Demonstration of Irrigation Technology
to Improve Crop Yields, Returns and Water Quality in the
Arkansas River Valley of Colorado

by
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Progress Report
to
Colorado Water Conservation Board
Department of Natural Resources
March 1998

1997 was a very disappointing year because of the failure, once again, to establish either grasses or legumes on Pivot #7. Also, because of the untimely rains, quantity and quality of the alfalfa grown under Pivot #8 was much lower than expected. Only the fact that the stand of alfalfa on Pivot #8 was improved by overseeding in the spring of 1997 was there any real success.

Again as in 1996, different grass mixtures and/or grass-legume mixtures were planted in Pivot #7 as were two different types of sorghum/sudangrass. The different grasses and grass-legume mixes were planted in early spring and irrigated with water from Well #11, which has better water quality than previously applied using Well #13. The Total Dissolved Solids (TDS) in Well #11 was down to 1,200 ppm as compared to the 4,000 ppm when using Well #13. Seedling sprouts were found throughout the field, however; very few of these sprouts emerged above the soil surface. The grasses and grass-legume mixtures were sprinkle irrigated to germinate the seed and plans were made to irrigate this area using drag lines extending down from the sprinkler heads to the ground. Applying irrigation water in this manner would have eliminated saline water being applied to the leaf surface, thus, reducing the possibility of increased salinity due to crystalizing of this water on the leaf. Grasses planted include NewHy Wheatgrass and different mixtures of Orchardgrass, Smooth Bromegrass and Intermediate Wheatgrass as well as Birdsfoot Trefoil and Cicer Milkvetch.

The two different types of sorghum/sudangrass planted under Pivot #7 were a standard type and a Brown Mid Rib type. The Brown Mid Rib type has been show to be more palatable because of the reduction in lignin. The Brown Mid Rib appeared to be more susceptible to salinity as the early growth was not as vigorous as the standard, however; excessive amounts of weeds masked any results that would have shown this effect. Early growth of the sorghum/sudangrasses was encouraging but stunting of the plants started to occur just as the weeds were emerging. The weeds were sprayed aerially as the crop could not be cultivated because of the close row spacing. Unfortunately, the spraying did not give the kill that was anticipated and resulted in weeds continuing to be competitive with the crop. The sorghum/sudangrass was harvested twice during the growing season, but, again, untimely rains severely reduced the quality of the hay.

Because of the extreme salinity level of the soil under Pivot #7, Dr. Gary Banuelos, soil and plant scientist with the USDA- ARS Water Research Laboratory in Fresno, California was contacted. Dr. Banuelos is doing work with salt and selenium tolerant crops, looking at tolerant crops being grown in different areas of the world. Soil and water samples from the demonstration site, Pivot #7, were sent and a greenhouse study with some of the more salt tolerant crops he had found that might be adapted to the Arkansas River Valley of Colorado is being conducted. Dr. Banuelos planted a special type of Tall Fescue grass and two different types of Trefoil. The crops were grown in soil taken from Pivot #7 and irrigated with water synthesized from river and ground water samples sent from the demonstration site. The crops are being grown with saline soil and good river water, saline soil and saline groundwater and good soil with good river water and good soil with saline groundwater. His report (see attachment) indicated the Tall Fescue grass is the most tolerant of the three crops producing lush growth of forage. The Trefoil has been affected by the combination of saline soil and saline water, however; using saline soil and good quality river water, the Trefoil appears to be doing fairly well. This greenhouse grow out will continue through the winter/spring of 1998 to observe the continued response of the different crops to the different growing conditions

Alfalfa production on Pivot #8 was less than expected this first year of production. Planted in the fall of 1996, bare spots under the pivot were reseeded in the spring of 1997 and very acceptable stands were achieved. The alfalfa produced 2.75 tons per acre from the first cutting but untimely rains totaling over five inches occurred while the windrows were in the field. These rains delayed harvest over two weeks and significantly reduced the quality of the hay. The Relative Feed Value (RFV), which will exceed 150 with high quality alfalfa, ranged from a low of 107.6 to a high of 117.7. Because of the delay in harvesting, regrowth into the windrows delayed drying of the cut alfalfa and raised the moisture level of the baled hay. Also, because of the windrow being on top of the new growing hay, the regrowth was affected which reduced potential for the second cutting.

