2008 PROCEEDINGS

Colorado State University

Extension

SOUTHERN ROCKY MOUNTAIN AGRICULTURAL CONFERENCE & TRADE FAIR

Conference Sponsored By:
San Luis Valley Extension

Trade Fair Sponsored By:
Monte Vista Chamber Ag Committee

26th Annual

Southern Rocky Mountain Agricultural Conference And Trade Fair

February 12 - February 15, 2008
Ski-Hi Park
Monte Vista, Colorado

CONFERENCE PROCEEDINGS

Conference Planning:
Merlin Dillon, Area Extension Agent, Agronomy
Rob Davidson, Extension Seed Potato Specialist

Conference Sponsored By:
Colorado State University Extension
Proceedings Developed By:
Colorado State University Extension

POTATO DAY
Tuesday, February 12

7:00 BREAKFAST
Sponsored by: **Monte Vista CO-OP**

Potato Storage Management Seminar

8:00 The Potato Crop from Field to Storage, Mike Lewis, ***Technical Consultant, Cerexagri/Deco, Fruitland, ID.***

8:50 Managing Storage for Optimum Quality, Keith Crane, ***AgroEngineering.***

9:30 Emerging Technologies in the Post Harvest Arena, Sastry Jayanty, ***CSU PostHarvest Research Scientist,SLVRC.***

10:10 Refreshment Break (Trade Fair)

10:30 Wrap-up Storage Panel, Mike Lewis, Keith Crane, Sastry Jayanty.

10:50 Potential Threat and Impact of Quarantine Diseases in the SLV, Rob Davidson, ***CSU Ext Seed Potato Specialist, SLVRC, Center, CO.***

11:30 Breeding for Early Maturity in Russet Potatoes, David Holm, ***Leader, Cultivar Development Program, SLVRC, Center, CO.***

12:10 LUNCH And VISIT TRADE FAIR
Sponsored by: Farm Credit of Southern Colorado

1:30 Managing Potatoes for Improved Skin Set, Tuber Yield & Quality, Samuel Essah, ***Research Scientist, SLVRC.***

2:10 Colorado Seed Certification; Current Issues and Future Prospects, Kent Sather, ***Manager, Colo. Potato Certification Service, SLVRC, Center, CO.***

2:40 Use of Vydate for Control of Corky Ring Spot on Potatoes, Brian Charlton, ***Asst. Professor, Cropping Systems and Potato Research, Oregon State University, Corvallis, OR.***

3:20 Food Safety Issues in Potatoes, Walter Ram, ***Director of Food Safety, The Giumarra Companies.***

4:10 SOCIAL HOUR (4-H Barn) for Growers & Speakers.
Sponsored by: **A & L Coors, Alamosa, CO.**

PLEASE return your evaluations for prize drawing.
Evaluations are encouraged by door prize drawings from filled or partially filled evaluations.

GRAIN DAY
Wednesday, February 13

7:00 BREAKFAST

Sponsored by: **SLV Rural Electric CO-OP**

Small Grain Management Seminar

8:00 New Weed Management Options in Wheat and Barley, Charlie Hicks, ***Field Development Rep, Bayer CropScience, Ft. Collins, CO.***

9:00 Small Grain Update: Varieties, N Rates and Cereal Cyst Nematode, Merlin Dillon, ***CSU Area Extension Agronomist, SLVRC, Center, CO.***

9:50 Refreshment Break (Trade Fair)

10:20 Seven Marketing Missteps to Avoid, John Deering, ***Regional Ag Business Extension Specialist, Akron, CO.***

11:10 Potential Soil Erosion of Various Potato Rotation/Tillage Plans, Cindy Crist and Richard Sparks, ***NRCS DC and NRCS Regional Agronomist.***

12:00 LUNCH And VISIT TRADE FAIR

Sponsored by: **First Southwest Bank**

1:30 KEYNOTE SPEAKER: Baxter Black,
Veterinarian and Cowboy Humorist

Sponsored by:
Farm Credit of Southern Colorado

2:30 Refreshment Break (Trade Fair)

Energy Planning Seminar

3:00 Planning for SLV Power Needs, Mark Murray, ***Tri-State Power Co, Denver, CO.***

3:45 Producing Biodiesel On-Farm, Raph Shay, ***Outreach Coordinator, ICAST, Lakewood, CO.***

4:30 SOCIAL HOUR and Biodiesel Demonstration (Growers & Speakers)(4-H Barn)

Sponsored by: **A & L Coors, Alamosa, CO.**

FORAGE DAY
Thursday, February 14

7:00 BREAKFAST
Sponsored by: **Sunflower Bank**

Alfalfa Management Seminar

8:00 Weed Management in Alfalfa, Rick Arnold, ***New Mexico Science Center, Farmington, NM.***

8:50 Alfalfa Production Missteps to Avoid, Mike Velde, ***Hybrid Alfalfa Breeder, Dairyland Seed Co, Clinton, WI.***

9:40 Refreshment Break (Trade Fair)

10:20 Alfalfa Growth Responses to Water and Partial Season Irrigation, Brad Lindenmayer, ***CSU Graduate Student, Ft. Collins, CO.***

11:10 Grasses for Forage Production, Richard Sparks, ***NRCS Regional Agronomist, Center.***

12:00 LUNCH and VISIT TRADE FAIR
Sponsored by: **Community Banks of the Rockies**

Production & Marketing Seminar

1:20 Improving Soil Health and Productivity, Jessica Davis, ***CSU Extension Soil Specialist, Ft. Collins, CO.***

2:10 Growth in the Organic Potato Market, Eric Keizer, ***Business Dev. Mgr, ICAST, Lakewood, CO.***

3:00 Refreshment Break (Trade Fair)

3:15 H2A Guest Worker Program, Chris Salazar, ***Colorado Workforce Center, Monte Vista, CO.***

3:50 Busch Malt Barley Variety Development, Blake Cooper, ***Barley Breeder, Busch Ag Resources Inc, Ft. Collins, CO .***

4:30 SOCIAL HOUR (Growers & Speakers)
Sponsored by: **A & L Coors, Alamosa, CO.**

WATER/LIVESTOCK DAY
Friday, February 15

7:00 BREAKFAST

Sponsored by: **San Luis Valley Federal Bank**

Water Management Seminar

8:00 SLV Drip Irrigation Initiative, Merlin Dillon, ***CSU Area Extension Agronomist, Center, CO.***

8:40 Planning Drip Irrigation for the SLV, Ross Roberts, ***Diversity-D, Brownfield, TX.***

9:20 Current Water Issues of the SLV, Mike Sullivan, ***Division Engineer, Division of Water Resources, Alamosa.***

10:00 Refreshment Break (Trade Fair)

10:20 Your Farm Unit and Sub-District No.1, ***Lynn Kopfman and Sub-district Board Of Managers. (Examples to calculate your water usage, credits & CREP)***

11:10 Enhanced CRP for the SLV, Tim Davis, ***Ag Conservation Consultant, Sterling, CO.***

12:0O LUNCH and VISIT TRADE FAIR

Sponsored by: **Mountain View Restaurant**

CSU Calving School

1:00 Preparing Cows and Heifers for Calving Season, Jack Whittier, ***CSU Ext Beef Cow Specialist, Colorado State University, Ft. Collins, CO.***

2:00 Calving Management and Calving Assistance, Bob Mortimer, ***DVM, CSU Veterinary Teaching Hospital, Ft. Collins, CO.***

3:00 Neonatal Calf Health Management, Roger Ellis, ***CSU Ext Veterinarian, Colorado State University, Ft. Collins, CO.***

4:00 Questions and Discussion

5:00 SOCIAL HOUR (4-H Barn)

Sponsored by: **A & L Coors, Alamosa, CO.**

9:30 am,Tuesday, Feb 12, 2008

New Postharvest Technologies and Methods

Sastry Jayanty, Postharvest Physiologist
San Luis Valley Research Center ,Center CO

Disease detection methods in storages

Huge losses are incurred by the potato industry due to disease spread in potato storages. These diseases are caused by both bacterial and fungal pathogens. All harvest operations result in some amount of bruising and wounding of tubers, which provides avenues for pathogen infection. These pathogens can thrive in the high humidity conditions which are necessary for long-term storage. Visual inspection, bad odors and temperature sensors are currently the only reasonable means of detection for diseases in potato storage. Existing temperature and other sensors detect problems only after symptoms appear and damage has taken place. Devices that are sensitive enough to detect the presence of a pathogen prior to the development of a disease would provide a powerful tool for reducing potato losses during storage.

