

THE COLORADO EXPERIMENT STATION

FORT COLLINS

A PROGRESS REPORT ON ONION INVESTIGATIONS IN THE ARKANSAS VALLEY

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Commercial onion production in Colorado has become of major importance to the vegetable industry of the state, and during the past 10 years has increased from a small acreage to its present size of approximately 7,000 acres. The most rapid expansion has been in the Arkansas Valley, where the Sweet Spanish, or Valencia variety, was first grown on a commercial scale.

This type of onion was first suggested by Dr. E. P. Sandsten, state horticulturist, who recommended that the variety be tried by the growers. Onions were not grown to any extent in the valley previous to 1927, and, naturally, with the rapid expansion in acreage, production problems quickly confronted the growers. Losses were sustained which might partly have been avoided if the production and storage methods had been better understood.

The Western Slope district, previous to 1929, held the lead in total production. However, in that year, the Arkansas Valley shipped out 2,508 carloads, as compared to 1,328 carloads from the Western Slope. The production in the Arkansas Valley has increased from 183 carloads in 1927 to the above figure in 1929. The Northern Colorado district shows less increase than the other two districts and has not developed to the same extent.

For the information of interested growers, the following production and price tables have been included from information furnished by the U. S. Bureau of Agricultural Economics. These tables show that the average yield per acre is the low figure of 303 bushels, that the average price per bushel over the 8-year period is 80 cents, and that the value per acre is close to \$240.43.

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ACREAGE, PRODUCTION AND SHIPMENTS OF COLORADO ONIONS

Year	Acreage	Yield per	Production bu.	Total carlot shipments	Shipments by Districts		
		acre bu.			W. Slope	Arkansas Val.	N. Colo.
1929-30	7,000	369	2,586,000	4,019	1,328	2,508	183
1928-29	3,700	310	1,147,000	2,244	1,231	743	270
1927-28	4,300	320	1,376,000	1,460	1,172	183	105
1926-27	3,700	275	1,018,000	1,758	1,411	91	256
1925-26	3,520	325	1,144,000	1,809	1,743	15	51
1924-25	3,410	270	921,000	1,064	944	10	110
1923-24	2,620	250	655,000	928	839	8	81
1922-23	1,900	280	532,000	651	570	13	68
1921-22	1,300	300	390,000	447	391	0	56
1920-21	760	340	258,000	150	128	0	22

Average yield per acre, 303 bushels (1920-1928).

AVERAGE PRICE PER BUSHEL, VALUE PER ACRE

Year	Price per bu.	Total value	Value per acre
	\$		
1920	.72	186,000	244.73
1921	.53	597,000	460.00
1922	.52	277,000	145.00
1923	1.08	707,000	269.00
1924	.58	534,000	156.00
1925	.78	892,000	253.41
1926	.50	509,000	135.57
1927	.45	619,000	144.00
1928	1.42	1,629,000	440.00
1929	.42	1,097,000	156.57

Average price per bushel, \$0.80 (1920-29).

Average value per acre, \$240.43.

The rapid development of the onion industry, particularly in the Arkansas Valley, has brought out a number of problems which have caused losses to the growers. For this reason and in response to a request by the growers of the district, the Horticultural Department of the Colorado Agricultural College, temporarily established a horticultural substation at Rocky Ford to assist the onion growers with their production and storage problems. This work was started in the spring of 1929 and has continued thru the present year (1930).

The information furnished in this bulletin is being published as a preliminary progress report, so that the onion growers and others interested in the industry may know the results of the experiments as they become available. It must be remembered, however, in going over the work that it represents preliminary and not conclusive observations. In order to obtain definite and conclusive results, it is necessary that experiments be repeated many times, to reduce variations due to soil and climatic

differences. This requires a period of from 3 to 5 years, during which time the experiments under field conditions are repeated each growing season.

The object of the different experimental projects at Rocky Ford has been to determine the correctness of the opinions of the onion growers that the Valencia variety of onions is best adapted to that district, to run strain tests in order to determine better sources of seed, to work out best cultural methods, and to develop better methods of curing and storing.

Variety Trials

In these trials, nine of the leading commercial varieties of the country were included. The varieties were planted in four-row plots with rows 20 inches apart, and they were run in duplicate each year. Notes on germination, resistance to thrips and date of maturity were taken. At harvest time, the plots were carefully pulled and topped and the onions weighed and graded according to size. A two-crate lot of each variety was placed in storage and compared as to keeping qualities.