Results from the second cutting on Pivot #8 were also affected by heavy rains reducing the quality of the alfalfa even more that first cutting. RFV ranged from a low of 75.0 to a high of 117.0, again far below the potential. The alfalfa produced 2.25 tons per acre which was also much less than anticipated.

Third cutting results were much better from a quality standpoint as RFV ranged from a low of 163.8 to a high of 189.2 which shows the reduction in potential on the first and second cuttings. Because of the delayed harvesting on the first and second cuttings, third cutting was also lower than expected at 1.25 tons per acre. The 6.25 tons per acre yield for the growing season was fairly good but below the expected while quality on the first two cuttings severely reduced the value of the crop.

Because of the conditions of the crops and excessive amounts of rainfall, no field tours were held at the Stonewall Springs farm in 1997. However; Dr. Banuelos and Dr. Paul Beuselinck, trefoil plant geneticist for the USDA-ARS located at the University of Missouri, were presenters at an Irrigation Water Management Workshop held February 26 in La Junta, Colorado. Over 70 people attended the workshop, including some 30 farmers, to learn of how to combat or live with

the increasing saline conditions in the Arkansas River Valley of Colorado. Both scientists indicated they would continue to work with the project in an advisory capacity. They will give us access to some new varieties of Tall Fescue and a newly developed Trefoil with rhizomes.

The project will be continued in 1998 under a no-cost extension anticipating better growing conditions for the alfalfa under Pivot #8 and new attempts to establish crops under Pivot #7. A March 24, 1998 meeting of the CWCB planning group will discuss a new cropping plan and other items concerning preparation for the 1998 cropping season.

PROGRESS REPORT ON "ABILITY OF THREE FORAGE SPECIES TO TOLERATE HIGH SALINE CONDITIONS IN COLORADO"

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Objective:

The objective of this greenhouse study is to compare biomass production and chloride accumulation of different forage species, e.g., birdsfoot trefoil and tall fescue under typical saline conditions found at specific sites in Colorado.

Progress:

CSU Extension sent G. Bañuelos two representative soils; "good" and "saline". Electrical conductivity (EC) was <1 dS/m for the "good" and ≈5 dS/m for the "saline". Water samples were also sent. These included "good water" (Pueblo River; EC=0.8 dS/m), "medium quality water" (Pueblo well; EC=1.6 dS/m), and "saline water" (Arkansas River; EC=4.2 dS/m). Seeds of tall fescue, narrow leaf birdsfoot trefoil, and broadleaf birdsfoot trefoil were planted 11/1/97 in each type of soil and irrigated with each type of water, respectively. Narrow leaf germinated the slowest among the three species irrespective of treatment. Thirty days after planting, tall fescue was clipped for the first time in all treatments. Tall fescue appears to thrive in the soils, irrespective of treatment. Approximately 25 days later, tall fescue was again clipped. The third and fourth clipping of tall fescue occurred in 20 day intervals respectively thereafter. Tall fescue continues to thrive. Type of soil and quality of water appear to have no effect (based on biomass) on growth of tall fescue as of 1/22/98.

Both species of birdsfoot trefoil have not been clipped as of 1/22. Broadleaf birdsfoot, which is growing better and thicker than narrowleaf birdsfoot, will be clipped on 1/25/98. Both species have stunted growth in "saline soil" and "saline water" compared to all treatments. Interestingly, both species of birdsfoot trefoil look better in "saline" soil and "good water" than those growing in "good" soil and "good water". We are expecting increased growth from all species in the coming days as temperatures and day length increase. At the same time, we expect to observe more obvious differences among the treatments for the three species, as salinity levels gradually increase in the soil. As of today (1/22/98) tall fescue is the most vigorous plant species under these test conditions.

Evaluating the Ability of Three Forage Species to Tolerate High Saline Conditions in Colorado

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P.R. Beuselinck, Research Geneticist, USDA, ARS, 207 Waters Hall, University of Missouri, Columbia, Missouri 65211.

Objective

The objective of this study is to compare biomass production and chloride accumulation of different forage species, e.g., Birdsfoot trefoil and Tall fescue, grown under saline soil conditions found at specific sites in Colorado.

Methods and Materials

Salt tolerance, chloride (Cl^-) accumulation, and biomass production by selected plant species will be evaluated under greenhouse conditions in Fresno, California. Commencing September 1,1997, the proposed plant species are as follows: Broadleafed Birdsfoot trefoil (*Lotus corniculatus* cv. Steadfast), Narrowleafed Birdsfoot trefoil (*Lotus glaber* cv. HMB), Tall fescue (*Festuca arundinacea* cv. Alta).

