9 | 59.4 | 54.8 | 77.6 | 72.8 | 68.5 | 63.4 |
| July 3 | 72.1 | 68.1 | 63.4 | 61.1 | 56.0 | 78.4 | 73.6 | 70.0 | 65.4 |
| July 10 | 73.3 | 69.4 | 64.4 | 61.9 | 56.8 | 77.2 | 74.8 | 70.5 | 62.1 |
| July 17 | 72.2 | 70.9 | 66.0 | 63.9 | 57.9 | 76.3 | 76.6 | 72.6 | 57.8 |
| July 24 | 74.6 | 70.7 | 66.2 | 64.2 | 58.4 | 80.7 | 76.0 | 72.1 | 68.3 |
| July 31 | 73.4 | 68.7 | 65.9 | 64.4 | 59.0 | 76.8 | 72.7 | 71.4 | 68.5 |
| August 7 | 74.1 | 70.4 | 66.6 | 64.7 | 59.5 | 78.6 | 75.2 | 71.9 | 68.3 |
| August 14 | 69.6 | 67.7 | 65.6 | 64.5 | 60.0 | 71.2 | 70.5 | 69.8 | 67.8 |
| August 22 | 69.1 | 65.3 | 63.5 | 62.8 | 60.0 | 68.7 | 67.1 | 66.3 | 65.2 |
| August 28 | 69.6 | 66.2 | 63.8 | 63.0 | 59.7 | 70.7 | 68.0 | 66.7 | 64.8 |
| September 4 | 68.9 | 65.1 | 63.8 | 63.2 | 60.0 | 69.7 | 67.1 | 66.7 | 64.8 |
| September 11 | 67.1 | 63.9 | 62.4 | 62.1 | 59.7 | 69.2 | 66.2 | 65.2 | 63.8 |
| September 18 | 64.2 | 62.9 | 61.5 | 61.2 | 59.4 | 67.3 | 65.7 | 64.8 | 63.3 |
| September 28 | 61.0 | 59.4 | 59.5 | 59.9 | 58.8 | 64.8 | 62.6 | 63.6 | 62.7 |
| October 2 | 59.5 | 58.3 | 59.0 | 59.4 | 58.5 | 62.5 | 61.1 | 62.8 | 62.0 |
| October 13 | 49.5 | 51.9 | 54.5 | 56.0 | 57.3 | 49.9 | 51.8 | 56.8 | 57.8 |
| October 16 | 48.2 | 49.3 | 52.8 | 54.8 | 56.6 | 44.2 | 49.2 | 54.4 | 56.3 |
| October 23 | 50.2 | 49.4 | 50.9 | 52.9 | 55.5 | 51.3 | 50.1 | 52.6 | 54.1 |
| October 30 | 50.8 | 49.7 | 50.8 | 52.3 | 54.5 | 51.2 | 50.6 | 51.8 | 53.2 |
| November 7 | 50.1 | 46.6 | 49.6 | 51.4 | 53.7 | 43.7 | 46.1 | 50.9 | 51.2 |
| November 21 | 39.6 | 40.9 | 43.7 | 46.4 | 51.4 | 38.9 | 39.4 | 43.4 | 45.4 |
| November 28 | 25.1 | 39.9 | 42.9 | 45.3 | 50.0 | 35.4 | 39.4 | 42.3 | 44.7 |
| December 4 | 47.8 | 39.8 | 42.4 | 44.6 | 49.3 | 37.0 | 37.9 | 41.8 | 43.9 |
| December 20 | 33.3 | 35.3 | 38.7 | 41.5 | 46.9 | 31.4 | 33.0 | 37.4 | 40.2 |
| December 26 | 35.0 | 35.3 | 38.0 | 40.7 | 46.0 | 34.2 | 33.3 | 34.4 | 39.2 |
| January 2, 1891 | 31.7 | 35.3 | 38.0 | 40.7 | 45.1 | 31.1 | 33.1 | 37.4 | 39.1 |
| Sums | 1877.4 | 1823.8 | 1800.2 | 1786.4 | 1750.9 | 1933.9 | 1888.7 | 1882.3 | 1827.9 |
| Means | 58.67 | 56.99 | 56.26 | 55.825 | 54.716 | 60.43 | 58.96 | 58.76 | 57.12 |

## BAROMETER.

The mercurial barometer No. 2,976, made by Green, is the same one on which our records depend since, and including part of, 1888. Its position has remained unchanged since first hung in 1888, until September 6 of this year, when it was removed to our office in the new building. The cistern is 2.61 feet higher than in the old location, as determined by leveling. This would make a correction on the average of 2.5 thousandths of an inch to be added. This correction has been applied to the daily means to the end of 1890.

The cistern of the barometer, as at present located, is 24.39 feet above the railroad bench mark at the depot, three-quarters of a mile distant, which from the railroad surveys, is 4,972 feet above sea level. Consequently the elevation to which these readings are reduced, former position, is 4,993.8 feet.

The means of the two daily readings are given in an accompanying table:

## MEAN BAROMETER, 1890.

| DATE. | January. | February. | March. | April. | May. | June. |
|---|---|---|---|---|---|---|
| 1 | **24.702** | 24.925 | 25.164 | 24.983 | 25.013 | 24.908 |
| 2 | 25.117 | 24.839 | 25.007 | 24.925 | 24.927 | 24.832 |
| 3 | 24.936 | 24.940 | 25.007 | 24.936 | 24.922 | 24.778 |
| 4 | 24.737 | 24.935 | 24.856 | 25.038 | 24.972 | 24.942 |
| 5 | 24.754 | 25.084 | 24.822 | 24.944 | 25.047 | 25.116 |
| 6 | 24.886 | 24.914 | 24.840 | 24.906 | 25.065 | **25.287** |
| 7 | 25.050 | 25.127 | 24.940 | 24.739 | 24.927 | 25.259 |
| 8 | 25.116 | 24.905 | 24.853 | 25.075 | 24.711 | 25.133 |
| 9 | 24.751 | 24.982 | **24.568** | 25.159 | 24.823 | 24.923 |
| 10 | 24.562 | 25.019 | 24.750 | 24.969 | 25.034 | 24.971 |
| 11 | 24.826 | **25.436** | 24.980 | **24.711** | 24.918 | 25.033 |
| 12 | 24.897 | 24.982 | 25.170 | 24.908 | 25.093 | 24.825 |
| 13 | 24.825 | 24.606 | 25.254 | 25.127 | 25.069 | 24.929 |
| 14 | 24.814 | 24.865 | **25.265** | 25.139 | 24.931 | **24.520** |
| 15 | 25.121 | 24.913 | 25.138 | 25.159 | **25.136** | 24.936 |
| 16 | 24.875 | 24.752 | 24.900 | 25.125 | 25.001 | 25.030 |
| 17 | 24.874 | 24.708 | 24.764 | 24.954 | 24.825 | 24.921 |
| 18 | 24.746 | 24.679 | 24.816 | 24.842 | 24.978 | 24.914 |
| 19 | 24.812 | 24.825 | 24.681 | 24.788 | 24.977 | 24.922 |
| 20 | 24.987 | 25.078 | 24.610 | 24.937 | 24.863 | 24.869 |
| 21 | 24.969 | 24.925 | 24.848 | 24.904 | 24.828 | 24.965 |
| 22 | 24.869 | 24.766 | 25.029 | 25.014 | 25.078 | 24.905 |
| 23 | 25.159 | 24.584 | 24.690 | 25.097 | 24.939 | 24.952 |
| 24 | 24.902 | **24.503** | 24.949 | **25.169** | 24.982 | 24.927 |
| 25 | 24.606 | 24.730 | 25.105 | 25.154 | 24.948 | 24.837 |
| 26 | 24.902 | 24.742 | 24.614 | 25.110 | 25.020 | 24.934 |
| 27 | **25.201** | 24.969 | 24.907 | 25.082 | 24.724 | 24.997 |
| 28 | 25.121 | 25.168 | 25.028 | 25.130 | **24.659** | 25.104 |
| 29 | 25.051 | ..... | 25.034 | 24.992 | 24.839 | 25.134 |
| 30 | 24.816 | ..... | 24.827 | 24.936 | 25.031 | 25.147 |
| 31 | 25.113 | ..... | 25.051 | ..... | 25.030 | ..... |
| Sums | 772.096 | 696.601 | 772.467 | 749.952 | 773.310 | 748.951 |
| Means | 24.906 | **24.889** | 24.918 | 24.998 | 24.942 | 24.965 |

## MEAN BAROMETER, 1890.

| DATE. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|
| 1..... | 25.118 | 25.039 | 25.089 | 24.929 | 25.223 | 24.890 |
| 2..... | 25.149 | 25.075 | 25.011 | 24.795 | 25.305 | 24.780 |
| 3..... | 25.135 | 25.152 | 25.058 | 24.972 | 25.166 | 24.768 |
| 4..... | 25.018 | 25.258 | 25.036 | 25.099 | 24.900 | 24.616 |
| 5..... | 24.961 | 25.178 | 24.801 | 24.913 | 24.731 | 24.938 |
| 6..... | 24.915 | 25.200 | 24.938 | 25.023 | 24.882 | 25.096 |
| 7..... | 24.923 | 25.175 | 25.111 | 24.775 | 24.845 | 25.202 |
| 8..... | 25.064 | 25.298 | 25.101 | 24.806 | 24.730 | 25.269 |
| 9..... | 25.007 | 25.211 | 25.082 | 25.038 | 25.024 | 25.102 |
| 10..... | 24.930 | 25.222 | 25.071 | 24.932 | 25.151 | 24.936 |
| 11..... | 25.088 | 25.213 | 24.938 | 24.863 | 25.104 | 25.239 |
| 12..... | 25.050 | 25.141 | 25.187 | 24.813 | 25.264 | 25.140 |
| 13..... | 25.010 | 25.293 | 25.021 | 25.036 | 24.943 | 25.006 |
| 14..... | 25.121 | 25.264 | 24.996 | 24.829 | 25.149 | 25.010 |
| 15..... | 25.119 | 25.199 | 25.047 | 24.926 | 25.306 | 25.074 |
| 16..... | 25.116 | 25.353 | 24.974 | 24.867 | 25.031 | 25.327 |
| 17..... | 25.162 | 25.296 | 24.896 | 25.015 | 25.021 | 25.198 |
| 18..... | 25.064 | 25.250 | 25.084 | 25.202 | 25.251 | 25.079 |
| 19..... | 25.036 | 25.231 | 25.084 | 24.953 | 25.305 | 24.924 |
| 20..... | 25.138 | 25.151 | 25.078 | 25.036 | 25.161 | 25.081 |
| 21..... | 25.214 | 25.283 | 25.193 | 25.085 | 25.453 | 25.227 |
| 22..... | 25.222 | 25.179 | 25.149 | 24.964 | 25.368 | 25.154 |
| 23..... | 25.147 | 25.092 | 25.167 | 25.066 | 25.166 | 25.118 |
| 24..... | 25.181 | 25.122 | 25.113 | 25.123 | 25.128 | 24.996 |
| 25..... | 25.140 | 25.123 | 25.068 | 25.333 | 25.298 | 24.972 |
| 26..... | 25.059 | 25.156 | 25.163 | 25.218 | 25.278 | 25.076 |
| 27..... | 24.929 | 25.155 | 25.285 | 25.220 | 25.166 | 25 267 |
| 28..... | 24.970 | 25.198 | 25.264 | 25.116 | 25.229 | 25.044 |
| 29..... | 24.952 | 25.213 | 25.202 | 25.106 | 25.234 | 24.942 |
| 30..... | 25.091 | 25.109 | 25.018 | 25.218 | 25.084 | 24.818 |
| 31..... | 24.985 | 25.106 | ..... ..... | 25.186 | ..... | 24.778 |
| Sums ..... | 777.014 | 780.845 | 752.225 | 775.457 | 753.896 | 776.067 |
| Means..... | 25.065 | 25.1885 | 25.074 | 25.014 | 25.130 | 25.034 |

## Annual Summary of Meteorological Observations, Agricultural College, Fort Collins, for the Year Ending December 31, 1890.

| MONTH | Mean Pressure, Corrected for Temperature Only. | TEMPERATURE. (Degrees.) | | | Tot'l Precipitation (rain and melted snow), Inches. | Total Snowfall, Inches. | WIND. | | Relative Humidity Mean. | Dew Point, Mean. | No. Stormy Days, .01 Precipitation or More. | No. Days on which F'st or Dew was Observed. | | No. of Days whose Temperature was Below 32°. | No. of Days whose Minimum Temp. was Below 32. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean. | Max. | Min. | | | Prevailing Direction. | Maximum velocity or Force, Miles. | | | | Fr'st. | Dew. | | |
| January | 24.906 | 20.76 | 65.6 | —13 | 0.13 | 2.1 | W. | 70 | 75.4 | 11.21 | 2 | 20 | 0 | 26 | 29 |
| February | 24.889 | 24.94 | 68.3 | —20 | 0.24 | 2.3 | W. | 52 | 68.02 | 13.01 | 1 | 9 | 0 | 20 | 24 |
| March | 24.918 | 36.02 | 70.1 | — 9.0 | 0.22 | 2.7 | W. | 39 | 52.92 | 17.73 | 3 | 6 | 0 | 8 | 24 |
| April | 24.968 | 45.17 | 78.0 | 13.8 | 3.92 | 4.5 | W. | 38 | 63.53 | 30.27 | 0 | 10 | 2 | 1 | 13 |
| May | 24.942 | 55.36 | 85.0 | 29.1 | 1.19 | 0.8 | W. | 25 | 59.13 | 38.98 | 8 | 3 | 13 | 0 | 3 |
| June | 24.965 | 64.03 | 92.2 | 32.7 | 0.12½ | ..... | SW. | 36 | 51.36 | 44.15 | 3 | 3 | 3 | 0 | 0 |
| July | 25.074 | 71.14 | 93.4 | 46.9 | 1.27 | ..... | S. SW | 24 | 61.83 | 55.38 | 10 | 0 | 8 | 0 | 0 |
| August | 25.188 | 66.08 | 95.3 | 39.5 | 3.17 | ..... | SW. | 36 | 68.15 | 52.15 | 13 | 1 | 12 | 0 | 0 |
| September | 25.074 | 58.32 | 85.3 | 30.1 | .07 | ..... | SE. | 24 | 52.97 | 37.46 | 2 | 21 | 5 | 0 | 4 |
| October | 25.014 | 47.40 | 77.0 | 15.7 | .695 | ..... | SW. | 24 | 60.26 | 26.22 | 2 | 16 | 1 | 0 | 16 |
| November | 25.130 | 38.10 | 75.7 | 21.33 | .32 | 3.2 | W. | 24 | 69.98 | 20.155 | 2 | 9 | 0 | 7 | 26 |
| December | 25.034 | 37.77 | 62.9 | 15.8 | .12 | 2.2 | SW. | 36 | 65.45 | 15.63 | 1 | 10 | 0 | 14 | 29 |
| Sums | 300.122 | 588.99 | ..... | ..... | 11.43½ | 17.8 | ..... | ..... | 749.80 | 362.34 | 56 | 117 | 44 | 76 | 168 |
| Average | 25.010 | 49.08 | ..... | ..... | ..... | ..... | ..... | ..... | 62.48 | 40.10 | 4.6 | ..... | ..... | ..... | ..... |

**Annual Summary of Metcorological Observations, Made by H. H. Griffin, San Luis Experiment Station, Del Norte, for the Year Ending December 31, 1890.**

| MONTH. | Mean Pressure, Corrected for Temperature Only. | TEMPERATURE. (Degrees) | | | Tot'l Precipitation (rain and melted snow), Inches. | Total Snowfall, Inches. | WIND. | | Relative Humidity Mean. | Dew Point, Mean. | No. Stormy Days. .01 or More Precipitation. | No. Days on which F'st or Dew was Observed. | | No. Days whose av. Temperature was Below 32 Deg. | No. of Days whose Minimum Temp. was Below 32. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean. | Max. | Min. | | | Prevailing Direction. | Maximum velocity or Force, Miles. | | | | Frost | Dew. | | |
| January | 22.551 | 21.03 | 52 | —16 | .10 | ½ | W. | ..... | 77.95 | 8.93 | 1 | ..... | ..... | 25 | 31 |
| February | 22.507 | 31.26 | 65 | — 7 | .65 | 7 | W. | ..... | 75.94 | 18.85 | 3 | ..... | ..... | 15 | 28 |
| March | 22.542 | 36.5 | 64 | 5 | .02 | ¼ | W. | ..... | 75.35 | 24.73 | 1 | ..... | ..... | 9 | 30 |
| April | 22.599 | 42.8 | 68 | 12 | 3.49 | 15½ | W. | ..... | 82.80 | 38.78 | 4 | ..... | ..... | 1 | 24 |
| May | 22.593 | 52.7 | 81 | 29 | .02 | ..... | W. | ..... | 68.18 | 43.52 | 1 | ..... | ..... | 0 | 7 |
| June | 22.685 | 58.216 | 86 | 29 | .21 | ..... | W. | ..... | 54.16 | 46.51 | 3 | ..... | ..... | 0 | 3 |
| July | 22.792 | 74.61 | 88 | 42 | 1.27 | ..... | SW. | ..... | 76.72 | 55.31 | 12 | ..... | ..... | 0 | 0 |
| August | 22.687 | 62.87 | 89 | 38 | .91 | ..... | W. | ..... | 77.51 | 53.34 | 10 | 0 | 5 | 0 | 0 |
| September | 22.692 | 55.069 | 80 | 30 | 1.33 | ..... | W. | ..... | 77.93 | 44.39 | 7 | 6 | 0 | 0 | 6 |
| October | 22.662 | 43.62 | 70 | 14 | .22 | ..... | W. | ..... | 58.72 | 23.60 | 2 | ..... | ..... | 1 | 29 |
| November | 22.732 | 33.35 | 63 | 2 | .55 | 1½ | W. | ..... | 68.20 | 17.46 | 3 | ..... | ..... | 9 | 28 |
| December | 22.685 | 25.58 | 50 | — 4 | 0 | 0 | W. | ..... | *77.25 | *10.01 | 0 | 3 | 0 | 26 | 31 |
| Sums | 271.728 | 537.64 | 856 | 174 | 8.77 | 24½ | ..... | ..... | 880.71 | 385.43 | 47 | 9 | 5 | 86 | 217 |
| Averages | 22.644 | 44.80 | 71.33 | 14.5 | 0.73 | ..... | ..... | ..... | 73.3758 | 32.12 | 3.75 | ..... | ..... | 7.166 | 18.085 |

* For 16 days.