Early detection of diseases in potato storages gives a number of options to the storage manager. Tubers can be marketed early to limit the losses. Remedial measures such as reducing the humidity and running the dry air through the storage can reduce disease spread. Additionally isolating the infected area can be effective in reducing the disease spread if marketing conditions are not economically viable. During my presentation I would like to discuss new methods and new approaches that we are working in our lab.

DMN Studies

I initiated studies on the effect of 1, 4 DMN on pressure bruise and tuber dormancy. Tubers of four different cultivars placed at two different depths with humidity and temperature sensors in commercial storages. Some of these storages are treated with
1, 4 DMN to study the effect of chemical treatment. Tubers were also placed in storages with variable speed fans (VSF) and without to study the effect of VSF on pressure bruise. Small scale studies are also being conducted in the lab on pressure bruise. Study is in progress as some of these commercial storages have not been opened yet. Once these storages open we will evaluate tubers for pressure bruise and effect of VSF.

During my presentation I will also highlight some of the responses that I received in my survey and I would like to thank you all for your valuable inputs.

10:50 am, Tuesday, Feb 12, 2008

MANAGING LATE BLIGHT IN THE SAN LUIS VALLEY

by Robert Davidson, CSU Extension Seed Potato Specialist
and Andrew Houser, CSU Research Associate

Information is derived from the Colorado Late Blight Management Plan (pg. 2-5)

Destroy Cull Piles and Eliminate Volunteers:

- Destroy cull potatoes by composting, burial, chopping, freezing, or feeding to livestock prior to new crop emergence.
- Monitor cull disposal sites and treat emerging sprouts with herbicides.
- Exercise most vigilance for destroying cull potatoes in a timely, acceptable manner during the growing season (May 15th - October 1st).
- Control volunteers with a combination of cultivation, herbicides and suppressive crops.

Use Certified Seed:

- Select seed lots carefully to avoid bringing in late blight on the seed. It is especially important to contact seed growers prior to winter to be certain that the seed lots of interest are available and will be sorted and graded to your specifications.
- Do not plant "year out" seed.
- Save suspect seed pieces during cutting and have them evaluated by an expert.
- Do not mix seed lots.

Scout Fields for Late Blight:

- Scout fields at least twice a week, beginning when plants are six inches in height.
- Concentrate scouting on low-lying areas, field edges, the center tower of pivots, wet and shaded areas, and any place where fungicide application is difficult.

Protect Plants with Fungicide:

- Apply protectant fungicides before late blight appears.
- Make the first fungicide application prior to plants touching within the row.
- Continue fungicide applications at intervals determined by the potential for late blight following the forecasts and recommendations from Colorado State University and local crop care providers.
- Use the correct nozzles, pressure and water volume to ensure thorough coverage of the foliage and avoid application skips.

Harvest Only After Vines Are Completely Dead:

- Time vine kill so that leaves and stems are completely dead at least two weeks prior to harvest, or at the earliest time acceptable tuber size has been reached.
- If late blight is found in the region, continue fungicide applications until vines are completely dead.
- Avoid harvesting wet tubers and minimize skinning, cuts and shatter bruise.
- Harvest tubers as soon as acceptable skin set has been achieved. This will also reduce the impact from other soil borne diseases such as silver scurf and *Rhizoctonia*.

Manage Storages to Reduce Decay:

- Sort tubers coming into storage and remove decayed tubers.
- Do not plan on long-term storage if more than 2% of the tubers show late blight.
- Begin monitoring the pile for hot spots immediately.
- Dry and cool the pile quickly by utilizing large volumes of air.

GENERAL STRATEGIES FOR LATE BLIGHT MANAGEMENT

Occurrence in Colorado

- The genotype currently found in Colorado (US-8) is classified as aggressive and resistant to metalaxyl or mefenoxam (Ridomil).

Spreading of late blight

- Inoculum is produced on volunteer potato plants, from cull piles, or infected seed.
- Infected plants produce spores that can be carried in moist air for long distances (50 miles+).

CULTURAL CONTROL METHODS

Before planting

- Reduce or eliminate inoculum sources; cull piles, infected volunteer potato plants from the previous season, and infected seed potatoes.
- Plant only certified seed which has been inspected and/or screened for late blight.
- Select fields for planting potatoes having good water infiltration and drainage characteristics.
- Do not plant potatoes in areas of fields where plants cannot be sprayed with fungicide.

During planting

- Do not mix seed lots to avoid possible contamination between diseased and disease-free seed.

Early season

- Cultivate fields to increase water infiltration and control weeds.
- Form high, wide hills to reduce exposing tubers to late blight spores that may be washed from infected plants.
- Scout fields regularly, concentrating in areas that remain wet for extended periods of time.
- Look for early indications of late blight on volunteer potatoes and monitor cull disposal sites.

Mid-season

- Apply heavier, less frequent water applications rather than light, frequent ones.
- For evening irrigation sets, consider beginning after midnight when dew would normally wet the leaves anyway.
- Continue scouting, especially low lying areas, pivot corners, field borders, and weedy patches.
- Although late blight readily spreads with moist air, to reduce risks, people entering fields may want to wear high boots that can be disinfected between fields , or wear disposable boots and pants that can be changed between fields, and reused after washing and drying.
- Destroy small patches of late blight infected potato plants in the field as soon as possible after discovery.

Late season

- Avoid excessive irrigation.
- Avoid late season fertilizer applications.
- Continue scouting to identify and mark late blight infected spots in fields.
- Kill vines at least two to three weeks prior to the anticipated harvest date making sure the vines are completely dead.

Harvest and storage

- Remove as many decayed tubers as possible coming into storage during harvest.
- Avoid harvesting during wet conditions, before skins are mature, and minimize skinning, cuts and shatter bruises.
- Remove vines, loose soil, and anything else that may interfere with air distribution in the pile.
- If foliar late blight was present in the field, dry tubers as quickly as possible after placed in storage. Plan to rapidly reduce storage temperatures to 38-40^{0}F to retard decay if longer term storage is contemplated.
- Immediately begin observing potatoes in storage for developing hot spots.
- Supply additional air to hot spots in storage and remove potatoes as soon as possible.
- Use shallow tillage practices that leave tubers on the surface or within the top two inches of soil to encourage freezing during the winter.

CHEMICAL CONTROL

Selecting a fungicide

- A list of fungicides labeled for potatoes for controlling late blight is included in the action plan.
- The fungicide selected is not as important as having complete coverage and proper timing for the disease pressure present in the area.
- Using copper or tin fungicides alone is not recommended for controlling late blight. These products provide excellent control when used in combination with other fungicides.

Consider these factors when selecting and using an application method

- Chemical label instructions dictate if a fungicide may be applied by ground, air or chemigation.
- Field size, shape, tillage practices, and obstacles that may hinder application.
- If using air or ground applications, be certain the equipment will be available when needed.
- Be sure the field is completely covered and fungicides are applied at the proper time during the season and that intervals between applications are appropriate and follow the label. Rotate chemistries (especially systemic or translaminar types) to avoid pathogen resistance.
- With air or ground applications, an irrigation may be needed to redistribute the chemical uniformly through the crop canopy.