The results of the variety trials will be found in the following tables. Due to uneven stands, it was necessary to make corrections for yield from the stand counts. Both actual and corrected yields are given and the varieties are ranked in order as based on corrected yields.

The results of the variety trials confirm the observations previously made by growers in the district who have found the Valencia variety best adapted to their growing conditions. The data in the above tables show the greater adaptability of the Valencia variety. It has shown much larger yields and better grades of larger onions. The percentage of doubles compares favorably with those of the other varieties. Losses in storage were comparatively low.

Perhaps the greatest determining factor in the larger yields from the Valencia onion is its resistance to thrip attack. Onions from the lower-yielding varieties developed small tops and matured from 2 to 3 weeks earlier than the Valencia as a result of thrip injury. The list of varieties ranked according to corrected yields also gives a comparative rating in degree of resistance to thrip injury.

As would be expected from these observations, the varieties more closely related to the Valencia, such as the Ailsa Craig, Denia, and Gibraltar show more resistance and give yields proportionately comparable to their degree of resistance.

RESULTS OF VARIETY TRIAL, 1929-30

Variety	Corrected yield per acre (Pounds)	Percentages different grades*				Doubles	Percent- age Stand	Actual yield per acre (Pounds)
		0 to 1 in.	1 to 2 in.	2 to 3 in.	3 in. and up			
Valencia	42,859	.....	2.51	49.27	43.08	5.10	53.16	21,624
Ailsa Craig	31,210	.....	10.66	53.75	12.57	24.08	42.29	11,568
Denia	26,638	.....	14.9	65.48	7.94	11.24	38.01	10,648
Gibraltar	23,655	.....	17.28	60.70	14.85	7.62	58.95	13,125
Prizetaker	19,903	.....	.....	.....	.....	.....	10.65	2,134
Yellow Globe								
Danvers	15,845	28.98	47.38	18.37	.....	5.26	56.89	8,189
Ohio Yellow Globe.....	15,281	13.06	32.83	51.15	.....	2.92	57.72	7,618
Mountain Danvers.....	14,219	24.78	31.47	40.76	.....	2.84	53.0	5,866
Australian Brown.....	13,096	23.8	35.83	40.3	.....	.....	50.99	6,602

*Percentages of different grades based on 1 year's results (1930).

VARIETIES IN STORAGE*

Variety	Loss in Storage (Rots and sprouts)
	Percentage
Australian Brown	1.65
Mountain Danvers	2.91
Ohio Yellow Globe	2.92
Valencia or Sweet Spanish	3.58
Gibraltar	4.48
Yellow Globe Danvers	4.88
Denia	6.39
Yellow Globe	7.01
Ailsa Craig	7.89
Prizetaker	20.13

*One year's results.

Valencia Strain Tests

The strain tests were run in four-row plots and planted in duplicate, the rows being 20 inches apart. Seed for these trials was obtained from three sources, California, Colorado and Spain. Notes on germination and maturity were taken during the growing season. At harvest time the strains were pulled and topped, the onions weighed and separated into grades according to size.

A five-crate lot of each strain was placed and held in storage for comparison of keeping qualities. The results of the tests are tabulated below. The corrected yields were determined from stand counts.

The tests give a comparison of home or Colorado-grown seed, California seed, and seed imported from Spain. The results of 2 years' work show that Colorado-grown seed is superior in regard to yield and grade of onions produced, but show a greater loss in storage, possibly due to immaturity of the bulbs. Observations of seed stock during the summer of 1930 showed that bulbs from California seed came into bloom a week or 10 days

RESULTS OF VALENCIA STRAIN TESTS
1929-30

Strain	Corrected yield per acre, lbs.	Percentages Different Grades*				Percent- age Stand (Pounds)	Actual yield per acre (Pounds)
		3 in. and up	2 to 3 in.	1 to 2 in.	Doubles		
Colorado No. 1.....	53,141	44.93	46.58	4.71	5.18	53.2	22,444
Colorado No. 2.....	50,548	45.49	41.6	2.81	9.98	47.23	23,113
California No. 1.....	46,508	38.31	35.76	8.29	17.64	39.51	19,155
California No. 2.....	43,875	36.67	49.56	7.67	6.18	52.62	22,733
California No. 3.....	40,822	34.38	43.82	10.07	13.96	46.91	18,935
California No. 4.....	36,934	29.85	46.71	5.86	21.09	42.65	15,821
Spanish Seed**	45,848	43.51	36.47	3.64	15.8	48.15	21,943

*Percentage of different grades based on 1 year's results (1930).
**Grown 1 year (1930).