**Annual Summary of Meteorological Observations, Made by Frank Watrous, at the Arkansas Valley Experiment Station, Rocky Ford, Colo., for Year Ending Dec. 31, 1800.**

| MONTH. | TEMPERATURE. (Degrees.) | | | Tot'l Precipitation (rain and melted snow), Inches. | Total Snowfall, Inches. | WIND. | | Relative Humidity Mean. | Dew Point, Mean. | No. Stormy Days, .01 Precipitation or More. | No. Day whose av. Temperature was Below 32 Deg. | No. of Days whose Minimum Temp. was Below 32. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Max | Min. | | | Prevailing Direction. | Maximum velocity or Force, Miles. | | | | | |
| January | 21.4 | 74 | (—10) | .34 | 6 | NW. | ..... | 78.40 | 14.98 | 2 | (22) | (29) |
| February | (30.0) | 79 | (— 8) | .15 | 2 | W. | ..... | 75.32 | 22.02 | 2 | (11) | (18) |
| March | (38.7) | 80 | ( 3) | .15 | ..... | W. | ..... | 64.89 | 20.89 | 1 | (10) | (13) |
| April | (48.9) | 86 | (19) | 2.97 | 5 | W. | ..... | 60.35 | 37.48 | 5 | [ 2] | [ 3] |
| May | (50.7) | 91 | (42) | .29 | ..... | ..... | ..... | 69.87 | 48.51 | 2 | 0 | 0 |
| June | (71.18) | 102 | (39) | .77 | ..... | ..... | ..... | 69.26 | 59.04 | 5 | 0 | 0 |
| July | (77.79) | 104 | (55) | 1.14 | ..... | W. | ..... | 75.74 | 66.49 | 5 | 0 | 0 |
| August | (73.08) | 103 | (47) | .74 | ..... | W. | ..... | 77.03 | 62.76 | 3 | 0 | 0 |
| September | (63.83) | 96 | (31) | .08 | ..... | W. | ..... | 70.74 | 50.87 | 1 | 0 | [ 1] |
| October | (50.58) | 83 | (22) | .0 | ..... | WNW | ..... | 68.46 | 38.23 | 0 | 0 | [22] |
| November | 40.75 | 80 | (13) | .30 | 1.5 | W. | ..... | ..... | ..... | 1 | 0 | [30] |
| December | 35.6 | 70 | ( 6) | .0 | .0 | W. | ..... | ..... | ..... | 0 | [10] | [31] |
| Sums | 608.51 | ..... | ..... | 6.93 | 14.5 | ..... | ..... | 719.06 | 427.27 | 27 | 55 | 147 |
| Averages | 50.7 | ..... | ..... | ..... | ..... | ..... | ..... | 71.9 | 42.73 | 2.25 | ..... | ..... |

Numbers in brackets or parenthesis are derived from 7 a. m. and 7 p. m. readings.

Respectfully submitted,

L. G. CARPENTER,

*Meteorologist and Irrigation Engineer.*

# Report of Grass Station.

*Dr. Geo. Vasey, Chief of Botanical Division, Department of Agriculture:*

SIR—I have the honor to transmit herewith a report of work done during the season of 1890 at the Grass Station, established here by your Department, for the purpose of co-operative experiment in growing grasses and forage plants without irrigation.

The land selected for the experiment of growing grasses without irrigation is situated on the open prairie, four and one-half miles north of Fort Collins and four miles from the foothills, on the farm of Mr. S. H. Birdsall. The surface is even, with a slight slope to the south and west. The surrounding land rises gradually for a short distance on the north and east, and on the south and west it slopes gradually away to the bottoms of the Cache la Poudre River.

The plat chosen, embracing five acres, was plowed and fenced late in the fall of 1889. The plowing was of just of sufficient depth to turn the native sod, about four inches.

The work of the season of 1890 began March 26. The plat was measured and divided into two equal parts by an east and west line. The north half was taken for the spring seeding, reserving the south half to be seeded in the fall.

This north half was again divided east and west into five equal parts, to be plowed according to the following schedule, which had been previously submitted to your Department for endorsement:

One plat to be plowed 5 inches deep.
One plat to be plowed 7 inches deep.
One plat to be plowed 10 inches deep.
One plat to be plowed 7 inches deep and sub-soiled 5 inches.
One plat to be plowed 5 inches and sub-soiled 7 inches.

These plats were each 52 feet wide. The plowing was carefully and correctly done in accordance with the schedule, and the work finished March 28.

Plat 5 was enlarged by extension south to 62 feet in width. Seven feet of this addition was for division into small plats to accommodate those grasses of which we had but a small quantity of seed. The remaining 3 feet was designed for a passageway between the small plats and the larger ones.

A portion of the ground was harrowed with an "Acme" harrow, March 28. March 29 the harrowing was completed and most of the seed sown. The soil worked down smoothly and the seed bed was all that could be desired.

The division into plats for sowing was made north and south, so that each should share the different depths of plowing. These plats were thirty-five in number, each 260 feet long, and from 3 to 30 feet in width, according to the quantity ot seed available. Passages two feet in width between the plats were provided for. In sowing, lines were stretched along each side of the plat and care taken to confine the seeding within them. The

seed was applied broadcast by hand. On plats Nos. 1 to 21 inclusive, it was raked in by hand, on the balance of the plats it was worked in by the harrow. The seeding of plats Nos. 1 to 28 was finished March 29. Plats 29 to 35 were seeded April 2. On the night of March 29 an inch of snow fell; this melted on the 30th, serving a good purpose in settling the soil about the seed. During the fore part of April there was little cloudiness, and the sun, aided by warm west winds which prevailed for several days, exerted a wonderful influence in drying out the soil. On the 6th an examination showed that to the depth of three inches it was dry to dustiness. April 12, a storm began, which lasted until the 15th, the total precipitation during this time being 1.32 inches. April 17, an examination of the soil was made; there were no surface indications that rain had fallen; to the depth of one inch it was dry, below that there was a perceptible degree of moisture and the soil was cold to the touch. Seeds from several plats were examined; they appeared as hard and firm as when sown.

April 20, rain began again and continued at intervals until the 28th, giving a total precipitation of 3.16 inches. In the afternoon of the 28th I again visited the station. The soil had so thoroughly absorbed the rain as it fell that the surface, though moist, was not at all muddy.

The seed on each plat was examined. Ten of the grasses and six of the forage plants were found to be germinating. I append, in tabular form, the list of grasses and forage plants occupying the large plats, giving space occupied, the source from which the seed was obtained, with observations on each species.

From the tabulation of the large plats, it appears that of the 35 species sown, 14 species of grasses and one

forage plant (*Trifolium hybridum*) failed in the germination of the seed. In some cases, at least, I think this failure was owing to the immature condition of the seed when collected. With the twelve species of grasses that did germinate the seed, there was an evident struggle for existence from the start; none made a strong growth, and it became simply a question of power of endurance.

Plat 1—*Avena flavescens*, L., was very weak from the beginning and at no time gave any promise of reaching maturity. No advancement in growth was made after May 14, and by June 24 every plant was dead.

Plat 3—*Cynosurus cristatus*, L., showed no plants until May 3. On the 14th, though very small, they were thick enough to give a green appearance to the plat. They made no further growth and slowly died out, enduring a little later than did the plants of *A. flavescens*.

Plat 5—*Lolium perenne*, L., germinated early, came up thickly and on May 3 the plat appeared green and promising. Growth continued until the leaves were three and four inches long and then stopped. No apparent growth took place after the 1st of June, but the plants retained their green color until about the middle of July, when the leaves began to turn brown. When examined in October, many plants were found to be alive at the crown, though the leaves had all dried up.

An examination, November 21, found the plants still alive, some of them showing green leaves at the center of the crown.

Plat 6—*Holcus lanatus*, L., germinated late, came up unevenly and made very little growth. The plants were at no time more than one inch high. A large portion of the plants succumbed early, but some retained life, and on the last examination, November 21, were still alive.

Plat 8—*Koeleria cristata*, Pers., was very weak from the start, made scarcely any growth, and all the plants were dead by June 24.

Plat 10—*Bromus inermis*, Leyss., started early, came up thickly and evenly, and on June 7 the plat appeared to give promise. The plants were then three inches high and stood thickly. After this date the plants began to droop and die.

Plat 12—*Phalaris arundinacea*, L., was very slow in starting, came up unevenly and soon succumbed to circumstances adverse to its nature.

Plat 16—*Agropyrum tenerum*, Vasey. This was observed to be germinating May 3. The plants came thickly, and made a fair growth until June 7. From this time the plants on the south half of the plat dried up and died rapidly. On the north half they seemed to fare better, remaining green for some time, and a few plants threw up culms which bore short spikes. These blossomed and bore fruit. The last time the plat was examined, November 21, a number of plants were found to be alive. This was the only grass at the station that blossomed or formed culms.

Plat 22—*Festuca ovina*, L., produced but few plants. These made but very little growth and soon died.

Plat 23.—*Festuca ruba*, var. *dumetorum*. But few plants came, and these were all dead by June 24.

Plat 25—*Festuca heterophylla* came up late. The plants were uneven in size and distribution, and lasted but a short time.

Plat 24—*Festuca elatior*, L., started earlier than the others of this genus. The plants came thicker, but they attained no greater advancement than the others. They, however, showed greater endurance; the leave did not turn brown as quickly. Most of the plants finally died,

but some still retained life when last examined, November 21.

The forage plants sown upon the large plats all came up, except the Alsike clover (*Trifolium hybridum.*)

Plat 27—The Kidney Vitch (*Anthyllis*) came thick and even, but the season's growth above ground was very small. Each plant consisted of a small tuft of leaves, 1 to 2 inches high. Some plants died out during July, but there were many green plants as late as October. The slender roots of these plants have penetrated deep into the ground, and should they survive the winter, we may expect a more promising growth next season.

Plat 28—Burnet (*Poterium sp.*). The plants came up slowly and irregularly, and the growth above ground was very small. At no time could plants be found more than 3 inches high. They remained green throughout the season, and most of them made good roots. This plant, like the *Anthyllis*, is perennial, and I would not condemn it until its growth the second season had been observed.

Plat 29—*Vicia villosa.* This species started early, came rather unevenly, and made a very slow and slender growth. June 24 a few plants were in blossom, and they continued to bloom during July. The plants early became prostrate, and retained life through August. There seemed to be nothing of promise in this species.

Plat 30—*Ornithopus sativus.* The plants were late in coming up, but came thickly. They grew very slowly, and soon began to die out. A few plants endured till late in July, reaching a height of 5 to 8 inches.

Plat 31—*Spergula maxima.* This gave no promise of value as a plant for dry lands. The plants came thickly enough, but the growth was feeble, and they soon began

to die out. A few plants were in blossom June 25; they were only 3 to 4 inches high. The tallest plant measured during the season was only 7 inches.

Plat 32—*Lotus major* produced but few plants, and these made but very little growth; most of them died in June. A few endured until late in July.

Plat 34—*Calega officinalis.* The plants of this species came very slowly. By the 7th of June they stood thickly, but were very small. Blossoms were first observed July 24, some of the plants then being 8 inches high. At both ends of the plat the plants died, but in the middle there were still a number of plants alive in October.

Plat 35—*Onobrychis sativa* (Sanfoin). The plants came thickly, but the growth was small, and they died rapidly. A few plants were found to be alive August 23. This plat was depredated to some extent by prairie dogs.

SMALL PLATS.

The grasses and forage plants represented by small quantities of seed were sown by hand in drills 6 inches apart on the ground prepared for the purpose, a space of 12 inches being left between each kind. The number of rows of each kind varied from one to twenty, according to the amount of seed possessed. One plat 6x7 feet was planted with the native prairie sod; one species was sown on two plats, and besides these there were eighty-seven numbers. Of these, sixty-four were named grasses. The remaining twenty-three were undetermined, or doubtfully named grasses and leguminous plants, with two species of *Carex*, and one *Juncus*. Of these twenty-three plats, plants came up on only five; two plats of lupins, and three of grasses. These made a very small growth and

died. None of the plants reached sufficient development to enable a determination of the species, so I pass these twenty-three plats without further remarks.

Of the sixty-four named grasses, seventeen germinated the seed and came up. These are arranged in tabular form, and appended.

The scale on which these grasses were tried was a very small one, and their failure to show value need not necessarily condemn them all as worthless for sowing upon unirrigated lands. There were some differences in the time of starting, but the differences in duration were trifling. None of them made any growth later than June 7, and some ceased growth before that time. The grass making the earliest start and the strongest growth was the worthless *Bromus secalinus*; what its advancement and duration would have been I can not say; early in June it was eaten off, probably by prairie dogs, and was kept eaten down until it died. This was the only grass thus attacked. There is no question as to the value of the Gramma grass (*Bouteloua oligostachya*) as a range or pasture grass where it is established. It has great endurance, and recuperative power second only to that of the true Buffalo grass (*Buchloe dactyloides*). On the open prairie and on close pastured ranges its growth is short and close, the flowering culms only from 4 to 6 inches high, but I have seen it forming a thick turf and producing culms 10 to 15 inches high on unirrigated meadows, where it afforded excellent pasturage in September. It is a pasture grass. Can it be sown and induced to form a turf on unirrigated lands? Its failure this season on one small plat does not prove that it cannot be. It is worthy of further trial. Though the seven forms of the genus *Agropyrum* failed this season, I would advocate their further trial. In a season less unfavorable, I believe that some, at least, would succeed. The species *Tenerum*

*glaucum* and *violaceum* grow wild in very dry situations. I have collected them on the open prairie, and on the summits of the foothills. The other forms are most frequent at higher elevations. The greatest development of *A. unilaterale*, *A. divergens* and the green form of *A. violaceum* was seen on the mountain sides in the neighborhood of Cameron Pass, at an altitude of 11,000 feet. Here in the open glades among the timber, in soil kept always moist by the melting snows above, they make a thick, rank growth.

WEEDS.

Although the growth of grasses was so small, the plats were by no means bare of vegetation. Weeds sprang up in surprising numbers, grew and thrived throughout the season. Forty-one specimens were collected, a list of which I append. They were not equally abundant, and in the order of their abundance and persistence, I would name as the worst ones:

*Munroa squarrosa*, Torr.
*Echinospermum Redowskii*, Lehm.
*Krynitzkia crassisepala*, Gray.
*Verbena bracteosa*, Michx.
*Amarantus albus*, L.
*Amarantus blitoides*, Watson.
*Chenopodium leptophyllum*, var. *oblongifolium*, Watson.
*Chenipodium Fremontii*, var. *incanum*, Watson.
*Euphorbia glyptosperma*, Engelm.
*Bahia oppositifolia*, Nutt.
*Abronia micrantha*, Torr.

Of the forty-one species, twenty were found growing in the immediate neighborhood of the Station; the others were found nowhere in the vicinity. We conclude that their growth was induced by cultivation from seed which in previous years had found lodgment in the soil. The small plats and the passages between the large plats were cleaned of

weeds once and the larger weeds pulled from the large plats. This was done between June 28 and July 5, at a cost of $16.25. All the weeds pulled were collected and removed from the station grounds.