Application methods

- Always use the highest rate of fungicide allowed regardless of application method or fungicide combination.

Ground application

- Apply at least 20 gallons of water per acre; 50 gallons may improve coverage.
- Adjust sprayer pressure towards the upper operating range recommended for the nozzle type.

- Use hollow cone and extended range flat fan nozzles.
- Re-calibrate the sprayer often and replace nozzles that are under or over applying by more than 10%. Raise the boom height as the crop grows to maintain the proper overlap in spray pattern.

Air application
- Use 5 gallons of water per acre; more water does not improve coverage and distribution.
- Calibrate nozzle output often and replace those that are under or over applying by more than ten percent.
- Skips can be avoided by marking spray passes with permanent flags and alternating spray passes on the flags and between flags on subsequent applications.
- Use a ground applicator to spray areas missed or inaccessible by air application.

Sprinkler application
- Use appropriate chemigation equipment making sure the injection pump operates the entire set.
- Use the highest labeled rate of fungicide to ensure an effective concentration on the leaves.
- For all irrigation systems, make sure there are no potatoes outside of the water coverage area.
- For solid set, inject the fungicide during the last 15 minutes of the irrigation set, or make a separate application between irrigations. Make sure the fungicide has flushed out of the end nozzles before shutting off the system.
- For center pivot systems, adjust the revolution time to the fastest setting to reduce fungicide wash off.

When to apply fungicide

Initial applications
- All fields should be sprayed with a protectant fungicide before row closure followed by a second application in seven to ten days.

Applications through late season
- Rigorously scout fields for late blight and access the CSU VegNet or the SLVRC code-a-phone to obtain the most up-to-date information regarding weather, disease forecast models, disease sightings and IPM strategies.
- If late blight is found in the area or weather conditions are conducive for disease development, continue spraying protectant fungicides.
- If late blight is found in the field, use of the systemic and/or translaminar type fungicides is warranted and should be considered to hold the infection in check. Use of protectant fungicides for early protection makes it much more effective to control the disease spread in-field and out-of field. Be sure to follow label directions, rotate the various chemistries and alternate a protectant type fungicide between applications of the systemic/translaminar fungicides or use in the mix as directed.

Late season
- Continue fungicide applications at intervals based on weather conditions and recommendations.
- Protectant fungicides may need to be applied even after vine desiccation, until all green vines are completely dead, if late blight was present in the region or field.

Recommendations to reduce late blight tuber rot
- Provide season-long control of the late blight fungus on the vines (leaves and stems).
- Follow the recommendations above to reduce the chance of tuber infection during harvest.

1:30 pm Tuesday, Feb 12.
Presented as part of (Managing Potatoes for Improved Skin set, Tuber Yield & Quality)

Potato Management for Improved Skin Set and Tuber Maturation

Samuel Essah, Potato Research Scientist,
San Luis Valley Research Center

Skin set can be defined as the development of resistance to tuber skinning injury. During growth and for a period during potato plant senescence, the periderm (skin) covering the tuber is immature and as such is fragile and susceptible to sloughing. The sloughing-type wounds are frequently referred to as skinning injuries, or skin wounds. Skinning can be extensive during harvest and handling operations, and results in costly disease, dehydration, and defect development that adversely affects all sectors of the potato industry (Lulai and Orr, 1993, 1994).

The process of skin maturation is initiated after growth ceases, and the potato vines die or begin to die in the field (Murphy, 1968). Vine killing or desiccation remains the standard means of promoting skin maturation and related development of resistance to skinning injury. Reasonably good skin set development generally requires about three weeks of skin maturation following vine-killing treatment (Lulai and Orr, 1993).

Tuber (skin) maturity is the key to avoid skinning injury:

The subject of skin set is very important globally because of the various quality issues that are affected by inadequate skin set. Skinning wounds are difficult to control at harvest unless the tuber is matured and the skin is set to resist skinning injury. Immature tubers have a thin, delicate skin, which are prone to skinning, that expose the tuber flesh. The exposed tuber turns dark when subjected to wind, sun, and air. This makes the tuber less acceptable for the fresh market, increases moisture loss, and opens the tuber to infection by rot pathogens. Physiologically mature tubers resist skinning and form wound periderm faster than immature tubers. Skinning can, however, occur in mature tubers if they are roughly handled.

Effect of Environmental Conditions on tuber skin set:

The rate of skin maturity is related to environmental conditions. Tuber skins mature more slowly under cool or damp soil conditions. Cool wet weather may increase the time needed to properly mature tubers. Soil temperatures between 50 to 85 ^{o}F favor skin set, with 70 to 75 ^{o}F being optimum. Low temperatures of 45 ^{o}F or extremely high soil temperatures (90 ^{o}F) hinder skin set. In general, tuber maturity (skin set) is favored by warmer temperatures.

Effect of Soil Conditions on tuber skin set:

Generally lighter soils favor skin set because of better aeration and possible higher soil temperatures. Soils with high alkali salt content can result in poor skin set.

Effect of Cultural Practices on tuber skin set:

Cultural practices and conditions, such as excessive amounts of fertilizer applied or remaining in the soil because of dry growing conditions followed by rain near the time of harvest, may drastically increase the time required for skin set (Stark and Love, 2003). Fertilizer rates and the timing of applications should be adjusted according to the growing season and the anticipated harvest date to achieve skin set by harvest time. Allow sufficient time between vine kill and harvest (usually between one to three weeks) for the skin to toughen. Tubers can delay in maturity if N is applied late in the season. Excessive late season N application usually reduce tuber specific gravity and skin set. Excessive potassium (K) application can reduce skin set. Phosphorus to a certain extent can counteract the effects of excessive N and K and in some cases enhance skin set.

Avoid late application of chemistries that prolong vegetative growth of the plant. This can contribute to delayed skin maturity.

Wet soils during tuber maturation reduce oxygen to tubers that is necessary for skin development. Dry soils also reduce skin set. Soil moisture should be between 65 and 80% for optimum russet skin development.

Where possible, plant early and harvest late for tubers to have enough time to mature. In recent studies, it was observed that early planting provided tubers with improved skin set and the latest vine kill time produced the highest skin set in Russet Burbank (Table 1).

Table 1. Effect of planting date and vine kill date on skin set of Russet Burbank tubers. All values are presented as the torque required to excoriate the periderm

Planting Date	**Skin Set (mN.m)**
4/17/03	**298a**
5/1/03	**278b**
5/15/03	**289ab**
Vine Kill Date	**Skin Set (mN.m)**
8/19/03	**286b**
9/31/03	**272b**
9/15/03	**306a**

From Sabba et al., 2007 Vine kill or vine desiccation method can influence skin set (Table 2). The effectiveness of desiccation method has to do with regrowth. Use a method that will not allow regrowth after vine kill or desiccation.

Table 2. Effect of vine desiccation method on tuber skinning of Atlantic potato.

Vine desiccation Treatment	**3 Weeks After Initial Treatment**	
	Torque (mN.m)	**% Skinning**
Control	**282c**	**53a**
Diquat @ 280 g/ha	**346a**	**15c**
Diquat @ 560 g/ha	**339a**	**15c**
Diquat @ 280 g/ha + diquat @ 280 g/ha	**353a**	**16c**
Diquat @ 280 g/ha + vine flailing	**289bc**	**45a**
Vine flailing	**303bc**	**30b**
Vine flailing + diquate @ 280 g/ha	**310b**	**25bc**

From Pavlista, 2002

Cultivar Differences:

In addition to cultural conditions, potato genotype is a major factor in skin set. Some potato cultivars skin easier than others. This can be broadly illustrated where russet genotypes generally mature more quickly whereas red-skinned genotypes often develop skin set slowly (Lulai and Orr, 1993). Some potato genotypes are unacceptable because skin set is extremely slow, leading to excessive skinning wounds.