STORAGE TRIALS OF ONIONS (1929)

Strain	Loss in Storage (Rots and Sprouted Bulbs) Percentage
California No. 2.....	3.48
California No. 3.....	3.64
California No. 1.....	3.69
Colorado No. 1.....	7.56
Colorado No. 2.....	9.37
California No. 4.....	12.14

ahead of the local stock, which may possibly be due to difference in stage of maturity. If the seed growers of the Arkansas Valley would improve their strains in regard to maturity, the present indicated high margin of superiority over California seed would be increased still further.

It is unfortunate that the imported Spanish seed was not available for the first year's trials, but the results from 1 year's trial seem to show that this seed may be compared favorably with the better California strains. No information is now available concerning the keeping quality of the Spanish onion in storage.

Cultural Methods

Due to the fact that the land upon which these experiments were conducted has been rented and the location changed each year, and due to the short time of operation, efforts to work out cultural methods have been limited.

Comparison of Transplanting with Field Sowing.—A comparison has been made of field-sown and transplanted onions. In this project, careful records have been kept of the total costs of each cultural operation concerned with the different methods of growing. Yield records were also kept. In 1929, an acre of each type of onions was grown and in 1930 a half-acre of each was grown. Results are submitted in the accompanying tables.

**COMPARISON OF COSTS AND YIELDS IN GROWING TRANSPLANTED AND
FIELD-SOWN ONIONS (ACRE BASIS) 1929-1930**

Transplants—1929										
Setting out plants	Irrigating	Cultivating	Hoeing	Pulling	Topping	Preparation of land	Rent of land	Cost of growing plants	Total cost	Yield lbs.
66.75	18.75	13.92	6.15	4.95	12.78	4.16	50.00	27.40	205.40	22,425
Transplants—1930										
45.60	19.50	3.10	17.20	6.90	11.88	3.50	50.00	22.80	180.48	18,749
Average										
56.17	19.12	8.51	11.67	5.92	12.30	3.83	50.00	25.10	192.94	20,587
FIELD-SOWN ONIONS—1929-30										
1929										
Planting	Irrigating	Cultivating	Hoeing	Pulling	Topping	Preparation of land	Rent of land	Total cost	Yield lbs.	
.70	15.55	13.24	7.35	5.15	12.78	4.16	50.00	108.93	22,425	
1930										
.70	18.90	3.10	45.60	7.50	12.78	3.50	50.00	138.08	20,235	
Average										
.70	17.22	8.17	26.47	6.32	12.78	3.83	50.00	123.50	21,330	

The cost of growing onions will vary from year to year as shown here. Variations may result from a number of causes. For example, onions planted on clean land will be more easily kept free of weeds than if planted on foul land. Also, a period of warm, rainy weather immediately after planting will bring on a host of weeds before the onions can get above the ground. This will necessitate careful and expensive hand weeding. These two factors explain the difference of \$38.25 in hoeing costs of the field-sown onions for the 2 years. With the transplanted onions, the difference in hoeing costs was not so great, as the plants were not set out until later in the season and weed seeds had time to sprout and be destroyed.

The preliminary evidence indicates that there is very little to recommend the growing of transplanted onions in the Rocky Ford district. In northern parts of the state, where the growing season is shorter, this method may be employed in order to produce mature bulbs. But in the Arkansas Valley, onions sown in the field may be easily grown to maturity. The decreased cost of hoeing transplanted onions is more than offset by the cost of growing and setting out the plants. Regular spacing of the transplanted onions may result in more uniform bulbs, but the difference is not great and larger yields of field-sown onions compensate for this.

The time and labor involved in growing and setting out onion plants preclude the possibility of using this method on a large scale. The total cost of growing transplanted onions is quite considerably greater than the cost of growing field-sown onions.