List of weeds collected at the Grass Station, 1890 :

*Cleome integrifolia*, Torr and Gray.
*Saponaria Vaccaria*, L.
*Psoralia campestris*, Nutt.
*Psoralia tenuiflora*, Pursh.
*Petalostemon candidus*, Michx.
*Astragalus microlobus* Gray.
*Oxytropus monticola*, Gray.
*Œnothera pinnatifida*, Nutt.
*Gaura coccinea*, Nutt.
*Mentzelia multiflora* Gray.
*Mentzelia pumila*, Torr and Gray.
*Aster tenacetifolius*, var. *Pygmaeus*.
*Helianthus annuus*, L.
*Helianthus petiolaris*, Nutt.
*Bahia oppositifolia*, Nutt.
*Dysodia chrysanthemoides*, Lag.
*Stephanomeria minor*, Nutt.
*Echinospermum Radowskii*, Lehm.
*Krynitzkia crassisipala*, Gray.
*Lippia cuneifolia*, Steud.
*Verbena bracteosa*, Michx.
*Salvia lanceolata*, Wind.
*Oxybaphus angustifolius*, Sweet.
*Abronia micrantha*, Torr.
*Amarantus retroflexus*, L.
*Amarantus blitoides*, Watson.
*Amarantus albus*, L.
*Chenopodium Fremontii*, var. *incanum*, Watson.
*Chenopodium capitatum*, Watson.
*Chenopodium leptophyllum*, var. *oblongifolum*, Watson.

*Chenopodium glaucum*, L.
*Chenopodium album*, L.
*Eurotia lanata*, Moq.
*Eriogonum tenellum*, Torr.
*Polygonum dumetorum*, L., var. *scandens*, Gray.
*Polygonum aviculare*, L.
*Comandra pallida*, A. DC.
*Euphorbia marginata*, Pursh.
*Euphorbia glyptosperma*, Engelm.
*Euphorbia maculata*, L.
*Munroa squarrosa*, Torr.

From the foregoing, it will be seen that of the ninety-nine named species sown at the Station, twenty-nine species of grasses and eight forage plants germinated the seed. These during the weeks following germination exhibited all degrees of endurance. Some made scarcely any growth, and died after a short struggle; others lived through till late in the summer. Four of the grasses and three of the forage plants have carried a portion of the plants produced through the whole season, and are still alive at this writing, November 22. The grasses are, *Lolium perenne, Holcus lanatus, Agropyrum tenerum, Festuca elatior.*

The fact that these grasses, sown alone on fresh-broken prairie, have had sufficient power of endurance to retain life in even a portion of the plants produced through a hot and unusually dry summer, is certainly enough to warrant their further trial. Of course, it remains to be seen whether the plants now alive will live through the winter. If they do, the strong roots they have will enable them to start early, and grow to maturity. The forage plants now alive and giving promise of growth next season, are the Kidney Vitch (*Anthyllis sp.*), Burnet (*Poterium sp.*), *Galega officinale.*

If the plants now alive all live through the winter, they will be thick enough to cover the plats. The *Galega*, as already mentioned, is alive only on the central half of the plat, but here the plants are thick.

The rainfall from January 1 to October 31, is as below. The observations for five months were taken at the Station, the others at Fort Collins, except for May, which is taken from the Middle Box Elder record. As the places of observation are but a short distance from the Station, the record may be taken as very nearly accurate for the Station :

| | | | |
|---|---|---|---|
| January | .13 | inches | Fort Collins. |
| February | .21 | " | " " |
| March | .22 | " | " " |
| April | 4.48 | " | At the Station. |
| May | 1.33 | " | Middle Box Elder. |
| June | 0.00 | " | At the Station. |
| July | 1.28 | " | " " |
| August | 2.13 | " | " " |
| September | .02 | " | " " |
| October | .69 | " | " " |
| Total | 10.49 | inches. | |

I have already remarked about the rains of April, which germinated the seed.

From May 1 to July 31, the rainfall was only 2.61 inches, and June contributed nothing to this. These rains of May and July came mostly as afternoon showers of short duration, and usually followed by hot sun for the rest of the day. Their effect was only in a small degree beneficial. During the greater part of May, and very nearly all of June, the days were cloudless, and the hot sun and warm winds exerted their drying influence to the fullest extent.

On only two plats was there any observed difference in different parts. The plants of *Anthyllis* which

lived are in the center, north and south, resting on the 10-inch plowing, and partly on the land plowed 7 inches and sub-soiled 5 inches. The other plat, *Agropyrum tenerum*, has all the living plants on the north end where the plowing was 5 inches deep.

I am not prepared to say that the differences in plowing had any effect whatever upon the growth or duration of the plants. Further observations will be made.

For the meteorological data above given I am indebted to Prof. L. G. Carpenter, of the Department of Engineering.

### THE GARDEN PLATS.

In sowing at the Grass Station, a small portion of the seed of each species was reserved and sown in the College garden, to be grown under irrigation. The land chosen was a nearly level piece in the west garden, under the No. 2 ditch. The soil is a clayey loam, with an admixture of gravel. It had been used for garden purposes for several years, and the abundance of weeds which sprang up gave us great trouble, and directly caused the loss of two plats, the *Anthyllis* and *Agropyrum divergens*. In laying off the plats, seven were made 2x10 feet, the balance 4x10 feet, with passages 2 feet wide between them. Most of the plats were seeded April 5, and a few on April 11.

The species which failed in the germination of the seed at the Station, in most cases failed in the garden, and this failure in both places seems to point strongly to an immature condition of the seed when gathered, as the cause. The exceptions were three species of *Poa*, viz.: *P. nemoralis*, L., *P. laevis*, M., and *P. temuifolia*, Nutt.

I attach a list of the species grown, with brief notes on each :

## TABULATION OF GARDEN PLATS, 1890.

| No. Plat. | NAME. | Where Seed was Obtained. | Date of Germination. | REMARKS. |
|---|---|---|---|---|
| 1 | Eleusine coracana, Gartn | Prof. S. M. Tracy | Apr. 29 | Came irregularly but made good growth; June 27, the light green leaves 5 to 8 in. high; July 17, 9 in. high; Aug. 16, the flat culms 12 in. high; in blossom Aug. 23; took specimens for herbarium and analysis Aug 26; gathered seed Sept. 22. |
| 3 | Panicum frumentaceum, Roxb | " " | Apr. 26 | Did not come even and grew slowly at first; May 21, leaves 1 to 1¼ in. long; June 27, leaves 5 to 8 in. long; July 17, leaves 10 to 14 in. long; Aug. 26, leaves now 18 to 26 in. long, stiffly erect; Sept 6, injured by frost; Sept. 12, forming culms; Sept 22, four plants in bloom. |
| 22 | Poa Tenuifolia, glaucous var. | Colorado, 1889 | May 14 | Leaves 1 in. long, May 21; grew to 5 in by July 17; plants grew in tufts; leaves slender, mostly decumbent; green up to Nov. 18; have produced no culms. |
| 24 | Poa nemoralis | U. S. Dept. Agr. | Apr. 29 | Came irregularly and grew slowly; leaves became 5 to 6 in. long; only one plant in blossom, July 17; the plants are all very small and deliciate in appearance. |
| 25 | Poa tenuifolia | Colorado, 1889 | Apr. 29 | Similar in growth and appearance to plat 22. |
| 26 | Poa lævis | " " | Apr. 26 | Plants came evenly and made a good growth; leaves were 4 to 7 in. long, July 17; culms are forming; one plant in blossom July 19, culms 10 in. high. |
| 27 | Poa andina | " " | May 17 | Came irregularly and the few plants grew slowly through the season, producing no culms. |
| 30 | Festuca elatior | U. S. Dept. Agr. | Apr. 29 | An even stand of strong plants; May 24, 2 in. high; June 27, 4 to 6 in. high. Seed was evidently mixed, Alopecurus pratensis appearing in abundance; the Festuca formed no culms. |
| 31 | Festuca ovina | " " | Apr. 29 | Not so strong a grower as the preceding; the plants appeared in tufts; the slender dark green leaves reached a length of 4 in. No culms were formed. |
| 32 | Festuca heterophylla | " " | May 3 | Made a short, weakly irregular growth; a few plants formed culms and were in blossom July 17, 10 in. high. |
| 33 | Festuca rubra, var. dumetorum | " " | Apr. 29 | Plants came evenly and made good growth; July 17, leaves were 5 in. long. No plants blossomed. |
| 40 | Elymus Canadensis | Colorado, 1889 | May 3 | Plants did not come evenly, but by May 24 the plat presented an even appearance, with the plants 2 in high; June 27, 4 to 6 in. high; July 17, 8 in. high, no culms; Aug. 5, culms 24 in. high, blossoms opening. |
| 43 | Poa pratensis | Seed sown in Spring of 1889 | ..... | Started growth early; April 29, the leaves were 9 in. long; May 30, the culms were 2 ft. high and June 12 it was in blossom. |
| 45 | Agropyrum violaceum, foliage green | Colorado, 1889 | May 5 | Plants even; May 24, 2 in. high; July 17, leaves 8 in. long, culms 2 ft.; in blossom July 27. |
| 46 | Agropyrum violaceum, glaucous | " " | May 9 | Came later and not so evenly as the preceding, but the growth through the season and time of blossoming were the same. |

## TABULATION OF GARDEN PLATS, 1890—Continued.

| No. Plat. | NAME. | Where Seed was Obtained. | Date of Germination. | REMARKS. |
|---|---|---|---|---|
| 48 | Agropyrum glaucum, foliage green | Colorado, 1889 | May 9 | Plants came evenly; they are more slender than those of A. violaceum; the growth was good; in blossom July 27. |
| 49 | Agropyrum tenerum | " " | May 9 | An even stand of strong plants; June 25, leaves 4 to 6 in. long, culms forming; July 11, in blossom, culms 2 ft. high. |
| 50 | Agropyrum tenerum, foliage green | " " | May 9 | Plants came irregularly but grew thriftily; June 25, the leaves were 6 inches long, culms 2 ft. high; first blossoms July 27. |
| 51 | Agropyrum unilaterale | " " | Apr. 29 | Plants even, thick, strong; culms began forming early in July but no blossoms opened until the 27th; culms 24 to 30 in. high; stouter than in other species. |
| 54 | Deyeuxia Canadensis | " " | Apr. 29 | Plants came thickly and even but made a slow growth; July 25, the leaves were only from 4 to 6 in. long; no culms were formed. |
| 61 | Muhlenbergia gracilis, var. breviaristata | " " | Apr. 29 | Came irregularly and grew very slowly; June 27, the leaves were only 1 in. high; July 25, the plants showed simply small clusters of rigid leaves 3 in. high; culms observed Aug 2, blossomed Aug. 16. |
| 64 | Bromus inermis | U. S. Dep. Agr. | May 7 | May 21, plants even, 1 in high; June 27 the plants showed a thick growth of leaves, mostly 6 in. long. |
| 65 | Bromus ciliatus | " " | Apr. 29 | Came thick and made a strong growth; June 27, leaves 5 to 8 in. high; July 25, leaves 8 to 12 in. high; first bloom Aug. 2nd. |
| 66 | Bromus secalinus | " " | Apr. 29 | Plants thick, even; made a stronger growth than any other grass; May 31, 5 in. high; July 25, the leaves very thick, 10 to 14 in. long; first bloom Aug. 2. |
| 68 | Bouteloua oligostachya | " " | Apr. 29 | Came unevenly and grew slowly, the plants remaining quite small throughout the season; leaves were from 3 to 5 in. long, culms 8 to 11 in. high, opening blossoms Aug 13. |
| 82 | Agrostis exarata | " " | Apr. 29 | Came irregularly and grew slowly; Nov. 18, green in small scattered tufts, 2 in. high, no culms were produced. |
| 83 | Phalaris arundinacea | U. S. Dep. Agr. | May 21 | Came evenly; June 27, the leaves were 5 to 8 in. high; the leaves reached a length of 10 to 12 in. and were very thick; no culms were formed. |
| 84 | Eragrostis Abyssinica | " " | Apr. 29 | Plants came thick and even; June 27, leaves 4 to 6 in. long; July 25, 8 to 12 in. long; culms were not formed until late in Aug.; blossoms appeared Sept 12. |
| 85 | Phleum alpinum | Colorado, 1889 | May 21 | Came evenly but remained very small throughout the season; did not reach the flowering stage. |
| 86 | Kœleria cristata | " " | June 7 | Came unevenly and remained uneven through the season; leaves grew to a length of 5 in.; no culms produced. |
| 87 | Hordeum nodosum | " " | Apr. 29 | Plants came evenly; leaves reached a length of 6 to 8 in., the culms 12 to 16 in.; first blossoms July 14. |

| | | | | |
|---|---|---|---|---|
| 88 | Cynosurus cristatus | U. S. Dep Agr. | Apr. 29 | Came irregularly and grew slowly; leaves grew to 6 and 8 in. in length; they are bright, shining green; no culms were formed. |
| 89 | Lolium perenne | " " | Apr. 29 | Came thick and even, made a strong growth, the leaves becoming 7 to 10 in. long; no culms produced. |
| 90 | Holcus lanatus | " " | Apr. 26 | Came thick and even and grew steadily; July 25, the leaves were 6 to 8 in. high; no culms. |
| 91 | Avena flavescens | " " | Apr. 29 | Plants came unevenly and the plat had an irregular appearance through the season; leaves grew to be 6 in. long; culms formed late in July; blossomed Aug. 16. |
| 93 | Grass No. 89 | Colorado, 1889 | Apr 29 | Came evenly and made a strong growth; leaves were 8 to 12 in. long, culms 20 to 28 in. high; blossomed July 25; this proves to be Agropyrum glaucum. |
| 97 | Grass No. 18 | " " | Apr. 29 | Came unevenly and made only a small tuft of leaves; no culms were formed; it is probably a species of Poa. |
| 100 | Poa, sp. ? | " " | Apr. 29 | Came evenly and made a low, thick mat over the whole plat, which was still green in November; no culms produced. |
| 101 | Bromus, sp. ? | " " | Apr. 26 | Came evenly and made a strong growth of leaves but did not blossom. |
| 102 | Poa, sp. ? | " " | Apr. 29 | Came irregularly; plants produced small tufts of leaves, which are still green, Nov. 18. |
| 103 | Burnet (Poterium sp. ?) | U. S. Dep. Agr. | Apr. 26 | Came evenly and made a steady growth; June 27, leaves 3 in. long; July 17, leaves 6 to 8 in. long; July 25, leaves mostly 12 in. high; leaves still green, Nov. 18. |
| 105 | Spergula maxima | " " | Apr. 26 | Came thickly; May 21, 4 to 6 in. high, plants very slender, little branched, leaves small; June 12, in blossom, plants 8 to 12 in. high; seed ripened by July 15 and the plants were dead by Aug. 1. |
| 106 | Galega officinale | " " | Apr. 29 | Came thick and even, made a very strong growth; May 21, they were 3 in. high; June 27, 20 to 24 in.; first blossoms July 8; July 25, bloom very abundant, flowers pale violet, plants 3 ft. high. |
| 107 | Vicia villosa | " " | Apr. 26 | Came thick and even, soon covering the ground, first bloom June 27; the stems are slender and the plants mat together; one plant measured 5 ft. 6 in. Aug. 23. |
| 112 | Ornithopus sativus | " " | Apr. 29 | Made an even growth; May 21, 3 in. high; June 23, in blossom; June 27, 7 in. high; July 25, 10 to 14 in. high; the plants seem too slender, with too little foliage to be of value. |
| 117 | Onobrychis sativa | " " | Apr. 29 | The plants came irregularly and made a slow growth; July 25, the leaves were 7 in. high. |

NOTE.—Plats 1 to 102, inclusive, were sown April 5, the balance on April 11.

*Eleusine coracana*, Gartn., is an annual, with coarse, rigid leaves. I see no value in it for our State, and the same remark will apply to the next, *Panicum frumentaceum*, Roxb., which is also very coarse. This last is a close relative of the barnyard grass, *Panicum crusgalli*, one of our worst weeds.

The five species of *Poa* produced plants much alike in appearance. They are small, tufted, with mostly narrow leaves, of a dark green color, which they still retained when notes were last taken, November 18. Two of the species, *P. nemoralis* and *P. laevis*, threw up slender culms 10 inches high, and produced blossoms and fruit. The others formed no culms. The four species of *Festuca* present greater differences in appearance than do the *Poas*. *F. elatior* is much more robust in growth than any of the others. Its leaves are broader, and of a lighter color. It did not blossom this year, but from its habit of growth, I think it will prove an excellent hay grass. *F. ovina*, L., and *F. heterophylla*, P. S., are much alike in habit of growth, neither producing very vigorous plants. *F. rubra*, var. *dumetorum*, made a fair growth, but not as strong as *F. elatior*. *F. heterophylla* was the only one to blossom. *Elymus Canadensis* is a strong growing, rather coarse grass, producing abundant leaves; the culms are from 24 to 30 inches high, blossoming early in August. It will make fair hay if cut early. The plat of *Poa pratensis* was sown early in the spring of 1889. The growth this season was strong, affording excellent hay. Seven forms, representing five species of the genus *Agropyrum*, were sown. *A. divergens* was lost; the others reached maturity. These are all good hay grasses. *A. glaucum*, known as blue stem, is probably the best, though there is little choice between it and *A. tenerum*. The forms of *A. violaceum* and *A. unilaterale* are of coarse habit, and the latter grows somewhat taller. *Deyeuxia Canadensis* (also

called *Calamagrotis Canadensis*) grew rather slowly in the early part of the season, but later it did better, and covered the plat with a thick growth of leaves. It produced no culms. From what I have seen of this grass, I think highly of it as a hay grass for moist meadows. It grows about 3 feet high, and has numerous leaves. In many places in the mountains it is abundant, and much prized by ranchmen. The three species of *Bromus* all made a strong growth. Of all the species sown, *Bromus secalinus* makes the rankest growth, yet is probably the least valuable, and not to be recommended for sowing unless it will succeed in places where no other will grow. *B. ciliatus* is but little better than *B. secalinus*. It is quite common in the foothills and mountains, growing in scattered tufts. *B. inermis* was not true to name. The grass sown is probably *B. arvensis*, which is regarded with some favor by English farmers. The grama grass, *Boutloua oligostachya*, did not come well, and made but small growth. The culms were 8 to 11 inches high, blossoming August 13. Later in the season the plants made some additional growth, and another year bid fair to cover the plat. *Eragrostis Abyssinica* grew rapidly, the leaves reaching 1 foot in length. It matures late, blossoming here September 13. The grass is an annual, and from its thick and rapid growth may be valuable. It deserves further trial. *Koeleria cristata* is one of our early native grasses, common on the plains and in the foothills. It blossoms in June. On the plat this season it produced no culms, and the growth was not strong. It is perennial, and careful record will be kept of its behavior next season. I have faith that it will prove valuable for cultivation. *Cynosurus cristatus* did not give much promise in the early part of the season, but later it grew rapidly, and thickened so as to cover the whole plat. The leaves are long, very numerous, bright, shining green. No culms were produced.