Summary and Conclusion:

Skin set of tubers is an indication of maturity. Immature tubers can skin easily. Excessive late season N application usually reduce skin set. Cultural practices that keep the vine actively growing will also keep the tuber skin actively growing. Therefore, any condition which tends to keep vines excessively green towards the end of the growing season would hinder tuber maturation and skin set. Proper management of fertilizer, cutting back on irrigation in the late summer and timely killing of vines are all important in periderm development and maturation of tubers. Due to improved cultural practices, better disease control, better fertilizer and moisture management, vines are kept green longer and maturation of tubers and skin set has become a problem. Tubers should be given a longer time to set their skin if the vines are killed when very green and actively growing.

Tubers set their skin earlier when vines are killed at the onset of senescence or when the vines are just about to enter the senescence stage. A good skin set will reduce tuber bruising during harvest, but skinning tubers are susceptible to tuber rots and storage shrink.

References:

Lulai, E.C. and P.H. Orr. 1993. Determining the feasibility of measuring genotypic differences in skin-set. Am Potato J 70:599-609.

Lulai, E.C. and P.H. Orr. 1994. Techniques for detecting and measuring developmental and maturational changes in tuber native periderm. Am Potato J 71:489-505.

Murphy, H.J. 1968. Potato vine killing. Am Potato J 45:472-477.

Pavlista, A.D. 2002. Skin set evaluation by skin shear measurements. Amer J of Potato Res 79:301-307.

Sabba, R.P., A.J. Bussan, B.A. Michaelis, R. Hughes, M.J. Drilias and M.T. Glynn. 2007. Effect of planting and vine-kill timing on sugars, specific gravity and skin set in processing potato cultivars. Amer J of Potato Res 84:205-215.

Stark, J.C. and S.L. Love. 2003. Tuber quality. *In*: (co-editors: J.C. Stark and S.L. Love) Potato production systems. JRAdams Publishing. Pages 329-343.

1:30 pm, Tuesday, Feb 12, 2008
Presented as part of (Managing Potatoes for Improved Skin Set, Tuber Yield and Quality)

Overcoming Obstacles in Canela Russet Production

Samuel Essah, Potato Research Scientist, SLV Research Center

INTRODUCTION

Canela Russet is a newly released potato cultivar with oblong-long tubers. It has a medium to high total yield potential (> 380 cwt/ac) with a very high percentage of US No. 1 tubers (90%, >350 cwt/ac), and excellent long term storage potential. The major drawback of this cultivar is its characteristic long dormancy which results in delayed field emergence after planting. It also produces very few stems/plant (average of 2). It was hypothesized that reconditioning the seed tuber at a high temperature for two to three weeks before planting could age the seed and break its dormancy, and therefore, accelerate sprout emergence in the field. It was also hypothesized that increasing the seed tuber size could result in more 'eyes' on the seed tuber and therefore increase the stem number per plant during field emergence.

The objective of this study was to evaluate the effect of seed tuber size and seed tuber reconditioning on the growth and yield of Canela Russet.

EXPERIMENTAL PROCEDURE

Seed tuber size treatments included seed tubers cut to 2.0 to 2.5 oz and 3.0 to 3.5 oz. The seed tuber was either stored at 38 °F until planted in the field or the stored seed tuber was reconditioned at 70 to 75 °F for 2 to 3 weeks before field planting. The final treatments were; 2.0 to 2.5 oz seed tuber stored at 38 °F until planted (control), 2.0 to 2.5 oz seed tuber stored at 38 °F and reconditioned for 2 to 3 weeks before planted (reconditioned), 3.0 to 3.5 oz seed tuber stored at 38 °F until planted, and 3.0 to 3.5 oz seed tuber stored at 38 °F and reconditioned for 2 to 3 weeks before planted. The experimental design was a randomized complete block with four replications. Plot size was 25 ft. long x 8.5 ft. wide and had 3 rows spaced at 2.8 ft. In-row seed spacing was 12 inches. The total urea ammonium nitrate (UAN) fertilizer rate applied was 120 lb N/ac. The initial soil nitrate N available was 35 lb N/ac and the background nitrate N applied with irrigation water was measured to be 15lb nitrate N/ac.

Plant stands were counted approximately every 2 days for 2 weeks, beginning June 6. Plants were sampled from each plot during the growing season to evaluate the above ground stem number per plant, tuber number per plant, plant canopy volume, and leave area index (green leaf surface area/unit land area). Total tuber yield was measured by harvesting and weighing the center row from each plot at maturity. Tubers were mechanically size-sorted into tubers 4 to 16 oz (marketable size tubers), 4 to 10 oz (medium size marketable tubers), and 10 to 16 oz (large marketable size tubers). All data were subjected to analysis of variance to test for main effects. Differences between treatment means was separated using LSD ($P<0.05$) (SAS Inst., 1991).

RESULTS AND DISCUSSION

Sprout Emergence

Seed tuber size did not influence sprout emergence as did reconditioned seed (Fig 1 A and B). At 25 days after planting (DAP), 40% of reconditioned seed tubers were observed to have emerged compared to 0% emergence for the non-reconditioned seed (control). All reconditioned seed tubers were observed to have sprout emerged at 32 DAP, and it was not until 39 DAP before the non-reconditioned seed tubers attained equal percent emergence as the reconditioned seed tubers (Fig. 1 B).

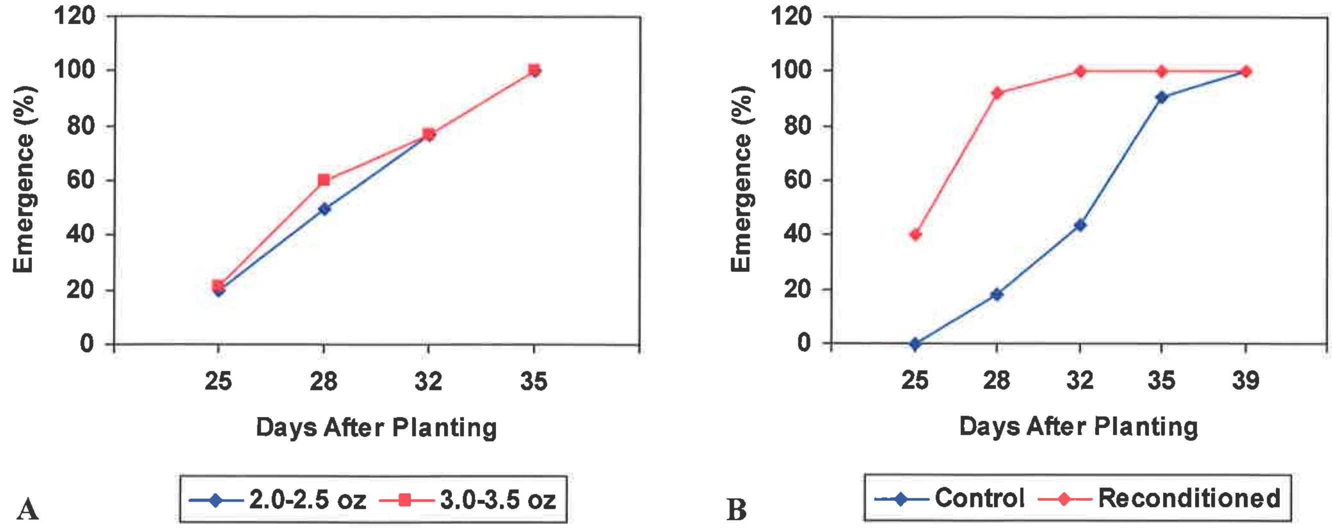

Fig. 1. Sprout emergence vs. days after planting as influenced by seed tuber size (A) and seed tuber reconditioning (B).