Under certain conditions growers might raise an acre or 2 of transplanted onions and be well rewarded for the extra labor. Seed planted in hot beds or greenhouses during the latter part of January or the first of February and grown to a good size, approximately that of a lead pencil, and set out during the early part of April, should mature in early or mid-August. Prices on the late summer market may range from 1 to 2 cents per lb. higher than on the early fall market.

Fertilizer Trials.—Fertilizer trials were run for the first time during the 1930 season. Results are too limited to warrant recommendations, but indications are that commercial fertilizers will prove of value in supplementing the use of manures.

Field Curing and Storage Projects

A number of experiments were carried on in regard to field curing and storage practices during the 1929-1930 storage season. The same projects are being repeated during the present season, but only the results for the 1 year's work are now available.

Onions in the Rocky Ford district are pulled, topped and placed in crates, and then cured in the field for a number of days before being placed in storage. The length of time for field curing varies considerably with different growers and with weather conditions. In an effort to determine the most desirable length of time required to properly cure onions, the following experiment was started:

Twenty-one five-crate lots of onions of the same variety and strain were weighed as soon as they were topped. One lot was moved into storage each day for a period of 21 days, giving curing periods of from 1 to 21 days. Weather during the curing was nearly perfect. There was 1 cloudy day and 1 day in which a fine mist fell for a few hours. The other days were uniformly bright and clear. The onions were kept until February 14 and the losses in storage were then determined. These data are tabulated below.

FIELD CURING RESULTS

Days Cured in field	Loss in moisture Percentage	Loss in Rots Percentage	Loss in Sprouts Percentage	Total loss Percentage
1	6.82	9.91	6.60	23.34
2	5.3	6.41	4.42	16.13
3	5.33	2.22	2.44	9.99
4	4.91	2.89	3.39	11.19
5	4.72	4.93	5.63	15.28
6	5.01	5.64	6.72	17.37
7	4.67	2.54	5.52	12.73
8	4.35	4.35	5.01	13.71
9	5.02	5.02	4.36	14.40
10	4.81	5.5	1.94	12.25
11	3.24	6.06	3.47	12.77
12	4.69	6.71	1.56	12.96
13	5.61	4.75	4.53	14.90
14	3.89	4.32	4.53	12.74
15	6.18	4.63	3.35	14.16
16	5.51	7.5	4.63	17.64
17	4.25	2.8	4.51	11.56
18	5.26	5.04	3.5	13.81
19	4.62	2.86	4.18	11.67
20	5.59	4.8	4.47	14.87
21	4.94	7.19	4.04	16.17

The results obtained are not exceedingly definite, but it would appear that a curing period of from 7 to 12 days would be advisable during favorable curing weather.

Curing In An Open Shed as Compared to Curing in the Field.
—In this project 10-crate lots of onions were used. One lot was weighed and placed in an open shed as soon as topped. Another lot was weighed and left in the field for curing. The curing period was for 10 days. Losses during this time and in storage were as follows:

**COMPARISON OF STORAGE LOSSES ON FIELD-CURED ONIONS
AND ONIONS CURED UNDER OPEN SHED**

	Moisture loss during curing period Percentage	Moisture loss in storage Percentage	Rot loss Percentage	Sprout loss Percentage	Total loss Percentage
Cured in open shed.....	.54	11.6	2.1	5.1	19.34
Cured in field.....	.22	9.75	2.88	4.1	16.95

From these results it would appear that curing in the field is the better method. However, the curing season of this year (1930) was quite rainy and it will be interesting to learn how this project works out under such conditions.

**COMPARISON OF KEEPING QUALITIES OF CLOSE-TOPPED BULBS
TO LONG-TOPPED BULBS**

	Loss in moisture Percentage	Loss in rots Percentage	Loss in sprouted bulbs Percentage	Total loss Percentage
Long-topped (2½ inches).....	8.7	1.3	2.1	12.36
Close-topped (close to bulb).....	7.7	0.0	8.28	16.02

The results are very interesting. Since the point of infection for most storage rots is in the neck of the bulb, and the diseases are usually brought into storage with the bulb, it may be reasoned that close topping of onions removes a possible source of infection. This is indicated by the fact that there was no rot loss in the close-topped bulbs. However, the loss due to sprouting was several times greater in the close-topped bulbs. The reason for this is not definitely known.