The plants have large masses of roots. They were still green November 22. It is a promising species. *Lolium perenne* and *Holcus lanatus* are also very promising species. Both made a strong growth. *Avena flavescens* came irregularly, and is a slow grower. A few plants blossomed August 16. The culms were only about 18 inches high. Though not evenly distributed over the plat, the plants are now, November 22, strong, and they will make a better showing next season. Burnet (*Poterium sp.*)—The growth of this plant was even over the plat, and about 12 inches high. It makes larger and stronger plants the first year than either alfalfa or sanfoin. It is still green November 22. It is a hardy perennial, and its growth the second season will better enable us to judge of its value as a forage plant for this region. Spurry (*Spergula maxima*)—This is an annual, and does not promise to be of any value. The plants on the plat were thick, but were so slender, and the foliage so scanty, that they furnish little forage. They were all dead by August 1. *Galega officinale* produces a large bulk of forage. It is a very strong and rapid grower. The plants were 3 feet high, thick and matted together. *Ornithopus sativus* is an annual, and, like the Spurry, seems too slender in habit to be of value as a forage plant. *Onobrychis sativa*, (sanfoin).—This first seasons growth of this well-known forage plant was small. The leaves grew to 7 inches in length. Ample roots have been made. The growth next season will be noted.

Water was applied to the garden plats, as follows: May 22 and 26; June 6, 13 and 14; July 5; August 12; September 10; October 14. The plats were weeded by hand four times during the season. The first time May 31.

With a view to obtaining seed of some of the species that failed this season, a two weeks' collecting trip was planned. Though very late when the idea was suggested,

it was thought that by going at once to a high elevation, the desired species could be secured. Accompanied by Mr. R. G. Sargent, a student at the College, and by Mr. A. N. Hoag, to whose knowledge of the country and experience derived from a previous expedition for a similar purpose much of the success of the trip was due, I left Fort Collins on the 29th of August. September 1 we arrived at Cameron Pass, and went into camp. Here we remained four days, devoting the time to collecting on the mountain sides of the pass. The mountain sides here are covered with timber, *Picea Engelmanni* predominating. Here and there among the timber are small, open glades, and these are usually covered with grasses, various species being represented. Three species of *Agropyrum* were found in considerable quantity — *A. violaceum*, *A. unilaterale* and *A. divergenes*. *Melica bulbosa* is also quite common, the plants usually growing singly. *Bromus ciliatus*, *Calamagrostis Canadensis* and two species of *Poa* were also found in these glades. Ascending to near timber line, where the trees are few and small, we find broad tracts covered with a dense growth of grass. The most abundant species is a *Poa*, probably *arctica*. *Phleum alpinum* is also abundant. It does not form a close turf, but grows in scattered tufts. A little higher, and growing mostly in gulches, where there is little vegetation, we find *Poa alpina* and *Deschampsia cæspitosa*, var. *alpina*. At timber line, and extending above, we found *Juncus Drummondii*, *Luzula spicata*, *Carex Pyrenaica*, *C. Preslii*, *C. festiva*, var. *Haydeniana*, and *C. atrata*. Under the spruces, near timber line, is *Poa acuminata*, its slender virgate culms 2 feet high. On the morning of September 5 we broke camp, and went on to North Park. We camped on a ranch where a large amount of native hay is annually cut from irrigated meadows. The system of irrigation here practiced is

peculiar. Water is turned on in the spring, and allowed to flow until they are ready to cut the hay. A large area had already been cut, but there was one field of some 40 acres not yet cut, and from which the water had just been turned. The soil was saturated, and in places water stood on the surface. The growth of grass was heavy, but it was then past its prime, the seed being nearly matured. The species constituting the greater part of the growth were *Calamagrostis Canadensis*, *C. neglecta* and *Agropyrum violaceum*. These were not mixed together, but grew in separate areas, where they constituted almost the entire vegetation. There were also extended patches of *Festuca ovina* and *Agrostis scabra*. Along one side of the field *Elymus Sitanion* was quite abundant, growing with two forms of *Stipa viridula*, and on one portion of the field I found an abundance of *Juncus Mertensianus*, and growing with it no less abundant were *Juncus Balticus* and *J. tenuis*. This field had been irrigated (flooded would be a better word) for three seasons, and I learned from the lessee of the ranch that these forms of *Juncus* were each year becoming more abundant. They appear to be running out the native grasses, a result of the system of irrigation. In the timber, which covers a portion of the park, there are many small openings. On these the vegetation is almost exclusively *Festuca scabrella*, and nowhere else did I see this grass. It is much sought after by cattle, and the evidence of its nutritious character is seen in the condition of the animals that feed upon it. A small quantity of seed, all that could be found, was collected.

We returned home by the same route taken in going, arriving September 12. I append a list of the species collected. Seed was secured of nearly all of them, though in some cases the amount was small. I am under obligations to Dr. George Vasey for aid in determining many of the grasses collected, and to Prof. L. H. Bailey

for the determination of the *Carices* and several species of *Juncus*.

List of grasses collected August 29 to September 12, 1890:

*8,090—*Stipa viridula*, Trin. A tall form.
*S. viridula*, Trin. A dwarf form.
*S. Richardsonii*, Link.

8,096—*Muhlenbergia gracillima*, Torr. Three forms.
*M. gracilis*, Torr.

8,105—*Phleum Alpinum*, L.

8,107—*Alopecurus aristulatus*, Torr.
*A. Occidentalis*, Scrib.

8,111—*Sporobolus depauperatus*, Torr.

8,120—*Agrostis scabra*, Willd.

8,124—*Calamagrostis neglecta*, Kth.
*C. canadensis*, Beauv.

8,126—*Ammophila longifolia*, Benth.

8,145—*Deschampsia atropurpurea*, Wahl.
*D. caespitosa*, Beauv.
*D. caespitosa*, var. *alpina*, Vasey.

8,146—*Trisetum subspicatum*, Beauv.
*T. subspicatum*, var. *molle*, Gray. Two forms.

8,169—*Bouteloua oligostachya*, Torr.

8,177—*Beckmannia erucaeformis*, Host.

8,224—*Melica bulbosa*, Geyer.

8,247—*Poa caesia*, Sm.
*P. caesia*, var. *strieta*.
*P. reflexa*, V. and S.
*P. cuspidata*, Vasey.
*Poa alpina*, L.
*P. rupestris*, Vasey.
*P. serotina*, Ehoh.
*P. nemoralis*, L.

8,251—*Graphephorum Wolfii*, Vasey.

8,254—*Festuca ovina*, L.
*F. scabrella*, Torr.

8,257—*Bromus breviaristatus*, Thurb.
*B. Pumpellianus*, Scrib.
*B. ciliatus*, var. *Coloradoensis*.
*B. ciliatus*, L.

8,272—*Agropyrum violaceum*, Beauv. Three forms.
*A. glaucum*, R. and S.
*A. tenerum*, Vasey.
*A. unilaterale*, Vasey and Scribner.
*A. divergens*, Nees.
*A. caninum*, Reich.

8,278—*Elymus Sitanion*, Schult.

* The numbers here used are the numbers of the genera, according to Durand's Index, which is based upon Bentham and Hooker's arrangement. They are inserted here to facilitate reference to the herbarium.

The following were also collected, and of most species a small quantity of seed was secured. These species are known to ranchmen as wire grasses. They are found in varying quantity in moist, mountain meadows, at all elevations.

JUNCACEAE.

7,610—*Juncus nodosus*, L., var. *megacephalus*, Torr.
*J. tenuis*, Willd.
*J. Drummondii*, Meyer.
*J. Balticus*, Dethard.
*J. Mertinsianus*, Meyer.
7,611—*Luzula spicata*, Desv.
*L. spadicea*, var. *parviflora*, Meyer.

CYPERACEAE.

7,988—*Carex marcida*, Boott.
*C. Pyrenaica*, Wahl.
*C. Preslii*, Stend.
*C. festiva*, var. *Haydeniana*, W. Boott.
*C. atrata*, L.
*C. variabilis*, Bailey.

THE FALL WORK.

Commencing October 17, the south half of the Station enclosure was plowed, according to the schedule, in the same manner as described for the spring plowing. The central strip, occupied by small plats, was also plowed, and again prepared for small lots of seed. It was widened to 8 feet, and the small plats have all been laid out 4 feet by 8 feet. The large plats are the same length as those prepared in the spring, viz., 260 feet. The work of preparing the ground was completed October 20. Appended is a list of species planted, with the dates of planting and the area occupied. The seed on all the plats, small and large, has been drilled in. There is still a portion of the ground unoccupied. This will be filled as soon as seed is obtained.

## TABULATION OF SMALL PLATS—4 x 8 Feet.

| No. Plat. | VARIETY. | Where Seed was Obtained. | Date of Planting. |
|---|---|---|---|
| 1 | Muhlenbergia gracilis | Colorado, 1889 | Nov. 13 |
| 2 | Deyeuxia Canadensis | " " | " |
| 3 | Ornithopus sativus | Dep't of Agriculture | " |
| 4 | Poa andina | Colorado, 1889 | " |
| 5 | Trifolium hybridum | Dep't of Agriculture | " |
| 6 | Festuca ovina | " " " | " |
| 7 | Anthyllis, sp.? (Kidney Vetch) | " " " | " |
| 8 | Eragrostis Abyssinica | " " " | " |
| 9 | Agropyrum violaceum | Colorado, 1889 | " |
| 10 | Elymus Canadensis | " " | " |
| 11 | Agropyrum tenerum | " " | Nov. 14 |
| 12 | Agroporum violaceum, foliage green | " " | Nov. 15 |
| 13 | Trifolium eriocephalum | " " | " |
| 14 | Agropyrum violaceum, glaucous | " " | " |
| 15 | Milium effusum | Dep't of Agriculture | " |
| 16 | Bromus ciliatus | Colorado, 1889 | " |
| 17 | Hordeum nodosum | " " | " |
| 18 | Spergula maxima | Dep't of Agriculture | " |
| 19 | Bromus secalinus | Colorado, 1889 | " |
| 20 | Agropyrum glaucum | " " | " |
| 21 | Deyeuxia Canadensis | " " | " |
| 22 | Kœleria cristata | " " | " |
| 23 | Muhlenbergia Wrightii | " " | " |
| 24 | Festuca rubra, var. dumetorum | Dep't of Agriculture | " |
| 25 | Agropyrum glaucum, foliage green | Colorado, 1889 | " |
| 26 | Bouteloua oligostachya | " " | " |
| 27 | Agropyrum violaceum | " 1890 | " |
| 28 | Bromus ciliatus | " " | " |
| 29 | Calamagrostis neglecta | " " | " |
| 30 | Agropyrum divergens | " " | " |
| 31 | Stipa viridula, small form | " " | " |
| 32 | Festuca ovina | " " | " |
| 33 | Bromus Pompellianus | " " | " |
| 34 | Agropyrum violaceum | " " | " |

**TABULATION OF SMALL PLATS—Continued.**

| No. Plat. | VARIETY. | Where Seed was Obtained. | Date of Planting. |
|---|---|---|---|
| 35 | Poa cæsia, a form | Colorado, 1890 | Nov. 15 |
| 36 | Muhlenbergia gracillima | " " | " |
| 37 | Calamagrostis Canadensis | " " | " |
| 38 | Festuca scabrella | " " | " |
| 39 | Poa arctica | " " | " |
| 40 | Poa cuspidata | " " | " |
| 41 | Poa cuspidata | " " | " |
| 42 | Poa reflexa | " " | " |
| 43 | Phleum alpinum | " " | " |
| 44 | Agropyrum violaceum | " " | " |
| 45 | Trifolium eriocephalum | " " | " |
| 46 | Carex festiva | " " | " |
| 47 | Andropogon furcatus | " " | " |
| 48 | Poa alpina | " " | " |
| 49 | Calamagrostis Canadensis | " " | " |
| 50 | Bouteloua oliogostachya | " " | " |
| 51 | Elymus Sitanion | " " | " |

TABULATION OF LARGE PLATS, 260 FEET LONG.

| No. Plat. | VARIETY. | W'th of plat, ft. | Where Seed was Obtained. | Date of Planting. |
|---|---|---|---|---|
| 1 | Festuca heterophylla | 10 | Colorado, 1889 | November 13 |
| 2 | Lolium perenne | 20 | Dep't Agriculture | " " |
| 3 | Avena flavescens | 5 | " " " | " " |
| 4 | Agropyrum tenerum | 6 | Colorado, 1889 | " " |
| 5 | Bromus arvensis | 12 | Dep't Agriculture | " " |
| 6 | Galega officinale | 10 | " " " | " " |
| 7 | Poa nemoralis | 10 | " " " | November 11 |
| 8 | Lotus major | 16 | " " " | " " |
| 9 | Festuca elatior | 16 | " " " | " " |
| 10 | Poa tenuifolia | 14 | Colorado, 1889 | " " |
| 11 | Burnet (Poterium, sp?) | 10 | Dep't Agriculture | " " |
| 12 | Holcus lanatus | 8 | " " " | " " |
| 13 | Andropogon scoparius | 3 | Colorado, 1889 | November 15 |
| 14 | Bouteloua oligostachya | 3 | " " | " " |

## TABULATION OF LARGE PLATS, 1890, (See pages 159-162).

| No. Plat. | SPECIES OR VARIETY. (Plats are 260 feet long). | Width, ft. | Where seed was obtained. | Observation April 28. | Observation May 3. | Observation May 14. | Observation June 7. | Observation June 24. | Observation July 24. | Observation August 23. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Avena flaveseens | 8 | Dept. of Agr. | Germinating | A few plants are pric'ng through | Plants came slow, unevenly | Plants do not advance at all | All dead | ..... | ..... |
| 2 | Eragrostis Abyssinica | 5 | " " | No germin'tion | ..... | ..... | ..... | ..... | ..... | ..... |
| 3 | Cynosurus cristatus | 5 | " " | Germinating | Plants are pric'ng through | Even. Leaves ½ to ¾ in. high | Plants have died in places | Dying out | All dead | ..... |
| 4 | Ammophila arundinacea | 3 | " " | No germin'tion | ..... | ..... | ..... | ..... | ..... | ..... |
| 5 | Lolium perenne | 5 | " " | Germinating | Plants thick | Plants thick 2 to 3 in. high. | No advance | Green, but not growing. | Leaves turned brown. | Many plants alive at crown. |
| 6 | Holcus lanatus | 8 | " " | " | No plants up | Plants up even ½ to ¾ in. long | Uneven, leaves 1 in. high | Dying | Nearly all dead | A few still have life in roots |
| 7 | Beckmannia eruciformis | 5 | Colorado, 1889 | No germin'tion | ..... | ..... | ..... | ..... | ..... | ..... |
| 8 | Koeleria cristata | 3 | " " | " " | No germin'tion | Scattered, very small | Very uneven and small | All dead | ..... | ..... |
| 9 | Oryzopsis cuspidata | 4 | " " | " " | ..... | ..... | ..... | ..... | ..... | ..... |
| 10 | Bromus inermis | 10 | Dept. of Agr. | Germinating | Plants up even, some 1 in. high | Thick, even 1 to 2 in. high | Promising, 3 in. long | Leaves lie flat, forming a mat | Leaves dead to ground | Plants all dead |
| 11 | Chrysopogon nutans | 8 | Colorado, 1889 | No germin'tion | ..... | ..... | ..... | ..... | ..... | ..... |
| 12 | Phalaris arundinacea | 4 | Dept. of Agr. | " " | No germin'tion | A few plants pric'ng through | Very uneven, 1 to 1½ in. high | Dying | All dead | ..... |
| 13 | Elymus Macounii | 4 | Colorado, 1889 | " " | ..... | ..... | ..... | ..... | ..... | ..... |
| 14 | Elymus Sibericus | 4 | " " | " " | ..... | ..... | ..... | ..... | ..... | ..... |
| 15 | Agropyrum glaucum | 4 | " " | " " | ..... | ..... | ..... | ..... | ..... | ..... |
| 16 | Agropyrum tenerum | 8 | " " | " " | Germinating | Plants up thick, leaves 1 in. long | Even, leaves 3 inches long | N. end green, s. end dead | Nearly all dead few plants head | At n. end many plants are alive |
| 17 | Andropogon furcatus | 8 | " " | " " | ..... | ..... | ..... | ..... | ..... | ..... |
| 18 | Andropogon scoparius | 12 | " " | " " | ..... | ..... | ..... | ..... | ..... | ..... |