Canopy Volume

Plant canopy volume is a measure of canopy size. Seed tuber size did not influence canopy volume as did seed tuber reconditioning (Fig. 2 A and B).

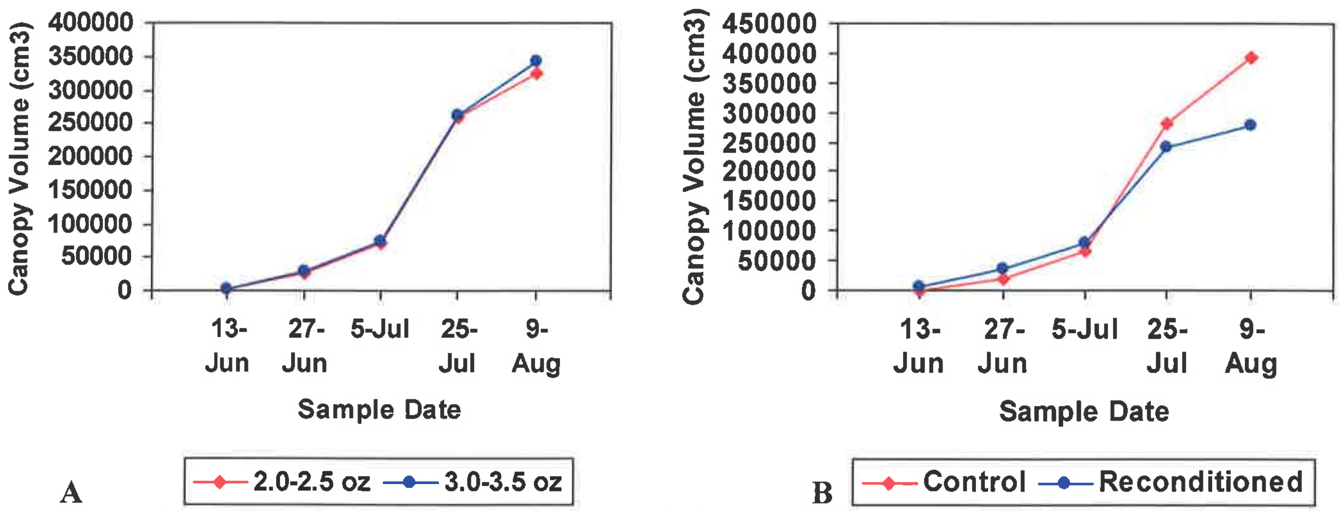

Fig. 2. Canopy volume vs. sampling date as influenced by seed tuber size (A) and seed tuber reconditioning (B).

Canopy volume was bigger for plants from reconditioned seed compared to the control until July 25 when the leaves of plants from the reconditioned seed tuber began to senesce and the canopy volume of reconditioned plants significantly reduced compared to the control (Fig. 2 B). The reconditioning temperature of 70 to 75 °F was too high and it did age the seed tuber to the extent that the plants senesced early. The non-reconditioned plants maintained a higher canopy volume from July 25 until vine kill.

Leaf Area Index (LAI) Leaf Area Index expresses the ratio of green leaf surface to the ground area occupied by the crop, and it is an indication of effective ground cover for maximum light interception for photosynthesis. Seed tuber size did not influence LAI of Canela Russet during the later part of the growing season (Fig. 3 A). However, from August 16 until vine kill, the plants from reconditioned seed showed reduced LAI compared to plants from the control plots (Fig. 3 B).

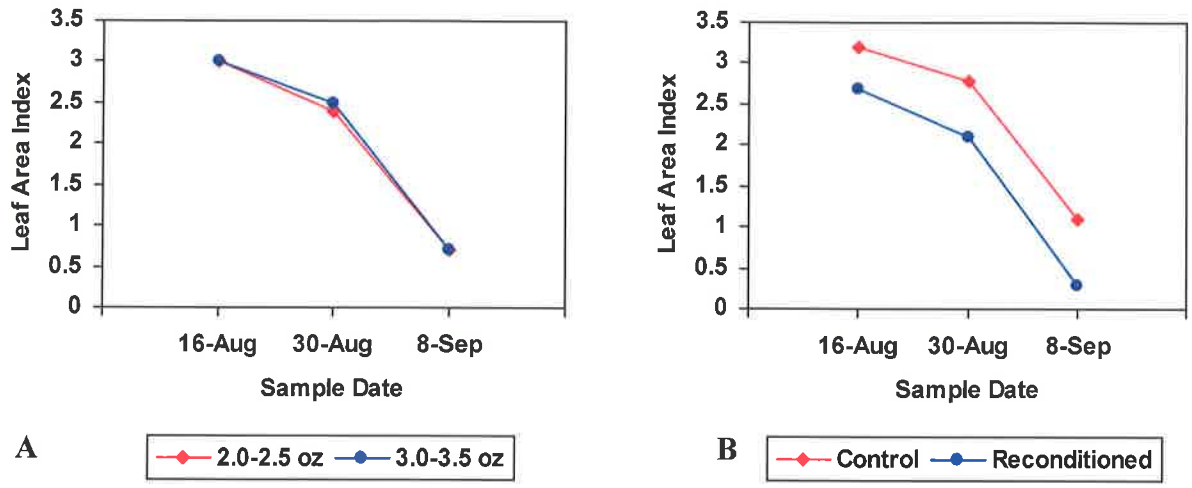

Fig. 3. Leaf Area Index vs. Sampling Date as influenced by seed tuber size (A) and seed tuber reconditioning (B).

The observed reduction of LAI for plants from reconditioned seed compared to the control was due to early leaf senescence of the reconditioned plants as observed for canopy volume (Fig. 2B). The high reconditioning temperature of 70 to 75 °F extremely aged the seed tuber, which resulted in early plant maturity and therefore early leaf senescence.

Stem and Tuber Number

Large seed size (3.0 to 3.5 oz) increased the average stem number of Canela Russet from 2 to 3, and tuber number from 6 to 8 per plant (Table 1). Iritani et. al. (1972) reported similar results for Russet Burbank. Reconditioned seed increased the average stem number from 2 to 3, but did not influence tuber number per plant (Table 2). This confirms studies conducted by Stuik and Wiersema (1999) who suggested that storing seed tubers at high temperatures could lead to increased physiological age of the tubers with a resultant increase of stem number per plant.

Table 1. Effect of seed tuber size on stem and tuber number of Canela Russet.

Seed Size	Stem Number/Plant	Tuber Number/Plant
2.0 – 2.5 oz	2	6
3.0 – 3.5 oz	3	8

Table 2. Effect of seed tuber reconditioning on stem and tuber number of Canela Russet.

Treatment	Stem Number/Plant	Tuber Number/Plant
Control	2	7
Reconditioned	3	7

Total and Marketable Yields

Large seed size (3.0 – 3.5 oz) increased the yield of medium size (4 – 10 oz) marketable tubers by 13%, when compared to small seed size (2.0 -2.5 oz), but did not influence total tuber yield and the yield of other size distribution groups (Table 3). Reconditioned seed did not influence the yield of large marketable size (10 – 16 oz) tubers, but caused a reduction in total, marketable (4 – 16 oz) and medium size marketable tubers (Table 4). The reduction in yield observed for the reconditioned seed treatment was due to early leaf senescence caused by the high temperature (70 -75 °F) and length of time (2 to 3 weeks) that the seeds were subjected to during reconditioning. Personal communication with successful growers of Canela Russet suggest that reconditioning the seed at 50 to 55 °F for 1 to 2 weeks could delay plant senescence and improve yields.