The experimental design is a completely randomized block with six replications (pots) for each species growing in the problem soil (yet to be provided to the USDA). In addition, there will be three replications for each species growing in control soil (these pots will be designated as "controls"). Eighteen liter growing pots will be filled with approximately 10 kg of sent soil that has been throughly mixed by a mechanical mixer and passed through a 5 mm mesh.

The irrigation will be synthetically constructed based on the actual compostion of the water to be used at the field site. Watering will be based upon approximated evapotranspiration losses determined by periodic weighing. Seeds from the above plant species will be sown 2 cm deep into each pot. Plants will be grown in a temperature-controlled greenhouse using a 24±2°C day/night temperature regime with an average photon flux density of 400 μmol $M^{-1}S^{-1}$ (measured with a Licor Quantum Radiometer).

Approximately 90-120 days after planting, all plant species will be completely harvested 2 cm above the soil surface. Harvested plant materials will be oven dried at 50°C for 7 d, dry matter recorded, and then ground in a stainless steel Wiley mill equipped with a 1 mm mesh screen. Tissue Cl^- concentrations will be determined potentiometrically after microwave acid digestion. Soil electrical conductivity, pH, and selected water soluble elements will be determined from a saturated soil paste from soil samples collected at preplant and final from selected pots.

Proposed Budget

The proposed budget for evaluating three plant species for a 90 day period:

Under graduate student, 10-15 hrs/wk at $7.00 hr. (soil preparation, weighing, planting, watering, monitoring, harvesting)	$2500
Sample preparation (grinding of plant and selected soils)	750
Chemical analyses for Cl⁻ and potentially other elements	500
Supplies:	
Greenhouse pots, trays, fertilizer, pesticides, sample bags	500
Travel to greenhouse (30 miles one-way)	250
Miscellaneous supplies and incidentals	250
Administrative USDA expense (15% of total)	713
Total	$5463

Colorado State University

January 27, 1998

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Cooperative Extension
Colorado State University
Southeast Area

Reply to Rocky Ford

For Immediate Release . . . . . .

SPECIALISTS TO SPEAK AT IRRIGATION WATER MANAGEMENT WORKSHOP

"Salting of irrigated farmland in the Arkansas River Valley is becoming more of a problem with each season and many crops yields are being reduced due to shallow or "perched" water tables" stated Jim Valliant, regional irrigation specialist with Colorado State University Cooperatiave Extension. "Some salting is very evident by the white soils but crop yields on other land are being reduced, however, the effect is being masked by the increase in yielding capability of our crops. If the yielding capacity of our crops had not been increased by improved varieties and types, many of our farmers would be out of business."

In an effort to help farmers cope with these problems, Colorado State University in cooperation with the Natural Resource Convervation Service is sponsoring an Irrigation Water Management Workshop. Specialists from the USDA-Agricultural Research Service, the Bureau of Reclamation and Colorado State University will speak at an Irrigation Water Management Workshop to be held Thursday, February 26, 1998 at the Capri Restaurant/Quality Inn in La Junta, Colorado.

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Some of the problems with "perched" water tables is due to over-irrigation. Farmers are looking for new methods of applying irrigation water more effectively to get the most dollars from each inch of water they apply. The workshop will start with registration at 9:00 am and the morning session will feature Mike Bartolo of the Colorado State University's Arkansas Valley Research Center talking about drip irrigation as a cost-wise method of applying water, especially to vegetable crops. This and the use of plastic mulches maximize the use of water and allows the farmer to produce higher yielding, more profitable crops. Rick Lentz of the USDA-ARS from Kimberly, Idaho will discuss his latest findings on PAM, a polymer used to reduce erosion and increase infiltration on furrow irrigated land. PAM to control erosion has grown very rapidly in the Arkansas from some eight acres in 1995 to over 10,000 acres in 1997. The morning session will end with Jim Valliant reviewing the 1997 results of his work with polymers, both PAM and HYDROGEL. Even with the bad harvest weather of 1997, tomato, pepper and onion yields were increased by the use of PAM and HYDROGEL.