## TABULATION OF LARGE PLATS, 1890—Continued.

| No. Plat. | SPECIES OR VARIETY. (Plats are 260 feet long). | Width, ft. | Where seed was obtained. | Observation April 28. | Observation May 8. | Observation May 14. | Observation June 7. | Observation June 24. | Observation July 24. | Observation August 23. |
|---|---|---|---|---|---|---|---|---|---|---|
| 19 | Poa nemoralis | 10 | Dept. of Agr. | No germin'tion | | | | | | |
| 20 | Poa lævis | 4 | Colorado, 1889 | " " | | | | | | |
| 21 | Poa tennifolia | 12 | " " | " " | | | | | | |
| 22 | Festuca ovina | 12 | Dept. of Agr. | " " | No germin'tion | A few very small plants. | Uneven, some 1 in. high. | Dying | All dead | |
| 23 | Festuca rubra, var. dumetorum | 6 | " " | " " | " " | Find but few small plants. | Few plants, 1 to 2 in. high. | All dead | | |
| 24 | Festuca elatior | 16 | " " | Germinating | Plants pricking through. | Plat green, ½ to 1 in. high. | Leaves 1 to 2 inches high. | Leaves turning brown. | Most died down to ground. | Roots, crown of many still alive |
| 25 | Festuca heterophylla | 16 | " " | No germin'tion | No germin'tion | Plants up, uneven, small. | Uneven, 1 to 2 inches high. | No growth after June 7, dying. | All dead | |
| 26 | Festuca scabrella | 16 | Colorado, 1889 | " " | | | | | | |
| 27 | Anthyllis, sp? | 10 | Dept. of Agr. | A few plants pric'ng through | Thick, even, but very small. | Plants ave. 1 inch high. | A few made second leaf. | Green, but not growing. | Still green, but no larger. | Very green, cluster, 2 in. |
| 28 | Poterium, sp? | 20 | " " | Germinating | Uneven, few plants, small. | Uneven, small | 1 to 2 in. high, leaves spr'd'g. | Plants numerous, but small. | No advance | Plants thick, best ones 3 in. |
| 29 | Vicia villosa | 12 | " " | " | Plants thick, ¼ inch high. | Uneven, grows slowly. | numerous, slender, 2, 3 in. high. | 5 to 8 inches, few blossomed. | Stems lie flat, still blooming. | Prostrate, and many dying. |
| 30 | Ornithopus sativus | 12 | " " | No germin'tion | No germin'tion | Plants thick, very small. | Thick, small, some 1 in. high. | Many died, some 2 to 4 in. | Scattering, 3 to 4 inches high. | All dead |
| 31 | Spergula maxima | 12 | " " | Germinating | Plants thick, ½ inch high. | No apparent advance. | Thick, 1 to 3 inches high. | Few show bl'm, 3 to 4 in. high. | Plants dying, a few 7 in. high. | All dead |
| 32 | Lotus major | 20 | " " | " | A few plants are just up. | Few plants, very small. | 1 to 2 in. high. | No advance | A very few still alive. | All dead |
| 33 | Trifolium hybridum | 12 | " " | No germin'tion | | | | | | |
| 34 | Galega officinale | 16 | " " | " " | Germinating | Even, very small. | Thick, small, largest 1 inch. | 2 to 4 in. high. | A few blos'm'd, stems 3 to 8 in. | Dead both ends 8 inches high. |
| 35 | Onobrychis sativa | 30 | " " | Germinating | Plants numerous, but small. | Some second leaf, very small. | Scattering, 2 to 3 inches high. | No advance. | Find but few plants, small. | A few plants still alive. |

NOTE.—The above plats, from Nos. 1 to 28, were sown on March 29, the balance on April 3.

## TABULATION OF SMALL PLATS, 1890. (See page 163).

| No. Plat | SPECIES OR VARIETY. (Plats 6 feet wide, rows 6 inches apart). | Where seed was obtained. | Observation April 28. | Observation May 3. | Observation May 14. | Observation June 7. | Observation June 24. | Observation July 24. |
|---|---|---|---|---|---|---|---|---|
| 5 | Eleusine coracana | Prof. S M Tracy | No germinat'n | No germinat'n | A few plants up, very small. | All dead | ..... | ..... |
| 9 | Panicum frumentaceum | " " | " " | " " | A few plants, small and weak. | Few plants, and these very small. | Leaves dying | All dead |
| 36 | Agropyrum unilaterale | Colorado, 1889 | " " | " " | A few plants, very small. | Uneven, a few are 1 to 2 inches high. | Nearly all dead | All dead |
| 37 | Agropyrum divergens | " " | " " | " " | Plants few, small. | Uneven, 1 to 2 inches high. | All dead | ..... |
| 50 | Agropyrum violaceum (foliage green). | " " | " " | Germinating | Plants even, 1 inch high. | Plants thick, 2 inches high. | No growth since June 7, dying. | All dead |
| 51 | Agropyrum glaucum (foliage green). | " " | " " | " | Plants up, even. | Even, 2 in. high. | No growth since June 7, dying. | All dead |
| 52 | Agropyrum violaceum | " " | " " | " | Up even, ½ inch high. | Thick, even, 2 inches high. | No growth since June 7, dying. | All dead |
| 53 | Agropyrum tenerum (foliage green). | " " | " " | " | Up evenly. | Even, 2 in. high. | Dying | All dead |
| 54 | Agropyrum violaceum, glaucous | " " | " " | " | Plants coming up irregular. | Uneven, largest 2 inches high. | Dying | All dead |
| 56 | Poa andina | " " | " " | No germinat'n | A few plants are coming. | Very irregular, small and weak. | All dead | ..... |
| 60 | Deyeuxia Canadensis | " " | Germinating | Plants pricking though. | Irregular, leaves ½ inch long. | Uneven, leaves ¼ to 1 inch high. | All dead | ..... |
| 66 | Muhlenbergia gracilis (var. breviaristatus). | " " | No germinat'n | No germinat'n | A few scattering plants, small. | Very uneven | All dead | ..... |
| 67 | Elymus Canadensis | " " | " " | A few small plants. | Very irregular, leaves 1 to 2 inches. | No advance | Dying | All dead |
| 73 | Bromus ciliatus | " " | Germinating | Up even | Even, leaves 2 inches long. | Leaves 2 to 3 inches long. | Leaves turned brown. | All dead |
| 74 | Bromus secalinus | " " | " | Even, strong, 2 inches high. | Plants making very strong growth. | Plants eaten off | Alive, but eaten down to ground. | All dead |
| 81 | Hordeum nodosum | " " | " | Uneven, 1 inch high. | Leaves 1 to 2 inches long. | No advance | All dead | ..... |
| 82 | Bouteloua oligostachya | " " | No germinat'n | Germinating | Plants scattering, a few 1 inch high. | No advance | All dead | ..... |

NOTE.—There were of Panicum frumentaceum, 3 rows; of Bouteloua oligostachya, 10 rows, and of all others 5 rows. The plats were all sown March 20.

Respectfully submitted,

CHAS. S. CRANDALL,
*Horticulturist and Botanist.*

REPORT OF

# San Luis Valley Experiment Station.

*To the Executive Committee of the State Board of Agriculture:*

GENTLEMEN—By the Director, I herewith submit the following report of the San Luis Valley Experiment Station.

The following are the different lines of experimental work, and the results of the same:

## AGRICULTURAL.

### WHEAT.

May 2 and 3, 13½ acres were sown to Amethyst wheat. The wheat was drilled in at the rate of 8 pecks per acre. A portion of this soil had been plowed the preceding fall; the remainder was plowed this spring. There was no apparent difference in the crop on the land plowed in the fall from that plowed in the spring. The wheat was well up by the twenty-third of May, and on June 16 we finished the first irrigation. The crop was irrigated four times during the season. The last irrigation was finished August 9. The wheat was ripe by September 1, and when threshed yielded 127 bushels of good grain. The yield was considerably lessened by loss in cutting, on account of short straw, by depredations from rabbits and prairie dogs, and by no growth upon some rocky portions.

April 30 the following varieties of wheat were sown for a comparative test, viz.: Amethyst, Upland, Hedgerow,

Sonora, Fountain and Nox No. 1. Two pounds of seed of each variety was sown by hand in drills 9 inches apart, and covered about 2 inches deep. Each plat contained 5.9 square rods. May 28 all varieties were up. The wheat was irrigated four times during the season, and each time all varieties received irrigation the same day.

So much of each kind was destroyed by rabbits that no comparisons can be made except as to date and time required for ripening, which is shown in the following table:

| Name. | Date of Ripening. | Time Ripening. |
|---|---|---|
| Amethyst | September 1, | 95 days |
| Hedgerow | September 10, | 105 " |
| Upland | August 25, | 89 " |
| Sonora | August 25, | 89 " |
| Fountain | September 15, | 110 " |
| Nox No. 1 | September 15, | 110 " |

BARLEY.

The Nepaul, Hulless and Melon varieties of barley were sown April 30, in drills 9 inches apart. Two pounds of seed of each variety was sown, and covered about 2 inches deep. Each plat contained 4.7 square rods. Each variety was almost entirely destroyed before ripening, by rabbits.

OATS.

May 6, 2 acres of White Australian oats was sown, and on May 19 and 20, 6.5 acres with the same variety.

The seed was drilled in at the rate of 9 pecks per acre. The portion sown first was ripe by the 28th of August; the other portion by September 15. The yield of grain was 170 bushels. This variety of oats requires, in this valley, about ninety days in which to ripen, and is well adapted to this section.

May 6, 30 pounds of Alexander oats were drilled in on 52.4 square rods of land. They were well up by

the 23rd of May, and were ripe by the 28th of August, thus requiring ninety-five days in which to ripen. Three irrigations were given these oats; first, June 17, the last July 31. The yield of grain was 6 bushels, weighing 241 pounds, or slightly over 40 pounds to the measured bushels.

RYE.

Twenty-two pounds of seed of Mammoth rye was drilled in on 29.3 square rods of land, May 6. This rye was nicely up May 20, and was ripe August 25. It was given three irrigations. The yield was 2 bushels of first-class grain, weighing 119 pounds.

BUCKWHEAT.

June 5, 27 pounds of buckwheat was drilled in between the orchard trees. It was of Silver Hull variety, and was ripe by the 26th of August. We harvested only a small part of the crop, from which 38 pounds of seed was obtained.

FIELD CORN.

The following varieties, viz.: Adams' Early, Australian White, Dakota Extra Early and Colorado Yellow Dent, were planted to test them for earliness in ripening. The seed corn was planted June 2, in rows 3 feet apart, and by June 20 the plants showed nicely. An irrigation June 7 to germinate the seed, and another July 18, was all the watering the corn received. Five cultivations and two hoeings were given. Adams' Early formed roasting ears by September 1. The other varieties scarcely formed ears, but made a growth of stalk of from 4 to 5 feet.

FIELD PEAS.

April 21 one acre was sown with 98 pounds of Canada field peas, and plowed under to a depth of 3 inches. Four irrigations were necessary to the crop. All ripened before frost, the greater part ripening by the 4th of September. The yield of peas from the

acre was 23 bushels. It requires the whole season here to ripen this variety. It is a valuable pea for this valley, especially for growing on the poorer lands. The soil we have requires from 85 to 90 pounds of seed per acre.

MILLETS.

May 7, 30 pounds of common millet seed was sown with the drill, on ½ acre of land. After drilling in, it was harrowed once. By June 8 the plants were up, a good stand being secured. Four irrigations were given. Portions of the millet attained a height of 2 feet and ripened, while other portions had a stunted growth.

On the same date as the above, 15 pounds of German millet was sown on ¼ of an acre, and received the same treatment as the common millet. This variety will not ripen in this valley.

CLOVERS.

May 14, 2 pounds of Alsike clover seed was sown on 16 1-10 square rods of land. A fair stand was obtained, but there was no growth to speak of this season.

May 14, 4 pounds of Mammoth Red clover seed was sown on 15.5 square rods of land. A fair stand was obtained, but could not secure a growth of any value.

May 7, 1 acre was sown to red clover seed, with drill, and harrowed once. We did not secure a stand on this land. It is a difficult matter, on this light soil, to secure a stand of clover where the plowing has been done but a short time before sowing. The seed becomes buried too deep, or is apt to be entirely uncovered by the high winds and irrigation.

On a piece of land measuring 44.07 square rods, which had not been plowed this season, May 7 we drilled in red clover seed. Before sowing, the land was harrowed three times. On this piece of land we secured a good stand, which has made a growth of from 15 to 18 inches, and was in blossom about September 1.

### ALFALFA.

Two acres of land was prepared for alfalfa by plowing well and harrowing about the middle of May. This land had grown wheat the previous season.

May 20, we put upon this land, by means of a drill, 50 pounds of alfalfa seed, and after sowing, harrowed it once. The 2 acres was then divided into three plats of equal size, for the purpose of giving to each a different treatment. On one plat we sowed wheat with the alfalfa, at the rate of 6 pecks per acre. The second plat was to be irrigated by flooding, and the third plat to receive the treatment of furrow irrigation, the furrows being about 3 feet apart.

All plats were given an irrigation the fore part of June, to germinate the seed. The alfalfa plants showed nicely by the 23rd of June, a good stand being secured. During the remainder of the season, the crop was irrigated three times. The alfalfa on the plat where the wheat was sown did very little. The wheat seemed to give too much shade, and the grass made a sickly growth. The growth of alfalfa on each of the other plats was about equal, being about 12 inches, and of a healthy nature, and promising to make growth the future season.

The alfalfa grown during the season of 1889 we plowed under this year in July. On parts of the land there was a fair stand, but other parts winter killed so badly we did not deem it advisable to give further trial.

### ENGLISH RYE GRASS.

May 14, 5 pounds of English rye grass seed was sown on 15.5 square rods of land. A good stand was secured by the 23rd of June, which made a growth of about 4 inches during the season.

### SANFOIN.

May 6, 8 pounds of sanfoin seed was sown with drill to a depth of 1.5 inches. We failed to secure a stand of this, only a small part of the seed germinating.

## HORTICULTURAL.

### PEAS.

April 23 we planted, for a comparative test, twenty-three varieties of peas, in drills 3 feet apart. The area in crop was 19 square rods. Six irrigations were given during the season.

| NAME. | Fit for Table use | Date of Ripening | Length of Vine Inches. | Length of Pod, Inches. |
|---|---|---|---|---|
| Cleveland Rural New Yorker | July 1 | July 28 | ..... | ..... |
| American Wonder | July 1 | August 7 | ..... | ..... |
| Alaska | July 1 | July 28 | ..... | ..... |
| Lee's Earliest | July 1 | July 28 | ..... | ..... |
| Culverwell's Telegraph | July 4 | August 7 | 30 | 2 |
| Laxton's Marvel | July 18 | August 2 | 30 | 2½ |
| Horsford's Market Garden | July 4 | August 2 | 18 | 2 |
| First and Best | July 3 | July 28 | 32 | 2 |
| McLain's Advance | July 18 | August 2 | 42 | 3 |
| Burpee's Quantity | July 10 | August 7 | 24 | 2 |
| Stratagem | July 18 | August 7 | 26 | 3 |
| Champion of England | July 18 | August 7 | 48 | 2½ |
| Sanders' Marrow | August 5 | Sept. 4 | 68 | 2½ |
| Fill Basket | July 20 | August 7 | 32 | 3 |
| Telephone | July 20 | August 7 | 46 | 4 |
| Bliss' Abundance | July 25 | August 10 | 32 | 2½ |
| Bliss Everbearing | July 10 | August 10 | 26 | 2 |
| Blue Imperial | July 25 | August 14 | 28 | 3 |
| John Bull | July 28 | August 14 | 32 | 3 |
| Caracticus | July 8 | August 2 | 36 | 2½ |
| Laxton's Charmer | July 18 | July 31 | 44 | 3 |
| G. F. Wilson | July 28 | Sept. 1 | 36 | 3 |
| Imported D. O'Rourke | July 5 | July 23 | 34 | 2 |

### CABBAGE.

Twelve varieties of cabbage plants were taken from the hot-bed and set in open ground May 19 and 20, for a comparative test of growth upon this soil. The ground

in which they were set had been well plowed, and enriched by the addition of barnyard manure, at the rate of forty loads per acre. Area in crop was 15.4 square rods.

| NAME. | Fit for Use. | REMARKS. |
|---|---|---|
| Early Winningstadt | August 8. | Mostly good sound heads. |
| Jersey Wakefield | August 8. | Headed good, one of the best. |
| Lee's Earliest | August 8. | Good. |
| Improved Flat Dutch | | Seed not true to name. |
| Large York | September 1 | Headed fairly well. |
| Cannon Ball | | Did not head well. |
| Marblehead Mammoth | September 1 | Only fairly well headed, good many of no value. |
| Filderkraut | September 15 | Good sound heads, not large. |
| Lee's Wonderful | August 20 | Only a part headed. |
| All Seasons | | Of not much value. |
| Stone Mason | | Of no value. |
| American Drum Head | | Seed not true. |
| Berkshire Beauty | September 10. | Headed fairly well. |

CAULIFLOWER.