Table 3. Effect of seed size on tuber yield and tuber size distribution of Canela Russet.

Seed Size	Total	4 – 16 oz	4 – 10 oz	10 – 16 oz
2.0-2.5 oz	473 a[1]	407 a	260 b	148 a
3.0-3.5 oz	478 a	413 a	300 a	114 a

[1]Means in the same column bearing similar letters are not significantly different at the 0.05 level of probability.

Table 4. Effect of seed reconditioning on tuber yield and tuber size distribution of Canela Russet.

Seed Treatment	Total	4 – 16 oz	4 – 10 oz	10 – 16 oz
Control	496 a[1]	436 a	300 a	137 a
Reconditioned	455 b	384 b	259 b	125 a

[1]Means in the same column bearing similar letters are not significantly different at the 0.05 level of probability.

SUMMARY AND CONCLUSION

The purpose of this study was to evaluate the effect of seed tuber size and seed reconditioning on the rate of field emergence, and stem number per plant of Canela Russet. Reconditioned seed increased the rate of sprout emergence of Canela Russet compared to non-reconditioned seed. Large seed size (3.0 to 3.5 oz) and reconditioned seed increased the average stem number from 2 to 3. In this study, seed tubers were reconditioned at a high temperature (70 to75 °F) over a longer period of time (2 to 3 weeks). This caused early senescence of leaves from reconditioned seed. The early seed emergence and increase in stem and tuber number observed with the use of larger seed tuber size, and reconditioned seed tuber did not translate into increased total and marketable tuber yield. However, large seed tuber increased the yield of medium size marketable tubers by 13%. It is suggested that growers use seed tubers in the 3.0 to 3.5 oz range, and recondition the seed tuber at 50 to 55 °F for 1 week before planting. This practice could increase the rate of sprout emergence, increase stem number per plant, and delay leaf senescence to increase tuber yield. Further studies are required to evaluate the effect of reconditioning Canela Russet seed tubers at 50 to 55 °F on plant growth and tuber yield.

2:10 pm, Feb 12, 2008

Colorado Seed Certification; Current Issues and Future Prospects

Kent Sather, Manager, Colorado Potato Certification Service
San Luis Valley Research Center, Center, CO

A successful potato marketing industry requires a quality seed potato program to provide seed stocks capable of producing optimum tuber yields. Healthy seed sources are a key component to yield and quality of subsequent crops. Quality and yield translate into grower profits. Amidst various situations, Colorado Potato Certification Service continues to maintain a scientifically based certification program. Various and changing issues constantly challenge the process and results of seed potato certification programs and growers participating as certified seed growers. Here are some of those issues:

National Protocols:

1. PVY testing survey:

A USDA funded survey has been ongoing for the past three years. This survey focuses on PVY and the presence of any strains of PVY in certified seed sources. The potato industry is threatened with the introduction of PVY strains (including tuber necrotic strains) that could seriously detract from tuber quality and cause yield loss and reduce marketability. Only certified seed lots have been surveyed. No common seed (non-certified potatoes) used to replant have been tested.

2. Potato Cyst Nematode surveys

Presence of cyst nematodes in soil is a very serious issue, requiring national quarantine measures to be initiated. A positive find in Idaho nearly two years ago began a chain reaction across the country and into the rest of the world. International trade was immediately affected, and trade within the states was scrutinized. An intensive soil survey was initiated as a result. Soil samples were gathered from acreage used to plant the 2006 crop. 100% of certified seed growers in Colorado participated. In addition, 10% of commercial acreage was surveyed. There are indications that this survey will continue in some form.

3. State National Harmonization Program (SNHP)

While all seed certification programs in the United States are similar, no federal government oversight program has ever been established. This federal umbrella is particularly important when dealing with export of our potato products to other countries. The SNHP is an agreement between the state agencies and USDA APHIS PPQ to establish minimum standards of seed potato certification set by state authority and to develop a framework for pest management cooperation. Future issues concerning regulated pests could be written into this document.

Pathogens and Diseases

1. Individual

Individual diseases and pathogens are those types that can be controlled within a grower's operation. Examples are bacterial ring rot, nematodes, and pink rot. These types of issues can be eliminated or controlled by sanitation, rotation, chemical control, cultivar selection and management or field, storage, and grading. The presence of certain pathogens will cause rejection of seed lot. Growers face a continuous internal battle to remain free from, or limit these pathogens.

2. Community

Community diseases are those not limited by the fence line or property boundary. These pathogens are easily spread by wind or insect vectors, regardless of source or location, making them very difficult to control in one field or farming operation. At present, the single, most important community disease affecting the quantity and quality of seed potatoes in the San Luis Valley is PVY (Mosaic). This disease was responsible for the rejection of 24% of the seed potato acreage entered for certification in 2007. Other examples of community diseases of major concern are Late Blight and Powdery Scab, and to some extent, Potato Leaf Roll Virus.

Importation of new disease/pests

As the supply of certified seed decreases locally, out of state sources may be imported to satisfy the demand. Pathogens presently not established in the San Luis Valley may be inadvertently imported on seed. Other seed growing areas have their own unique problems as well, some only recently confirmed. Those include, but are not limited to Potato Moptop virus, PVY tuber necrotic strain, Golden Nematode, Pale Cyst Nematode, and Potato Wart. At this point, none of these pathogens have been confirmed in the valley.

National reputation of Colorado potatoes

Quality and quantity of seed potatoes from the San Luis Valley has decreased over the past several years. Local growers would agree. The potato industry outside our state borders is also quick to note our challenges. The seed potato and commercial industry reflect on each other. A community effort is needed to rebuild the quality and reputation Colorado has enjoyed in the past.

What about future prospects for Colorado Potato Certification?

Increase of certified seed acreage

Just as in past years, certified seed acreage has decreased for a time. Eventually, the acreage has rebounded. Acreage in the program presently is decreasing. Seed growers will make necessary adjustments in their respective operations if they choose to continue to be involved in raising certified seed. Once those adjustments have been made, acreage will again increase.

Grower Entry Tier II

Another opportunity to increase acreage of inspected seed is a new grower entry level defined in the Rules and Regulations. This is called Grower Entry Tier II. It a seed program specifically for an individual grower/farming operation. Here is the description from the May 2007 Colorado Rules and Regulations for Certification of Seed Potatoes:

"Grower Entry Tier II "qualified seed potatoes" – this tier is for growers intent on meeting official disease control standards within their operation. A prospective grower must contact the PCS office prior to May 1st and outline how he plans to use the seed inspected to meet disease control standards within his operation. A review of progress will be made at the end of each growing season to determine the feasibility of continuing in the grower entry program. Normal fees will be assessed for acreage entered into the grower entry program. Seed produced under this tier is not "certified seed" and may not be sold to any other grower. It may be used only within the grower's operation and is intended only to meet disease control standards within that operation."

No other certification program includes this type of opportunity. It allows for:

- Inspections only on requested seed lots in farming operation
- Official inspections according to Rules and Regulations
- Documentation of seed lots
- Qualified seed for increase meets requirements for Mexico markets
- Quality control/review within farming operation
- Meets official disease control standards within individual operation

But it also has its limitations:

- Source seed lot must meet eligibility requirements for recertification
- Absolutely no sale of inspected, qualified seed. These seed lots are restricted to grower's own use.

This is NOT part of any proposed seed law. Several growers took advantage of this Tier II program last year, and are planning to continue this year. This is a new opportunity to monitor quality production within an individual farming operation.

International seed shipments

While national protocols and regulations may seem to be cumbersome, they do pave the way for new markets. Colorado seed potato growers have been successful in creating and growing a limited market for seed potatoes requested by foreign countries. This new market trend will continue as long as stringent export requirements are met.