After lunch, which is being furnished from funding by the USDA Patterson Hollow Hydrologic Unit Area Water Quality Project, the workshop will hear from Tom Musgrove, Compliance Specialist with the Bureau of Reclamation. Tom will discuss Dam Issues at the Pueblo Reservoir and give an update of the Field Services Program. New storage restrictions will result in a net loss of 38,000 acre-feet of storage to the Conservation Pool according the Southeastern Colorado Water Conservancy District. "The District sees three near-term impacts from the storage restrictions: 1) diminished Project Water yields; 2) no storage in Pueblo Reservoir under the Winter Water Storage Program; and, 3) maintaining timely contract repayment". Farmers will need to know the impact on their own operations.

Gary Banuelos, Plant/Soil Scientist with the USDA Water Management Research Lab in Fresno, CA will talk about using different plants on saline soils and potential selenium problems in the Arkansas River area. The workshop will conclude with Paul Bueslinck, Research Geneticist with the USDA-ARS in Columbia, MO talking about his work with Birdsfoot Trefoil and other plants for forage production under saline soil and saline water conditions. Birdsfoot Trefoil, a legume, is drought-tolerant, salt-tolerant, flood-tolerant, is non-bloat and has the ability to re-seed its own stand. Trefoil may offer an opportunity to grow high quality, good yielding forage on land that is now low yield or non-productive.

Colorado Certified Crop Advisors can get three CEU credits for attending the workshop and farmers will have an opportunity to visit with these specialists one-on-one to discuss their specific problems. Also, there will be displays on each of the subjects as well as a number of products displays.

People interested in additional information on the workshop can contact Jim Valliant or Pat Clifford in the Otero County Cooperative Extension Office at 411 North 10th in Rocky Ford or call 719-254-7608. Information is also available at Extension and NRCS offices throughout the Arkansas Valley.

ag journal

Spring Planter

March 6, 1998

Effective water usage key to irrigation;workshop participants receive tips

By Sue Keefer

LA JUNTA — Jim Valiant may have stated the theme of the Irrigation Management Workshop held here Feb. 26 when he said, "We need to effectively use our water. Over-irrigation doesn't effectively use it."

Valiant is the regional irrigation specialist and research scientist at the Colorado State University Cooperative Extension Field Office. The workshop was sponsored by CSU extension and the Natural Resources Conservation Service.

Mike Bartolo, regional vegetable crops specialist at the Arkansas Valley Research Center, talked about using drip irrigation and plasticulture in growing vegetables. Drip irrigation is the foundation of the plasticulture system, he said. It conserves water, maintains uniform moisture and prevents erosion. Considerations in using drip irrigation are soil type, water quality, water availability and cultural practices.

Plastic mulches come in different colors, different kinds of degradability and different textures. Bartolo said the main thing to remember when using plastic mulches is to make sure they are snugged down tightly, firmly against the soil.

Bartolo has done many experiments with the Arkansas Valley's major vegetable crop, onions. He has found that drip irrigation helps maintain uniform moisture and good fertilizer in the root zone, helps manage the movement of salts and cuts down on bacterial disease, which is rampant using furrow irrigation.

Plasticulture has also helped cantelopes be ready earlier. Bartolo said he has had the best success with clear mulch, which stimulates earliness and can aid cantelope in maturing approximately three weeks before they would on bare ground.

The quality of the fruit is also increased because it isn't sitting on the bare ground. In addition, clear row covers stimulate growth and development and provide frost protection. Clear row covers can add 7 to 10 days extra increase in earliness. Clear plastic is a good environment for weeds, so herbicide must be used, Bartolo said.

Watermelon is also very responsive to plasticulture and drip irrigation. Using both increases earliness and quality and increases yield — almost double, he said. Tomatoes can be produced 7 to 10 days earlier. The major change with tomatoes is increase in quality. Bartolo said moisture is steadier using drip irrigation/plasticulture and so tomatoes don't crack as much. Peppers are also responsive to the practices, as is sweet corn.

Mike Bartolo

However, he cautioned that producers consider the market for the different produce. Produce that is consumed immediately may be better for earliness than something like peppers. Since most people freeze peppers, they probably won't pay more for them in July when they know they can get them in August, he said.

A soil scientist at the USDA-ARS Northwest Irrigation and Soils Research Laboratory in Kimberly, Idaho, also spoke at the workshop. Producers can lose up to 50 tons of soil per acre per year from surface irrigation in fields, said Rick Lentz. The soil, with the nutrients added to it, goes into rivers and causes damage to riparian and aquatic systems.