Plants of selected Dwarf Erfurt and Lenormand's short stemmed varieties of cauliflower were set in open ground, May 20. The soil was not of sufficient fertility to produce heads.

BEETS.

The following varieties of beets were sown with the garden seed-drill in rows three feet apart, May 13, viz.: Flat Bassano, Egyptian Dark Red, Eclipse and Improved Long Blood. Irrigation was necessary to produce germination and only a poor stand was secured. The Eclipse variety attained the largest size and was the best of the beets grown. Norbiton's Giant and Long Red varieties of mangels were also grown; the latter attained the greater size.

### SUGAR BEETS.

Sugar beet seed of the following varieties was sown by hand in drills 20 inches apart, May 15, viz.: Florimond Desprez, Dippe's Kleinwanzleben, Vilmorin, Le Grande's White Improved and Bulteau Desprez.

A small packet of seed of each variety (imported from France) was received from the Director. The soil being dry at this time, it was necessary to irrigate to bring them up. A poor stand was secured, but there were enough of each variety to give us a knowledge of what growth they would make. Good cultivation was given, and the growth was all below the surface of the soil. None of the beets would exceed a pound in weight, and all varieties were about equal in size. Samples of each were sent to the central Station for analysis.

### CARROTS.

Seed of four varieties of carrots, sown May 1, failed to germinate.

### ONIONS.

Eight varieties of onions were grown this season, for a comparative test. The land was plowed as soon as it could be worked (middle of March) and sown with the garden drill, April 1. The land had been enriched with barnyard manure at the rate of forty loads per acre. The plants showed nicely the first week in May; all kinds matured well. The Mammoth Silver King, New Queen and Mammoth Pompeii, respectively, did the best. These produced fine, marketable onions, which sold readily. Only those above mentioned produced a crop profitable to grow:

| NAME. | Lbs. Grown on 138 ft. of row. | REMARKS. |
|---|---|---|
| New Mammoth Pompeii..... | 42 | A single specimen weighed 1¼ pounds. |
| Early Flat Red..... | 26 | Fair size, very good. |
| New Golden Queen..... | 25 | Some good ones, mostly small. |
| New Queen..... | 47 | Good size, splendid onions. |
| Very Large Flat Tripoli..... | 36 | Fairly good. |
| Mammoth Silver King..... | 50 | Good size, splendid grower. |
| Yellow Danvers..... | 26 | Fairly good, some good specimens. |
| Large Red Wethersfield..... | 25 | Of little value. |

CUCUMBERS.

A comparative test for earliness was made of six varieties of cucumbers, viz.: Early Frame, Gherkin, Nichol's Medium Green, Boston Pickling, Early Cluster and Green Prolific. The seed was sown May 30, and the plants were well up by June 18. Nichol's Medium Green and Boston Pickling had fruit fit for pickling August 7; Early Frame, Gherkins and Early Cluster August 10, and Green Prolific August 14.

MUSK MELONS.

May 30, seed of eight varieties of musk melon was planted. We secured good specimens of all varieties, but did not succeed in ripening any. The varieties grown are the following: Early Yellow Cantaloupe, Early Citron, Miller's Cream, Surprise, Early Christiana, Netted Gem, Hackensack and Long Yellow.

WATER MELONS.

Seed of seven varieties of water melon was sown May 30, but we did not succeed in ripening any fruit. The citron (Colorado preserving) did not ripen, but attained a size and maturity sufficient for preserving.

BEANS.

May 23, seed of twenty-one varieties of beans was planted for a comparative test. The area in crop was 13.9 square rods. All the bush beans grown, except Broad Windsor, matured their seed. Of the pole beans, only the Scarlet Runner and German Wax matured seed. Three irrigations were necessary to grow the crop. The last five in the table are pole beans.

| Name. | Fit for Use as String Beans. |
|---|---|
| Dwarf Horticulture | August 7 |
| Black Wax | July 28 |
| Flageolet Wax | August 7 |
| Dwarf White Wax | August 15 |
| Henderson's Earliest Red Valentine | August 15 |
| Early Champion | July 28 |
| Early Fiji | August 18 |
| Large White Kidney | August 15 |
| Canadian Wonder | July 28 |
| R. I. Dwarf Case Knife | July 28 |
| Date Wax | July 28 |
| Dwarf Mont D'Or | August 7 |
| English Canterbury | August 7 |
| Early Mohawk | August 7 |
| Emperor William's Bush | July 28 |
| Broad Windsor | ——— |
| White Dutch Case Knife | September 7 |
| Golden Butterpole | August 15 |
| Scarlet Runner | August 15 |
| Horticultural Tall | August 18 |
| Golden Wax Poles | August 25 |

TOMATOES.

The plants were taken from the hot-bed and set out June 9. The varieties grown were the following: Livingstone's Favorite, Yellow Plum, Scoville's Hybrid, Acme, Hathaway's Excelsior, Red Cherry, Dwarf Champion, Trophy and Mayflower. We ripened quantities of all,

except the Trophy. The Yellow Plum, Mayflower and Acme, respectiveiy, were the first to ripen fruit.

PUMPKINS.

We ripened the Connecticut Field and Large Tours varieties of pumpkins. The Cashaw and Large Cheese did not ripen.

SQUASH.

The Marblehead, Boston Marrow, Bay State, Mammoth Chili, Essex Hybrid, Butnam and Hubbard squashes ripened well. The Summer Crookneck squash grows well. The Winter Crookneck, Sibley, Dunkard Winter and Quaker Pie were of no value this season.

POTATOES.

May 26 we planted seed of thirty-one seedling and fifty standard varieties, on 44½ square rods of land, in rows 3 feet apart, and at intervals of 18 inches in the row. The seed was whole potatoes, of about medium size. After planting, the ground became dry, and June 5 they were irrigated. They were given three cultivations, and irrigated four times during the growing season. All varieties matured at time of digging, September 29.

| Name. | No. Hills. | Total Pounds. |
|---|---|---|
| Hawkeye | 28 | 19½ |
| O. K. Mammoth | 22 | 17½ |
| Hoag's Seedling | 52 | 41 |
| Chicago Market | 19 | 6 |
| Ohio Fancy | 17 | 12½ |
| Empire State | 17 | 9 |
| Mammoth Pearl | 21 | 19¾ |
| Pride of Ireland | 7 | 2¾ |
| Early Ohio | 14 | 9¾ |
| Dunmore | 52 | 50¼ |
| Early Pearl | 22 | 11 |
| Early Ease | 8 | 4¼ |
| Vermont Champion | 49 | 33 |

| Name. | No. Hills. | Total Pounds. |
|---|---|---|
| Perfect Peachblow | 4 | 2¾ |
| White Star | 67 | 68¼ |
| Triumph | 27 | 15½ |
| White Elephant | 70 | 52½ |
| Red Elephant | 17 | 8 |
| Thunderbolt | 77 | 57¼ |
| Rubicund | 27 | 24¼ |
| Mayflower | 36 | 31 |
| Sterling | 27 | 26 |
| Beauty of Hebron | 116 | 96½ |
| Pearl of Savoy | 43 | 25 |
| Barkley's Prolific | 41 | 41 |
| Watson Seedling | 4 | 4 |
| Pride of America | 26 | 27½ |
| Green Mountain | 52 | 46 |
| Yankee Nation | 42 | 31 |
| Champion of America | 6 | 2¼ |
| Seek-No-Farther | 14 | 9 |
| Newton | 27 | 15½ |
| Late Ohio | 22 | 13 |
| Queen of the Valley | 15 | 9 |
| Chicago Sun | 27 | 23½ |
| Urca Chief | 14 | 10¾ |
| Bliss' Triumph | 5 | 3¼ |
| St. Patrick | 15 | 11 |
| American Giant | 27 | 17 |
| El Paso | 20 | 14 |
| White Sport | 16 | 17¼ |
| Shannon Seedling | 15 | 9½ |
| New Queen | 41 | 29 |
| Rural Blush | 15 | 13½ |
| Cream of Field | 10 | 9½ |
| Burbank | 39 | 37 |
| New Champion | 25 | 31 |
| White Mercer | 17 | 12½ |

POTATOES—SEEDLINGS.

| Number. | No. Hills. | Total Pounds. |
|---|---|---|
| 49 | 10 | 5¾ |
| 39 | 13 | 8 |
| 19 | 29 | 12 |
| 34 | 15 | 8½ |
| 72 | 7 | 2¾ |

| Number. | No. Hills. | Total Pounds. |
|---|---|---|
| 32 | 7 | 3 |
| 13 | 10 | 6½ |
| 55 | 11 | 3¾ |
| 48 | 10 | 5¼ |
| 69 | 5 | 4¼ |
| 66 | 8 | 3¾ |
| 12 | 16 | 9 |
| 35 | 17 | 9¾ |
| 36 | 22 | 19½ |
| X | 18 | 10 |
| 105 | 27 | 14 |
| 72 | 8 | 5½ |
| 41 | 23 | 15 |
| 83 | 11 | 15 |
| 101 | 15 | 7 |
| 33 | 39 | 30½ |
| Y | 6 | 5½ |
| 53 | 23 | 25 |
| 68 | 16 | 14¼ |
| 75 | 8 | 8 |
| 85 | 15 | 16 |
| 62 | 5 | 3¼ |
| 102 | 22 | 14 |
| 58 | 41 | 17½ |

To test the benefits of manure for potatoes upon this soil, we applied barnyard manure at the rate of forty loads per acre on a piece of land, and May 27 planted seed potatoes of the varieties given in the appended table. Their treatment otherwise was similar to that given to those mentioned before in this report. The seed was good-sized specimens, and in halves. There was a marked difference in the product grown on fertilized and unfertilized soils. The yield on the fertilized was greater, single specimens larger, and the entire product more uniform in size. Barclay's Prolific grew on this soil at the rate of 17,920 pounds per acre, Beauty of Hebron as the rate 14,800 pounds per acre:

| Name. | No. Hills. | Total Pounds. |
|---|---|---|
| Mayflower | 18 | 20 |
| Beauty of Hebron | 45 | 52½ |
| Dunmore | 21 | 24 |
| Early Ohio | 12 | 7½ |
| Mammoth Pearl | 10 | 8¼ |
| Late Ohio | 17 | 10 |
| Pearl of Savoy | 22 | 12⅓ |
| Barclay's Prolific | 30 | 43¼ |
| Yankee Nation | 19 | 25 |
| Vermont Champion | 21 | 24¼ |
| Green Mountain | 36 | 36 |
| Thunderbolt | 37 | 36¾ |
| White Elephant | 17 | 12 |
| Seedling 33 | 17 | 9 |
| White Star | 25 | 10 |

SWEET CORN.

June 2, seed of the following varieties of sweet corn was planted to test them for earliness in producing ears and ripening at this altitude, viz.: Moore's Early Concord Triumph, Black Mexican, Honey Sweet, New Bonanza, Shaker's Early, Perry's Hybrid, Early Minnesota, Cory's Early and Crosby's Early. Cory's Early, Early Minnesota and Perry's Hybrid, respectively, produced roasting ears. The corn was cultivated five times, hoed twice and irrigated once during the growing season.

SUNFLOWER.

June 2, seed of the Russian sunflower was planted. The seed perfectly matured, single heads attaining a diameter of 11 inches.

## ORCHARDS AND FORESTRY.

APPLES.

During the fore part of May, the varieties of apples given in the table were set out. They were received from

the Central Station at Fort Collins and Rocky Mountain Nursery of Canon City, Colorado :

| Name. | No. set out. | No. growing. |
|---|---|---|
| Whitney (crab) | 2 | 2 |
| Martha (crab) | 2 | 2 |
| Red Bietigheimer | 3 | 3 |
| Maine | 6 | 6 |
| Yellow Transparent | 7 | 5 |
| McMahon | 4 | 4 |
| Duchess of Oldenburg | 5 | 5 |
| Red Astrachan | 3 | 3 |
| Pewaukee | 2 | 2 |
| Wealthy | 2 | 2 |
| Wolfe River | 2 | 1 |
| Early Ripe | 2 | 2 |
| Walbridge | 2 | 1 |
| Ben Davis | 5 | 5 |
| Tetofskey | 3 | 3 |

The varieties and numbers of each now growing from the planting one year ago, are the following: Five Duchess of Oldenburg, one Ben Davis, two Whitney's No. 20, two Limber Twig, three Hyatt's Beauty, one Winter Red, two Starke, two Red Bietigheimer, two N. W. Greening, three McMahon, two Yellow Transparent and one Macintosh.

We also have the following varieties, grown from the grafts set the spring of 1889, viz.: Scott Shopier, August, Elgin Beauty, Orange Winter, Newport Sweet, Harte, Forest, Rebecca, McMahon, Holister Sweet, Brodie, Black Fameuse, Piper, Elkhorn, Foote, September, Walworth Pipin, Louis Favorite, Bunker and Early Blue.

### PEARS.

The varieties of pears given in the following table were set out this spring. The McCandless and Bartlett have made some growth, but the others have done very little:

| Name. | No. set out. | No. living. |
|---|---|---|
| McCandless | 2 | 2 |
| Keifer | 5 | 2 |
| Bartlett | 3 | 2 |
| Beurre D'Angou | 4 | 1 |

PLUMS.

Two varieties of plums, one Big Ute and one Forest Garden, were set out May 12. The latter did not grow; the former made fair growth.

CHERRIES.

Two varieties of cherries, one Early Richmond and one Ostheim, were set out, but neither lived.

STRAWBERRIES.

May 7, 95 strawberry plants, comprising the Monmouth, Manchester, Jucunda, Crescent, Bubach, Jessie and Albany varieties were planted. Of this collection, success was attained only with the Monmouth, Manchester and Crescent. We also have growing, the Downing, Scarlet, Lida, Louisa, Summit, Albany, Iron Clad, Crescent Seedling, Captain Jack and Manchester varieties of strawberries, which were set out August 13, 1889. The Lida, Louisa, Crescent Seedling and Summit ripened fruit this season during the forepart of July.

SHRUBBERY.

May 13, the blackberries given in the following table were set out:

| Name. | No. set out. | No. growing. |
|---|---|---|
| Snyder | 6 | 2 |
| Stone's Hardy | 11 | 3 |
| Erie | 9 | 7 |

RASPBERRIES.

May 13, 64 plants, comprising six varieties, were set out, but we failed to succeed with them. The failure was partly due to poor stock.

GOOSEBERRIES.

Twelve gooseberries plants, of Smith's and Downing's varieties, were set out, but failed to grow.

CURRANTS.

Thirteen plants of the Fay and Cherry currants were set out, but did not grow.

GRAPES.

Five Worden, five Woodruff Red and two Early Victor grapes were set out May 13. All of the plants of the first two varieties lived and made growth, but the latter died.

FORESTRY.

The varieties of forest trees given in the following table were received from the Rocky Mountain nurseries, and set out the fore part of May:

| Name. | No. set out. | No. growing. |
|---|---|---|
| Black Locust | 5 | 4 |
| Maple | 5 | 5 |
| European Ash | 5 | 5 |
| Coffee Tree | 5 | 5 |
| Catalpa (Speciosa) | 5 | 5 |
| Box Elder | 5 | 5 |
| Elm | 5 | 5 |
| Birch | 4 | 3 |
| Mountain Ash | 5 | 1 |
| Black Walnut | 5 | 4 |

The Black Walnuts grown the season of 1889 winter killed to the ground, but most of them have come up again from the roots. The Green Ash survived the winter well. Most of them lived to the terminal bud. The Honey Locust makes rapid growth, and is hardy at this altitude. Two hundred seedling Cottonwoods were set out this spring. They were a poor lot, and only about one-quarter of them lived. These have been destroyed during the summer and fall by rabbits.