Colorado State Certified Seed Law

A state seed law is an industry decision. It will only be accepted when the overall industry benefits are understood. A seed law, in its proper form, will not inhibit the commercial production of potatoes. It will protect and enhance the overall quality and health of the industry, allowing for greater production of higher quality seed passing certification inspection tolerances.

Participation in the certified seed program is voluntary, and will always remain so. As such, it is the responsibility of the grower to carry out all recommendations and follow certification rules and regulations. The most important factors in the consistent production of good quality seed are the experience, expertise and integrity of the seed grower. A second most important factor is the support of the local commercial industry aiding in the control of community diseases.

Past issues have caused a decrease in certified seed acreage. In 1978, 17% of the certified seed acreage was rejected due to Potato Leaf Roll Virus. Between 1982 and 1987, 10 to 18% of the acreage was rejected each year due to Bacterial Ring Rot. When these issues noticeably and consistently affected the health and quality of the potato industry, concerned valley growers followed recommendations and new rules to make changes. Examples are the Late Blight quarantine and aphid suppression program. The local industry survived and seed acreage increased. Current issues jeopardizing the health of today's industry are no longer just seed grower issues. Some are community issues. Commercial growers and seed potato growers will need to work together to rebuild a quality seed program that will support a successful commercial industry.

More information concerning Colorado Potato Certified Seed Potato program can be found at www.colostate.edu/depts/PCS/

Not Presented at the Ag Conference; Research sponsored by CPAC, Area II, Monte Vista, CO.

Tuber Protection from Root-knot Nematode in Two Potato Crops Following a Single Application of Telone II at Different Rates

Dr. Russell E. Ingham, Professor
Dept. of Botany & Plant Pathology
Oregon State University
Corvallis, OR 97331-2902

Nick David, Research Manager
Hermiston Ag Research & Ext. Center
Oregon State University
Hermiston, OR

Introduction

The Columbia root-knot nematode (*Meloidogyne chitwoodi*, CRKN) has become a threat to quality potato production in the San Luis Valley (SLV). In addition to the fresh market, which has low tolerance for tubers expressing symptoms of root-knot infection, the SLV also produces potato for seed and export markets, which have no tolerance for root-knot infection in tubers. The soil fumigant Telone II® is recognized as one of the best products for nematode control and is commonly used for CRKN on potato in the Pacific Northwest at the labeled rates of 20 gpa or 15-20 gpa if used in combination with metam sodium. However, growers have questioned the economic return of using Telone in the SLV where yields are lower and pressure from CRKN is less due to fewer generations during a shorter and cooler growing season. Ways to reduce overall cost of Telone fumigation include reducing the rate and/or getting protection for two crops from one application. This study rested both strategies.

Procedures

Study design: Telone II was applied in fall of 2004 to a field with a high (500/250 g soil) population of CRKN. Treatments of 0, 12, 15 and 20 gpa were applied to two sets of plots using commercial equipment in a randomized block design with five replications. The first set of plots was evaluated in 2005 and 2007 without Vydate. The second set of plots was treated with Vydate in 2007 and tuber damage was only evaluated in 2007. Plots were 18 feet wide (the width of the Telone applicator) and 30 feet long, placed in the center of a 200 ft pass of the fumigator to ensure that the tractor had achieved the normal speed for application when passing through the plot. Fumigation occurred on October 15, 2004 and the soil was moist from recent rain and 51 F. The field was planted to a cultivar similar to Russet Norkotah on May 5, 2005 and May 3, 2007 and the center row of each plot was harvested with a level bed digger on September 21, 2005 and September 20, 2007. The field was planted to sudangrass cv Sordan 79 in 2006. During the 2007 potato crop, the field was treated with Vydate C-LV at 2.1 pts/a buffered to pH 5 and chemigated in 0.5 in. irrigation on May 18, June 7, June 18, July 4, July 21 and August 7. The first set of plots was covered with tarps during each application and received no Vydate.

Nematode sampling: Soil samples for nematode population assessments were collected by taking 10 one-in-diameter cores to a depth of 12 in. from the middle 20 feet of the center row of each plot before fumigation and at planting and harvest of the 2005 and 2007 potato crops. Soil was mixed and nematodes were extracted from 250 g subsamples by wet sieving-sucrose centrifugation and counted. Soil moisture was determined for each sample and populations were adjusted to number/250 g dry soil. A Spectrum Model Watchdog datalogger recorded soil temperature at seed depth for degree-day calculations.

Tuber evaluations: Plots were harvested with a level bed digger and two 25-tuber samples of 4-12 oz tubers were collected from each plot for evaluation of nematode infection. A datalogger was placed in one bag from each set to record degree-days from harvest to evaluation. One sample was evaluated as soon as possible (Harvest) and the other was stored at room temperature for an additional 700-900 degree-days (5C) to encourage maximum symptom expression of any CRKN that had infected the tuber. Only data from harvest samples are included in this report. Data from 2007 warm storage samples were not completed at the writing of this report and will be presented in a later report. Tubers were examined closely for damage from external galling and then peeled by hand and the number of root-knot nematode infection sites counted under a magnifying lamp. Infection parameters evaluated included percent external damage (tubers with any external symptoms), percent internal infection (any internal spots/tuber), and percent internal culls (6 or more spots/tuber). Percentage of external culls (tubers with 10% or more of external surface blemished) was also evaluated but few tubers met these criteria and data are not presented in this report.

Statistical analysis: All percent damage data were transformed to arcsin square root (x) and evaluated by analysis of variance (ANOVA). Nematode densities were adjusted for soil moisture to convert to density/250-g dry soil and transformed to $\log_{10}(x+1)$ before analysis (ANOVA). Means of transformed values were back transformed before reporting and Duncan was used to separate means only when ANOVA was significant at $P \leq 0.05$. All differences reported are at $P \leq 0.05$ unless otherwise stated.

Results and Discussion

In 2005, each treatment was evaluated for yield and grade and the economic benefit of each Telone treatment was evaluated. A complete description of these results and additional discussion of nematode population and tuber damage data from 2005 was presented in Pomme de terre: Vol, 12 No. 1, October 2006 available form the San Luis Valley Research Center.

Effects on root-knot nematode populations: CRKN populations in untreated plots declined 95% and 76 % over the winter following fumigation but increased 3 to 4.6 fold by the 2005 potato harvest in the first and second set of plots, respectively (Table 1). After sudangrass during 2006, population densities of CRKN declined from an average of 194/250 g soil following the 2005 potato crop to an average of 4/250 g soil at planting of the 2007 potato crop. However, during the 2007 potato crop, CRKN densities increased to 114/250 g soil in untreated plots and 70/250 g soil in plots treated with Vydate. There was no significant difference in harvest population densities between treatments with and without Vydate. In each rate of Telone, CRKN densities were reduced to trace amounts after fumigation and never increased during the course of the study. All Telone treatments had significantly fewer CRKN than untreated plots on all sample dates and there were no differences between rates on any date.

Effects on tuber symptoms: Symptom expression in tubers from the 2005 harvest sample was relatively low in unfumigated plots from the first set of plots but higher in the second set of plots (Table 2). This was probably due to higher CRKN densities at planting in the second set of plots. However, tubers in all untreated plots were infected with a high level of CRKN that could have potentially developed symptoms if tubers had accrued additional degree-days due to a later harvest and/or delay in reduction of storage temperature to below 41 F. Examination of tubers after an additional 850 DD_{5C} of warm storage determined that 48% and 72% of tubers would have been graded as internal culls in the first and second set of plots, respectively (Data not shown, see Pomme de terre Vol 16, No. 1). External symptoms did not increase with storage. None of the tubers examined from any of the Telone treatments had any external or internal symptoms at harvest and only traces of symptoms after the warm storage period. Plots that had not received Telone in 2004 and were not treated with Vydate in 2007 had similar levels of external damage in 2007 as had been observed in 2005 but a much higher severity of internal damage (Table 2). Plots that had been treated with Telone had only traces of CRKN symptoms and virtually no internal culls at any rate of Telone applied. Plots that had not received Telone in 2005 but were treated with Vydate in 2007 also had very low levels of tubers with symptoms and less than 1% internal culls.