Lentz has done considerable research using the polyacrylamide PAM, which adheres to the surface soil. It helps stabilize soil clods; is a powerful flucuating agent, forming larger soil particles which settle out of the flow; and reduces the friction of the water flow over the soil. In one study, Lentz said, the use of PAM reduced soil loss about 95 percent, increased filtration 15 percent, increased lateral wetting 25 percent and decreased nutrient losses 75 percent.

Lentz gave the following tips for selecting a polyacrylamide: make sure the formula contains 90 percent of the active ingredient; it should have a high molecular weight (greater than 12 mg/molecule); it should have a negative (anionic) charge; it should have a 10-40 percent negative charge, with higher being better; and should contain no more than .05 percent acrylamide monomer. Lentz suggested using a food grade PAM, which is biodegradable in water and soil and won't accumulate in plant material.

Water usage from B1

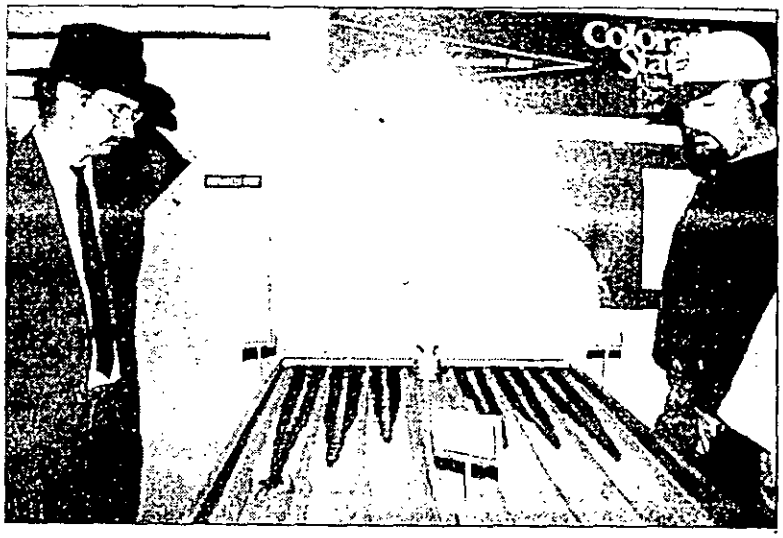

Photo by Sue Keefer

CSU COOPERATIVE EXTENSION exhibited a model of runoff using the polymer PAM at the Irrigation Management Workshop. PAM and other polymers reduce erosion by helping soil particles settle out. It also reduces the friction of the water flow over the soil. Participants watch the model, as PAM-treated water (left) collects little sediment and causes clear runoff.

Valiant addressed the use of reservoirs for irrigation. "The good news is we have water the year round; the bad news is we have water the year round," he said.

The river erodes the soil and takes land out of production, he said, but salinity is a bigger problem. East of Holly, dissolved solids have been recorded as high as 5100 parts per million. The use of surge irrigation reduces infiltration and increases lateral penetration. Producers can get the same yield with a 35 percent decrease in water use using surge irrigation, he said.

Valiant said polymers can absorb water about to 1400 times their own weight. Onion research has reduced the amount of topsoil loss by 83 percent using PAM; Hydrogel has increased tomato production by three and a half tons per acre. Valiant said soil and water should always be tested before planting.

Tom Musgrove, compliance specialist with the U.S. Bureau of Reclamation's Pueblo Field Office, gave an update on repairs to the Pueblo Dam. Research has found that one of the dam's buttresses could fall off because it is on a shale seam. However, this is not imminent and no movement has been detected since the dam was built.

But with public safety the Bureau's number one concern, in July a storage restriction was placed on the storage pool, and by April 15, 10,000 acre feet of water will need to be dumped. After discussing several ways to repair the dam, it has been decided to fill the plunge pool with concrete, put structural concrete over it and add the spilling basin on top.

The $25 to 38 million project is expected to be completed by the end of 1999. The U.S. government will pay 83 percent of the cost, with the remaining 15 percent to be paid for by water users in the Arkansas Valley, Musgrove said.

Gary Banuelos of the USDA Water Management Research Lab in Fresno, Calif., talked about his research using plants that are able to tolerate salts and use selenium. Although selenium doesn't appear to be a problem currently in the Arkansas Valley, he expects that it will be before long.