## METEOROLOGY.

No new instruments have been added to this department this year. Monthly reports have been sent to the Central Station at Fort Collins, Signal Service at Denver and Washington, D. C. The only spring storms of any importance occurred during April. Frost was not out of the ground to admit of plowing before the middle of March. One characteristic of the climate here is the warm days during April and May and cold nights during the same period, the maximum temperature not exceeding 40 degrees until well into June. An unusual amount of rain falling during August and the first part of September retarded to some extent the ripening of grains. The last spring frost occurred June 7. Slight Autumn frosts occurred September 7 and 8, but only severe enough to kill melon and cucumber vines. The first severe frost on the mesa land was October 4. The following table gives a summary of the most important meteorological observations of each month from November, 1889, to October 1890, inclusive.

| MONTH. | TEMPERATURE. | | | Precipitation, Inches. |
|---|---|---|---|---|
| | Max. | Minimum. | Mean. | |
| November | 48 | −10 | 14.1 | 1.27 |
| December | 56 | − 9 | 24.6 | 1.23 |
| January | 52 | −16 | 14.8 | .10 |
| February | 65 | − 7 | 26.0 | .65 |
| March | 64 | 5 | 32.0 | .02 |
| April | 68 | 12 | 40.0 | 3.45 |
| May | 81 | 30 | 54.0 | .02 |
| June | 86 | 31 | 59.0 | .21 |
| July | 88 | 42 | 63.8 | 1.27 |
| August | 89 | 38 | 56.3 | .91 |
| September | 80 | 30 | 45.0 | 1.30 |
| October | 70 | 14 | 39.3 | .21 |

Respectfully submitted,

HARVEY H. GRIFFIN,

*Superintendent.*

REPORT QF

# Arkansas Valley Experiment Station.

*To the Executive Committee, State Board of Agriculture:*

GENTLEMEN—I have the honor to submit the following report of Arkansas Valley Experiment Station:

It is the common belief among farmers that each season, with its peculiar meteorological conditions and their relations to soil and circumstances of growth, shows a marked adaptation to certain varieties of crops. The history of the past season goes to prove the correctness of the theory and to show the short-sightedness of single-crop farming. The extremely warm, dry summer, so congenial to sweet potatoes, melons and other garden crops, cut short wheat, oats and alfalfa seed nearly one-half, also reducing the corn crop to some extent. Wheat on clover sod, which before ripening gave promise of at least thirty-five bushels per acre, yielded sixteen bushels from the thresher; all grain was poorly filled and somewhat shrivelled. On farms near by, which would have produced three good crops of hay, alfalfa was saved for seed and gave a half crop of inferior quality. In 1889 wheat in this locality was good, as also were corn and oats. During both years which this Station has been in operation, garden crops have thrived. Fruit trees and vines have made remarkable growth in both seasons. Irish potatoes, under ordinary condition of soil and culture, have failed. These facts, with what weight they may be thought to carry, point to their own conclusions.

FARM EXPERIMENTS.

February 11, nine acres of fall-plowed corn ground was sown to Amethyst wheat at the rate of 75 pounds per acre. This ground was in the best condition, and seed was drilled fully five inches deep. The grain came up scatteringly; was damaged by cold and winds until April 19, when it was thought necessary to irrigate in order to bring up the remainder of the crop. Stand was not good and straw was short. It was irrigated four times and gave 16 8-9 bushels per acre. One acre of winter wheat on pea field killed out, and was replowed March 26 and sowed March 27 to 75 pounds of Amethyst. Wheat came up finely and promised a heavy yield. It was irrigated three times and yielded eighteen bushels. One acre of winter wheat on clover sod was thin on the ground, made good straw and fine looking heads, yield sixteen bushels. Five and one-third acres wheat and oat stubble plowed in the fall, cross plowed in spring, was planted May 7 to Colorado white corn. Ground was marked both ways and seed put in with hand planter; came up well, was hoed to cut out weeds, and then to two stalks in hill; cultivated five times, irrigated three times, making 30 bushels of excellent corn per acre. I am satisfied that corn will thrive better when one irrigation can be made to suffice. Four acres of alfalfa seeded in spring of 1889 was cut four times the past season; average yield about 1½ tons per acre at each cutting.

HALF-ACRE PLATS.

The system of half-acre plats was introduced for the purpose of answering the question so often asked, "What will this or that crop net per acre?" The vicissitudes which have modified results on these plats are the same that might occur in practical farming. As tabulations are seldom read, and yet more seldom understood, I prefer to

condense my notes into a plain statement. In making estimates, all work was reckoned from plowing of ground until crop was housed or marketed, as the case might be. Day's labor for man, $2; for man and team, $4. Cost of seed was also considered. It was endeavored to make these statements as near absolutely correct as possible.

WHEAT—SONORA.

Land was wheat stubble, fall and spring plowed. Seed drilled 6 inches deep, February 25, then smoothed with a heavy leveller. Stand, fair; damaged by wind and cold weather. Irrigated three times, harvested July 16. Yield 16 bushels of excellent grain per acre. Expense, $9.40; value of crop, $12; net, $2.60 per acre.

OATS—ALEXANDER.

Ground same as wheat. Thirty pounds of oats drilled 5 inches deep. Stand fair, straw short; irrigated three times, harvested July 16. Yield, 14 bushels; expense, $7.60; value of crop, $7.34; loss, 26 cents.

PEANUTS.

But for one failing this would be a very profitable crop in this vicinity. The pods grow extra large and fine, but do not fill and mature, as a rule. This failing, it was thought, could be overcome by adding lime to the soil, as is the common practice among growers in Virginia. Lime was applied in small quantities about plants in May. Crop was left in ground until late, in hope that the nuts would mature. They were lifted October 13, vines being turned upside down and left to season. This is the customary practice, as if housed at once they mold. An extraordinary hard frost came on the 14th and the whole crop was soured, making it unfit for market or use. The frost would not have injured the crop had it been fully matured. Expense, $28, value of crop would have been

$180, as there was a yield of 120 bushels, approximate, per acre; net, about $152.

WATERMELONS—ROCKY FORD.

Planted May 1, on one-half of plat; hills were enriched with compost of rotted manure, burned bones and sand. On other half, fine rotted manure was used. They came up well, were hoed three times, cultivated twice and irrigated three times. Crop not quite up to standard in size, but ripened two weeks ahead of regular planting. Those treated with compost ripened earliest, while other vines produced larger melons. The first were ripe July 29. Cost of crop, $36.50; sales, $134.50; net, $96.42 per acre.

MUSKMELONS—NETTED GEM.

Planted May 3, without fertilizing, the seed having been soaked in water for twenty-four hours before planting. Every hill came. They were hoed three times, cultivated twice, and irrigated seven times. First melons August 5, ten days ahead of general crop. Expense, $43.50; sales, 248.70; net, 205.20 per acre.

NAVY BEANS.

Planted by hand in furrows May 10. Stand was not good, and many hills being single stems; they were broken off by wind, making yield much lower than it should have been, giving a wrong impression of the crop in this vicinity, which, under fair conditions, is profitable. Beans were hoed twice, cultivated twice and irrigated three times. Yield, 450 pounds; expense, $17; value, $15.74; loss, $1.26 per acre.

SWEET POTATOES.

Only one thousand plants were obtained for this experiment, so that the plat was limited to one-fifth of an

acre. Set May 26, in rows 3.5 feet apart. Hoed twice, cultivated twice and irrigated three times. Yield, 5,150 pounds; expense, $42.50; sales, $170.95; net, $128.45 per acre.

CORN—COLORADO WHITE.

Planted May 23, in rows 4 feet each way. Owing to an accident, water stood on one end of plat and injured stand. Crop was hoed once, thinned to two stalks, cultivated twice and irrigated three times. Yield, 31 bushels; expense, $11.40; sold, $23.43; net, $12.03.

TOMATOES.

For the purpose of rendering assistance in establishing a canning factory, the Station was ordered to double the produce of a half acre. As a location of the factory was not assured until too late to grow plants, especially for this purpose, the remainder of plants in frames, comprising several different varieties, were set. Some were not desirable for canning, hence were not used. Plants were set June 6, hoed twice, cultivated twice and irrigated five times. Yield, 200 bushels per acre. Dwarf Champion and Livingston's Perfection are the most desirable varieties. Expense, $43.50; market value, $200; net, $156.50.

BUCKWHEAT—SILVERHULL.

Sown in rows 18 inches apart, with garden drill, using 15 pounds of seed, June 23. Hoed once, cultivated once, irrigated four times. Grasshoppers ate up clean six rows on south side. Yield, 14⅔ bushels; expense, $12; value, $22.92; net, $10.80.

SUGAR BEETS—RED TOP.

Sown on raw ground April 18, using 2.75 pounds of seed. They came up too thick, and were thinned to five inches in the row. Water was used only when needed, or absolutely necessary. Crop was hoed twice, cultivated three times and irrigated three times. Yield, six tons.

Three tons of these were sold to a dairyman in La Junta. He reported that in changing cows feed from bran and corn chop to sugar beets, the cows gained in milk the first week, but after that lost in quantity, though the milk was richer. As he ran a milk wagon, this was not what he wanted, so he changed back to chop. Expense, $27.40; value, five tons, $60; net, $34.60.

GARDEN CULTURE EXPERIMENTS.

Four varieties of wheat, five of oats, four of barley and one of rye were tested in garden drills. They were cultivated with hand plow twice, hoed once and irrigated four times. Below are tabulated names, time of planting, time to mature, yield in pounds and yield per acre. Each variety occupied 1-26 of an acre.

WHEAT.

| NAME. | Time Sowed. | Time to Mature. Days. | Yield, lbs. | Yield per Acre. |
|---|---|---|---|---|
| Fountain | March 25 | 125 | 38 | 16 1-2 |
| No. 10 | March 25 | 125 | 48 | 17 1-3 |
| Red River | March 25 | 125 | 39 | 16 5-6 |
| Northcote's Amber | March 25 | 125 | 35 | 15 1-6 |
| **OATS.** | | | | |
| Eureka | April 28 | 83 | 41 | 33 1-3 |
| Colorado Yellow | April 28 | 83 | 35 | 28 1-2 |
| Novelty | April 28 | 83 | 42 | 34 1-8 |
| Pringle's No. 4 | April 28 | 83 | 41 | 33 1-3 |
| Waterloo | April 28 | 83 | 36 | 26 1-8 |
| **BARLEY.** | | | | |
| Melon | April 22 | 84 | 57 | 30 1-8 |
| Phœnix | April 22 | 84 | 40 | 21 1-2 |
| Black | April 22 | 84 | 53 | 31 5-12 |
| Smooth Hulless | April 22 | 84 | 56 | 30 1-3 |
| **RYE.** | | | | |
| Mammoth | April 22 | 85 | 44 | 18 3-4 |

SUGAR BEETS.

The seed of six varieties were received from the College and of five others from Pueblo Board of Trade for trial. They were planted in drills by hand and covered with a hoe, being thinned to 5 inches in the row when large enough. Rows of the first six varieties were 120 feet in length, of latter 250 feet in length. Specimens of the first six varieties were sent to the College for analysis, and of the last six to A. R. Pierce, of Pueblo, by whom they were distributed to different institutions for analysis. The following table gives the name and estimated yield per acre:

| Name. | Tons per Acre |
|---|---|
| Red Top Sugar | 13 1-2 |
| Dippe's Vilmorin | 12 1-6 |
| Florimond Desprez | 10 5-10 |
| Simon Le Grande's White Improved | 8 1-3 |
| Bulteau Desprez | 12 1-6 |
| Dippe's Kleinwanzleben | 15 1-8 |
| French Early Rose | 9 5-10 |
| German White | 13 1-3 |
| Verbesita Rosa | 7 5-10 |
| Late French Rose | 17 1-10 |

IRISH POTATOES.

A plat was heavily fertilized with straw, ashes and rotten manure, being thoroughly pulverized by deep plowing and harrowing. March 15, two varieties, Chicago Market and California White, were planted in furrows, being covered six inches deep. Chicago Market seemed to make no first growth after July 5. When dug, they seemed small in size and badly sprouted. California White did not take second growth, and made fair-sized, smooth, potatoes. A peck of selected specimens were said by many to be as fine as any on exhibition at the State fair. They seemed to make no growth after July 12, probably due to extremely warm weather. Seed

of the Late Ohio was obtained from Monument, through the kindness of Mr. H. C. Herrick. These were planted March 27; took second growth; also, six varieties planted April 14 made very few marketable potatoes, though all varieties did better than the season previous. About one bushel of the best potatoes of each variety was saved for seed. A variety of Salt Lake potatoes, procured in market, were planted June 20, in heavily fertilized soil. In one row slacked lime was added to each hill; in another wood ashes, and in a third, both lime and ashes were applied, in each case a large handful to the hill. As sprouts had been rubbed off the potatoes twice before they were planted, many hills failed to grow, the first row having much the best stand, so it was impossible to give a fair comparison of the different treatments. The potatoes grew slowly until about September 1, when, as cooler weather came, they grew with much vigor. There was one unsuccessful feature about this experiment. The potatoes did not get quite ripe. They were dug the last week in October, and yielded at the rate of 160 bushels to the acre. Potatoes were of good marketable size, and fine quality. They should have been planted ten days earlier. There are several important points in the matter of growing potatoes in this section, the most important of which are thorough fertilization, late planting and judicious irrigation. If one irrigation can be made to answer, so much the better. The rows should run north and south, and it is believed that the potatoes will thrive better in plats of a half acre or more, than in small patches.

### FIELD CORN.

Four varieties of field corn, brought from the neighborhood of St. Louis, Mo., were planted to test their adaptability to this climate. Though planted late, some

of the corn ripened, and no doubt another season, with early planting, will produce good results. A small plat of Pride of the North corn was planted for seed. Being planted near an alfalfa field, the grasshoppers trimmed it so close as to spoil the crop.

PUMPKINS.

Connecticut and Sugar pumpkins were planted May 13, and produced exceedingly well.

SQUASHES.

Hubbard variety, planted May 13, grew thriftily, but none came to maturity on account of the depradations of the squash bug, which came in such overwhelming numbers that they could not be overcome by any known method of treatment. It would seem that the only way to combat this insect is to have ground prepared so it can be flooded, and wash the bugs away. No other remedy is adequate where numbers are so great.

BEANS.

Twenty-eight varieties of beans were planted May 13. Southern Prolific and Large Refugee were the most prolific varieties, the latter being prepared for canning purposes. Henderson's Earliest Red Valentine, Black Wax and Date Wax are the standard varieties, and the White Kidney and Navy for shell beans, though the common Mexican is the most prolific for general cultivation.

SWEET CORN.

Eight varieties of sweet corn were grown, with the result that much finer corn was produced on fertilized land, and also that less damage was done by worms this season than last. Henderson's Early Sugar and Stowell's Evergreen were the best and most prolific varieties.

SORGHUM.

Small plats of two varieties of sorghum were cultivated, and both made good stalks and ripened seed.

MILO-MAIZE.

A small plat was grown for seed. It thrives with but little attention. One irrigation is sufficient to grow this fodder plant in a dry season.

PEAS.

Twenty varieties planted March 25. All thrived much better than last year, showing advantage of fertilized soil. First and Best, Improved, D. O'Rourke were earliest. Champion of England, Blue Imperial, Fill Basket and Bliss' Abundance are excellent later varieties.

TOMATOES.

Eighteen varieties were tested for earliness, productiveness and general desirability. Island Beauty was earliest, but too small for market. Dwarf Champion for early market and Livingstone's Perfection for general crop cannot be excelled.

CUCUMBERS.

Boston Pickling planted May 9; they were large enough for use July 9. With rich soil and good culture this variety is very prolific and desirable.

MUSKMELONS.

Six varieties grown. New Early Hackensack is an early market melon and a good shipper, though its quality is not the best. Skillman's Netted is a late melon of excellent quality. The melon which comes nearest meeting all requirements is the Netted Gem. It is early, a good shipper and of the best quality.

### WATERMELONS.

Three varieties planted. The Rocky Ford was the finest in quality, but rather tender for shipping. Delaware was next in quality and much better for shipping. A cross between these varieties will be propagated in hope of combining the good qualities of both.

### CABBAGE.

A few plants of Mammoth Marblehead were set out May 22. They began heading about September 10; and by October 10 had attained good size and were solid.

### CAULIFLOWER.

Small number of Vick's Ideal set May 22; began heading about September 10; made best growth in October; very large, fine-grained and solid.

### EGG PLANT.

Set in open ground June 18; produced very large and particularly fine-colored fruit. Variety, New York Purple.

### CELERY.

This was found to make its best growth in September and October; requires soil superlatively enriched and the best success this year was had in planting seed in open ground. The most desirable varieties were White Plume, Golden Self-Branching and Dwarf Golden Heart.

## HORTICULTURE.

### ORCHARDS.

One hundred and fifteen apple trees of eleven varieties were purchased from the nursery of Mr. J. H. Crowley last spring and set in orchard on Station grounds. Holes for these trees were dug in February. They were 2 feet in diameter and 2 feet deep. Before trees were set, the surface dirt from the holes was thoroughly mixed with fine, well-rotted manure, three or four shovelfuls to the tree. When trees were set, dirt was shoveled carefully into the holes in form of a pyramid, upon the apex of which the center of the tree was set as nearly as possible, then dirt filled in and packed firmly about the roots. The trees were cultivated frequently, kept clear of weeds and watered once in two weeks until September 1, after which time no water was given until October 28. Every tree made a strong, stocky growth. Trees set the previous spring have also made excellent growth. Number of trees in orchard, 195.