**COMPARISON OF KEEPING QUALITIES OF GRADED, FIELD-RUN
AND CULL ONIONS**

	10-crate lots. Cured 10 days in the field.			Total loss Percentage
	Loss in moisture Percentage	Loss in sprouted bulbs Percentage	Loss in rots Percentage	
Graded bulbs	5.5	7.1	4.7	17.3
Field-run onions	4.8	10.0	5.2	20.0
Cull onions	8.6	38.6	11.7	58.9

These results show a much greater loss in sprouted bulbs and rots for the cull onions as compared to graded bulbs, and would indicate that the value of grading onions before putting them in storage would be in the removal of possible sources of infection from which diseases would spread to sound bulbs.

A Comparison of Keeping Qualities of Field-Sown and Transplanted Onions.—A 50-crate lot of onions from transplants was compared to a similar lot of field-sown onions. Transplanted onions showed a loss in storage of 7.24 percent, as compared to a loss of 7.12 percent for field-sown onions. This difference is exceedingly small. However, at the close of the storage season, while the transplanted onions graded out practically as well as the field-sown bulbs, they were uniformly of much less firmness and would not have held up much longer, while the field-sown onions were nearly as firm as when first placed in storage.

Ventilation in Storage.—Ventilation for onion-storage houses in the Arkansas Valley is in most cases provided by windows and doors. Additional ventilation thru roof or bottom ventilators has been recommended by some growers. To determine the value of additional ventilation, the storage house on the experimental farm at Rocky Ford was built with two compartments. One compartment was provided with doors and windows for ventilation. The other compartment was built with four ventilators placed on the foundation in addition to doors and windows. Temperature and humidity records in each compartment were kept by means of hydro-thermographs, and a 25-crate lot of onions was kept for comparison in each compartment.

A COMPARISON OF BOTTOM VENTILATION TO VENTILATION BY MEANS OF DOORS AND WINDOWS ONLY

	Loss in storage Percentage	Average relative humidity Percentage	Average temperature
Bottom ventilation	17.04	56.97	40.28° F.
Ventilation by doors and windows only	15.73	56.35	39.53° F.

From these results, it would appear that no advantage is obtained from the additional ventilation.

Summary

This progress report, while showing some indications, will not justify final conclusions or recommendations, as the work has been carried on for too limited a period. The following observations have been supported by experimental evidence covering a period of 2 years' work, and is made available as a progress report so that onion growers may benefit from the preliminary results.

1. The results strongly indicate the Valencia variety as the best adapted to growing conditions in the Arkansas Valley. It produced the highest yield per acre, was most resistant to thrip insect injury, yielded a higher percentage of large grade onions and ranked favorably in storage characteristics.

2. Colorado-grown Valencia seed produced higher yields and a better grade of onions than California and imported Spanish seed, showing a higher degree of selection on the Colorado strains in the trial.

3. Transplanting of onions under ordinary conditions probably does not pay in the Rocky Ford district. Yields were less than with the field-sown onions, and costs were considerably greater. Growing transplanted onions for the early summer market might prove to be profitable.

4. Fertilizer trials seem to indicate that commercial fertilizers may prove of value in supplementing the use of manures.

5. A curing period of from 7 to 12 days in the field seems advisable for onions, under favorable weather conditions.

6. No advantage is shown by curing onions in an open shed during a curing season of dry, sunny weather.

7. Close topping of onion bulbs decreased rot losses, but increased the loss from sprouted bulbs.

8. There is a greater storage loss on cull onions, due to rots and sprouted bulbs, than there is on graded bulbs.

9. Actual loss in storage of bulbs from transplanted onions was approximately the same as the loss of bulbs from field-sown onions.

10. Additional ventilation in the storage house did not decrease the loss in storage, or lower humidity readings.

Future Plans

More detailed investigational work will be started, providing funds for such work are available, on the disease and insect problems as related to the culture of onions. Breeding of onions for disease resistance has already been started, and the increase of the onion crosses is under way. The comparison of the

crosses with the parent stocks for disease resistance will be made under disease conditions. The variety trial has been an important means of determining varieties most resistant to disease, and these varieties are the ones to be used in cross breeding for a resistant type. Selection for disease resistance has also shown promising results.

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