### NURSERY.

Of the nursery stock set in spring of 1889, there are at present 6,131 two-year-old trees of large, stocky growth. The following table will give name, number set, number of marketable trees and height of each variety:

PEARS.

| NAME. | No. Set. | Marketable Trees. | Height. |
|---|---|---|---|
| Seckel | 100 | 45 | 4 to 5 feet |
| Bartlett | 100 | 31 | 5 to 6 feet |
| Flemish Beauty | 100 | 37 | 4 to 5 feet |

APPLES.

| NAME. | No. Set. | Marketable Trees. | Height. |
|---|---|---|---|
| Fall Wine Sap | 300 | 230 | 6 to 7 feet |
| Flora Belle | 400 | 310 | 5 to 6 feet |
| Wagoner | 360 | 217 | 5 to 6 feet |
| Red Bergheimer | 300 | 196 | 5 to 6 feet |
| Alexander | 300 | 204 | 6 to 7 feet |
| Isham Sweet | 300 | 238 | 5 to 6 feet |
| Sweet June | 300 | 222 | 5 to 6 feet |
| Smith Cider | 100 | 46 | 6 to 7 feet |
| Sutton Beauty | 200 | 130 | 5 to 6 feet |
| Baldwin | 100 | 72 | 6 to 7 feet |
| Mann | 300 | 254 | 6 to 7 feet |
| Utter's Large Red | 300 | 196 | 6 to 7 feet |
| G. G. Pippin | 400 | 296 | 5 to 6 feet |
| Talman Sweet | 300 | 205 | 5 to 6 feet |
| Twenty-ounce Pippin | 300 | 245 | 4 to 5 feet |
| Yellow Bellflower | 300 | 212 | 5 to 6 feet |
| Early Harvest | 300 | 200 | 4 to 5 feet |
| Fall Stripe | 300 | 240 | 4 to 5 feet |
| Sops of Wine | 300 | 217 | 5 to 6 feet |
| Northern Spy | 300 | 200 | 5 to 6 feet |
| Missouri Pippin | 300 | 233 | 5 to 6 feet |
| Lawver | 300 | 260 | 5 to 6 feet |
| Hays | 400 | 216 | 5 to 6 feet |
| Red Astrachan | 300 | 231 | 5 to 6 feet |
| Tetofsky | 300 | 225 | 4 to 5 feet |
| Wealthy | 300 | 225 | 5 to 6 feet |
| King of Tompkins County | 300 | 210 | 6 to 7 feet |
| Duchess of Orleans | 400 | 276 | 4 to 5 feet |
| Walbridge | 400 | 215 | 5 to 6 feet |

THREE-YEAR-OLD APPLES.

| | | | |
|---|---|---|---|
| McIntosh White | | 48 | 5 to 6 feet |
| Mann | | 18 | 5 to 6 feet |

THREE-YEAR-OLD PEARS.

| NAME. | No. Set. | Marketable Trees. | Height. |
|---|---|---|---|
| Duchess | | 14 | 6 to 7 feet |
| Keiffer | | 8 | 4 to 5 feet |
| B. D'Angou | | 6 | 4 to 5 feet |
| Clapp's Favorite | | 8 | 4 to 5 feet |

Nursery stock set April 1, 1890:

| Name. | No. set. | No. growing. |
|---|---|---|
| Black Arkansas | 250 | 122 |
| McMahon's White | 250 | 136 |
| Peter | 250 | 104 |
| Fink | 250 | 94 |
| Yellow Transparent | 250 | 125 |
| Wolf River | 250 | 129 |
| Delaware Red Winter | 215 | 118 |
| Florence Crab | 250 | 132 |
| Alexander Peach Trees | 50 | 22 |

There are growing on the grounds, 440 forest trees, of nine varieties, which are making a thrifty growth each season. Five hundred Cottonwoods, set for shade and hedges, are growing well.

VINEYARD.

All grape vines have made excellent growth this season. Some of the stronger vines of last year's setting bore a few grapes of excellent quality. Most of the bunches were picked off in the early part of the season. Vines were trimmed and laid down this fall, though not covered yet.

STRAWBERRIES.

The plants set in 1887, supposed to be Manchester, were found to be mixed, upon fruiting. Berries were small, but of good flavor. Sediment in water is a draw back to raising nice berries. Three varieties, Jessie,

Bubach No. 5 and Wilson were set last spring. The first was a very strong grower. Wilson also grew well, while Bubach No. 5 was tender, and several plants died. Gregg B. C. and Golden Queen raspberries grew well, and fifty Wilson blackberries were set this fall.

## MISCELLANEOUS.

### IMPROVEMENTS.

A front porch has been added to dwelling. An addition to the barn, 14x40 feet, has been built, to furnish stable room, while the former stable has been furnished with threshing floor, and fitted for storing seeds and grain. Barns and outbuildings have been newly painted.

### FALL PLOWING.

Four acres of alfalfa sod were turned under in November for spring wheat ground. Eleven acres of wheat stubble were also plowed in November.

### WINTER WHEAT.

A small plat of 1-26 of an acre with perfectly, heavily enriched soil, was sowed to Ruby, September 17.

### NEEDED IMPROVEMENTS.

It has been found impossible to do good work in the way of lawns and floriculture while using muddy water and the common system of irrigation. Work in this department would be much better facilitated if some means were provided for spraying clear water on lawns and flowers. This could be accomplished by means of an elevated tank, into which water might be pumped from ditch or reservoirs, either by aid of wind-mill or water motor, or by whatever power is thought best. The

water, after being allowed to settle, could be drawn by hose from above the line of sediment. This improvement would be of great value to the Station.

SUGGESTIONS.

Owing to successive failures in the attempt to produce Irish potatoes, the project is regarded with strong distrust. As this is a matter involving an expense of many thousands of dollars in this vicinity annually, I recommend that the Station cultivate an acre plat of potatoes next season, for the purpose, if possible, of assuring the farmers of this community, beyond all doubt, that potatoes may be grown successfully, in quantities at least, sufficient for home consumption.

The features which, above all others, seemed to attract attention and interest those who visited the Station this season, was the system of half-acre plats. Every intelligent farmer is interested in the history of these plats, and I recommend that they be continued next season. By adding new or untested crops to the list, these experiments will give practical results, which may be of great benefit to farmers in this community.

## SUPPLEMENTARY REPORT OF RENTED LANDS.

Owing, in some measure, to illness of lessee, Mr. Clark, and his subsequent blindness, with other family afflictions, the work on the 126 acres of rented land has been done without system or intelligent forethought. I have given assistance by furnishing implements at times; by work when asked. The predominating principle seemed to be, to do just as little real work as could possibly be made to answer. The crops, as a rule, were roughly planted, and I believe that at least two-thirds of the grain was not irrigated at all, while portions that were easily watered were deluged. From 60 acres sown to wheat,

there was threshed 492 bushels, and from 11½ acres of oats, 184 bushels. Twenty-eight acres of corn will average about 16 bushels per acre. Some of this corn was cultivated once, some watered once, and some not at all. There should be no trouble in raising 25 to 30 bushels of corn per acre. The grain ground is left foul with weeds, and in very rough condition. Twelve and one-half acres sown to alfalfa last spring made a fairly good stand, though there are many spots which will need re-sowing. The land occupied by small grain should be irrigated this winter, as it is likely that water can be had, and plowed as soon thereafter as the land comes in proper condition. This land, 7 acres, should be planted in corn next season, in order to kill out the weeds and pulverize the soil. I believe it to have been fully illustrated, also, that corn is a better paying crop, one year with another, than wheat, in this locality. Twenty-five acres of corn ground would be in fair condition for wheat or oats after having been irrigated, and the 30 odd acres of remaining, sandy land, would yield a larger profit in sweet potatoes, melons and Mexican beans, than any other crop. Sixteen acres of melons, properly handled, should yield more than the whole farm has the past season. All the land should be irrigated this winter, so that by freezing and thawing, the land which has been too wet, and become baked, may become loosened and aerated, and the other portions rendered moist enough to plow and to start a crop in the spring without irrigating to bring it up, which practice, from my experience, should always be avoided if possible. I recommend that whatever action the Board may see fit to take in relation to this land, it may be decided and made known at once, in order that steps may be taken in time to get the land in proper condition for use. If the matter is delayed until spring, there will be no prospect for better results than have been obtained the last season.

Respectfully submitted,

FRANK L. WATROUS,

*Superintendent.*

REPORT OF

# Special Examining Committee.

*To the Executive Committee, State Board of Agriculture:*

GENTLEMEN—The undersigned was appointed by the Master of the Colorado State Grange to examine the work and plans of the Experiment Station at Fort Collins, and to report upon the same. With this object in view, the Station was visited on the 5th day of December, 1890, and that day and the half of the day following spent in studying its work and plans. The books of the Secretary and Treasurer were examined with considerable care, and your Committee is satisfied that the work is done with the strictest fidelity. Business methods rule. Nothing is done without proper authority. Every dollar of the Station fund is carefully accounted for. The correspondence of the Director was examined, and it was noted, with a good deal of satisfaction, that a large number of competent and disinterested persons wrote in the highest terms of praise of the work done in Colorado. Whether they teach it or not, it is evident that the Station workers believe in the gospel of work, and it is but right that their diligence and zeal should be commended. The Station suffered a severe loss by the resignation of Prof. A. E. Blount. The work of the Agricultural Section, however, has been carried on without noticeable interruption, Director Ingersoll and Assistant Agriculturist McDowell taking upon themselves the duties of the Section. It is hoped that you will use good judgment in selecting, at an early day, an Agriculturist who shall

combine a practical knowledge of farming and stock breeding with a thorough scientific training, and who shall also be a man of sound judgment and a zealous advocate of agriculture and agricultural education in the practical line. Such a man, heartily supported by the Board and the farmers of the State, will be able to do much for the agriculture of Colorado.

During the year, Prof. C. S. Crandall has been placed at the head of the Section of Botany and Horticulture. His ability and industry have rapidly made him familiar with the needs and resources of the State in his special line, and the work he has formulated for additional work prove that the Board did wisely in electing him to his present position. It is recommended that a liberal appropriation be made to enable Prof. Crandall to successfully carry out his plans.

The work of the Chemical Section is peculiarly important, though it may seem to be little direct benefit to the farmer. Of the four bulletins published during the year, three would be comparatively valueless without the results of Dr. O'Brine's work. His analyses of grasses and sugar beets are particularly worthy of mention. The work in progress, to discover the cause and cure of the so-called loco disease, is important. Already enough has been done to satisfy your Committee that Dr. O'Brine is on the right track. The Board is urged to withhold no help that may lead to a satisfactory solution of the loco problem.

In Colorado it is difficult, if not impossible, to find a subject in which the farmers are more deeply interested than the subject of irrigation. This subject is being zealously and systematically studied by the Section of Meteorology and Irrigation Engineering. Special attention was given to this Section by your Committee, in view of the immediate and pressing need of the State for

definite and reliable information. It was found that Prof. L. G. Carpenter had worked with great diligence to inform himself on all matters relating in general, and irrigation in Colorado in particular. The bulletin recently issued on "The Measurement and Division of Water," indicates, in some degree, the wide range of his work. But this work cannot be properly carried on without books and instruments, which can be obtained only through the liberality of the Board. It is therefore particularly urged that the Irrigation Engineer be given ample means and the greatest possible freedom to enlarge the scope of his work, that it may be made of immediate and practical value to the State.

With unusual opportunity to know what other Stations are doing, your Committee is satisfied that no Station in the United States has published an equal number of bulletins that exceed in value the four issued during the present year by the Colorado Station. But the work already done is, as it should be only an earnest of what is yet to be done, and it is hoped that you will give the Station workers ample support in all good work proposed, holding them strictly to the idea that the work must be done with a view to its practical application.

A word in regard to the College: It is the observation of your Committee that nearly all educational institutions, Agricultural Colleges not excepted, educate their students away from farm work. This is not as it should be. It should be your study to make the Colorado Agricultural College an institution whose graduates shall not be afraid of contact with the soil, but who will grapple with the questions that vex the farmer, and never give up the struggle until the proper answer is found. In this line is suggested that a short course in agriculture be established. It might be modeled, to some extent, after the short

courses which the business colleges give, and which are so popular with students who lack time, means or desire to take a full college course. Practical farmers, stock-breeders and fruit-growers might be invited to deliver lectures upon subjects with which they are most familiar. Let an interest be taken in farmers' institutes; keep the College near its patrons. If these suggestions seem unwise, let something else be done to give an opportunity to those who cannot, or will not, take a full course in the Agricultural College. Abolish the matriculation and graduation fees, which amount to so little for the College and yet bear most heavily upon the students least able to pay them.

Your Committee is under obligations to President Ingersoll, Secretary Annis and other officers of the College and Station, for substantial favors.

Respectfully submitted,

D. W. WORKING,

*Committee State Grange.*

DENVER, Colo., December 10, 1890.

# The Agricultural Experiment Station Department.

Treasurer's financial statement for the fiscal year ending June 30, 1890:

RECEIPTS.

| | |
|---|---|
| From U. S. Treasurer, per appropriation of Congress | $15,000 00 |

DISBURSEMENTS.

| | | |
|---|---|---|
| For salaries, Station Staff, Officers and Assistants | | $ 9,243 15 |
| For stationery and supplies | | 47 50 |
| For Agricultural Section, labor and supplies | | 137 42 |
| For Horticultural Section, labor and supplies | | 267 04 |
| For Chemical Section, chemicals and apparatus | | 195 47 |
| For Printing Bulletins | | 967 40 |
| For Meteorology and Irrigation Engineering | | 200 82 |
| For expenses and per diem, Executive Committee | | 189 15 |
| For San Luis Valley Experiment Station | | 882 79 |
| For membership Association Agricultural Colleges and Experiment Stations | | 25 00 |
| For Arkansas Valley Experiment Station | | 1,012 57 |
| For building, Arkansas Valley Station | | 363 88 |
| For Veterinary Section, labor and apparatus | | 108 29 |
| For printing Annual Reports | | 1,359 52 |
| | $15,000 00 | $15,000 00 |

I, Frank J. Annis, Treasurer of the Agricultural Experiment Station Fund, do hereby certify that the above is a correct statement of the receipts and disbursements on account of said fund for the fiscal year ending June 30, 1890.

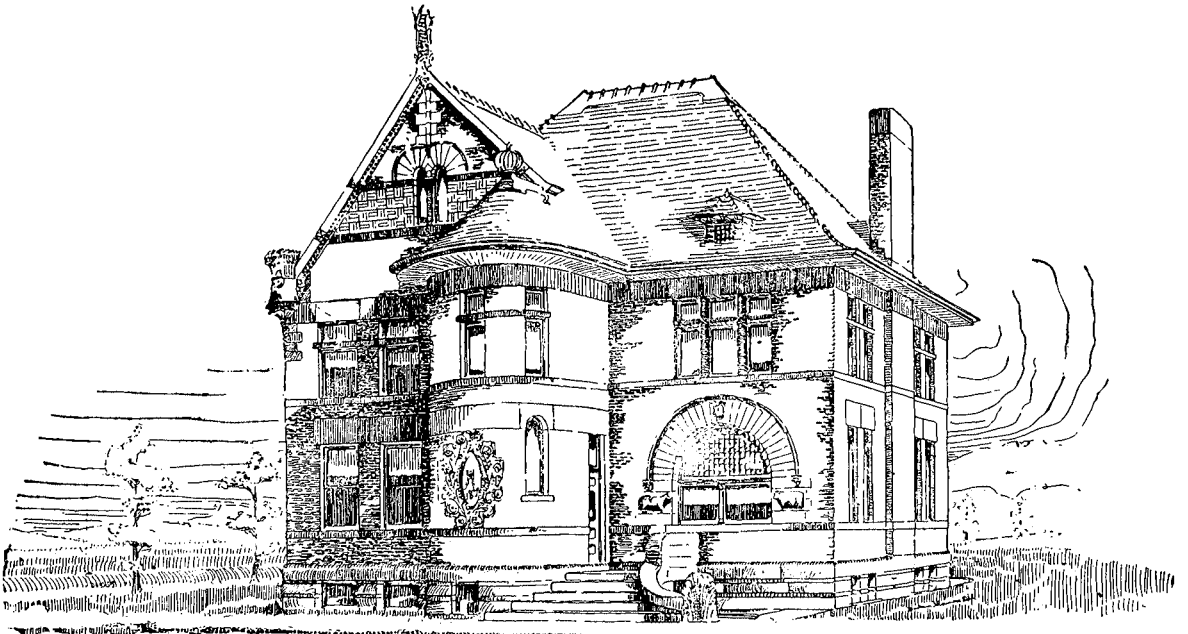
FRANK J. ANNIS.
*Treasurer.*

The undersigned, members of the Finance Committee of the State Board of Agriculture, do hereby certify that we have examined the books and vouchers kept and on file in the Treasurer's office of the Agricultural Experiment Station, and we find that the foregoing report is a correct and true statement of the receipts and disbursements for and on account of said Station for the fiscal year ending June 30, 1890, and as shown by said Treasurer's books; that the Treasurer holds, properly audited and receipted, vouchers for all of said disbursements. We further certify that the whole amount received by the said Treasurer, for the use of said Station, was expended during said fiscal year.

CHAS. H. SMALL,
W. F. WATROUS,
*Finance Committee.*

FORT COLLINS, Colo., December 11, 1890.

# INDEX.



Agricultural Hall, State Agricultural College.