No tubers from plots that received any rate of Telone in 2004 and Vydate in 2007 were graded as internal culls in the harvest sample.

Results from a second trial: In a second trial on a different farm, 25 plots with prefumigation densities of CRKN ranging from 330-2,090/250 g soil were treated with Telone at 12, 15, or 20 gpa on September 21, 2004. No unfumigated plots were included. At planting (May 5) and harvest (September 20) of potato cv Gemstar in 2005, average populations were $\leq$ 5/250 g soil for all three rates. A total of 625 tubers were evaluated after harvest (1,905 DD_{5C} since planting) and after warm storage for an additional 745 DD_{5C}. No tubers had any external symptoms of CRKN and no internal infection sites were present in any tuber at either examination. The field was planted to barley in 2006 and plots were resampled on May 5, 2007. No CRKN were recovered from any plot. More details on this study are available in Pomme de terre Vol 16, No. 1.

Summary

Telone at rates of 12, 15 or 20 gpa reduced population densities of CRKN to very low levels which had not increased three years after application. All rates controlled the expression of tuber symptoms due to CRKN infection to trace amounts in potato crops grown in 2005 and 2007. Tuber quality in all treatments would be considered acceptable for all domestic markets in both years. However, evaluation after warm storage in 2005 indicated that tubers from plots treated with 12 or 15 gpa had low levels of infection so these rates should not be considered for seed or export markets when treating fields with high CRKN densities. By contrast, plots treated with 20 gpa had less than 1% infected tubers after warm storage and would be acceptable for seed or export (Data not shown, see Pomme de terre Vol 16, No. 1). All rates of Telone had low levels of infected tubers at harvest in 2007 indicating that a second potato crop following Telone should not be used for seed or export. Negligible levels of infected tubers in plots that received Telone in 2004 and Vydate in 2007 suggest that this procedure may also be acceptable for seed and export, particularly for the 20 gpa rate of Telone. However, caution should be exercised since warm storage evaluations for 2007 have not yet been completed and tubers may be harboring nematodes that have not yet expressed symptoms.

Sudangrass suppressed population densities of CRKN substantially and may have contributed to the extended excellent performance of Telone in the second potato crop. However, CRKN levels increased rapidly in plots that had been planted to sudangrass in 2006 but had not received Telone in 2004 and tuber damage in these plots reached rejectable levels. This demonstrated that a green manure crop alone may not be sufficient in fields with a history of heavy tuber infection pressure from CRKN. However, following a sudangrass green manure treatment with Vydate applications during the potato crop provided excellent control of CRKN damage to tubers even when Telone had not been used in the past.

In conclusion, results from two trials suggest that two crops on potato can be protected from a single application of Telone. Protection for crops intended for domestic markets was equal for a12, 15 and 20 gpa but only 20 gpa should be used on fields intended for see or export if pretreatment populations are as high as those in this study. The second crop following Telone should not be used for seed or export unless treated with Vydate. This research should be repeated to further substantiate these conclusions.

Table 1. Effect of different rates of Telone II applied in fall 2004 on populations (No./250 g dry soil) of Columbia root-knot nematode (*Meloidogyne chitwoodi*) in potato grown in 2005 and 2007. Vydate was applied to one set of plots in 2007. San Luis Valley, CO.

Treatment[1]	Prefumigation Total[2]	Planting 2005[3]	Harvest 2005[4]	Planting 2007[5]	Harvest 2007[6]
No Vydate in 2007					
No Telone	620	32 a[7]	94 a	4 a	114 a
Telone II @ 12 gpa	450	1 b	2 b	<1 b	2 b
Telone II @ 15 gpa	830	<1 b	<1 b	<1 ab	<1 b
Telone II @ 20 gpa	490	<1 b	0 b	<1 b	<1 b
Vydate in 2007					
No Telone	265	64	294	3 A	70 A
Telone II @ 12 gpa	250	--	--	0 B	<1 B
Telone II @ 15 gpa	605	--	--	0 B	1 B
Telone II @ 20 gp	455	--	--	0 B	<1 B

[1]Applied October 15, 2004. [2]October 1, 2004. [3]May 5, 2005. [4]September 21, 2005. [5]May 7, 2007. [6]September 19, 2007. [7]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were log transformed before analysis and back-transformed means are presented. Plots with and without Vydate were analyzed separately.

Table 2. Effect of different rates of Telone II applied in fall 2004 on tuber symptoms from Columbia root-knot nematode (*Meloidogyne chitwoodi*) in potato grown in 2005 and 2007. Vydate was applied to one set of plots in 2007. San Luis Valley, CO.

	Harvest 2005[2]			Harvest 2007[3]		
Treatment[1]	% Ext. Damage[4]	% Int. Infect[5]	% Int. Culls[6]	% Ext. Damage	% Int. Infect.	% Int. Culls
No Vydate in 2007						
No Telone	17 a[7]	18 a	5	19 a	76 a	40 a
Telone II @ 12 gpa	0 b	0 b	0	<1 b	4 b	<1 b
Telone II @ 15 gpa	0 b	0 b	0	<1 b	2 b	0 b
Telone II @ 20 gpa	0 b	0 b	0	<1 b	7 b	0 b
Vydate in 2007						
No Telone	56	32	12	6	6	<1
Telone II @ 12 gpa	--	--	--	<1	0	0
Telone II @ 15 gpa	--	--	--	0	4	0
Telone II @ 20 gpa	--	--	--	0	<1	0

[1]Applied October 15, 2004. [2]Harvested September 21, 2005, 1,750 DD_{5C} from planting to peeling.
[3]Harvested September 20, 2007, 1,832 DD_{5C} from planting to peeling. [4]Percentage of tubers with any external symptoms of CRKN.
[5]Percentage of tubers with one or more visible internal CRKN infection sites.
[6]Percentage of tubers with six or more visible internal CRKN infection sites. [7]Means within the same column that are followed by the same letter are not significantly different ($P \leq 0.05$). Columns with no letters had no significant differences between means. Data were transformed before analysis and back-transformed means are presented. Plots with and without Vydate were analyzed separately.

8:00 am, Wednesday, Feb 13

Small Grain Crops Update

Merlin A. Dillon, Area Extension Agronomist, San Luis Valley Research Center

Cereal Cyst Nematode (CCN)

Cereal Cyst Nematode has been an intermittent problem in the SLV for several years. It may or may not develop into an important problem; probably not. However, the field area used for small grain trials at the Research Center developed a heavy, damaging infestation. And, an oat field in SE Saguache County also had high levels of CCN, causing spotty damage. CCN may have caused damage other places that was not documented by lab tests. Recent soil samples of potato ground for the Potato Cyst Nematode also show results for CCN, causing some alarm.

Symptoms: stunted plants, poor tillering, can be chlorotic, severe yield reduction in spots.

Small grain variety trials in 2004, 2005, 2007 were impacted by CCN. This includes almost all trials of oats, malt barley, and the various wheats.

The formula to estimate damages is below:

Log (% Yield Loss) = .000488 x Log (CCN/250 g soil)

Soil test results show these results for CCN for SLVRC fields:

NW = 53/250 g soil
SW = 0
NE = 48/250 g soil
SE = 85/250 g soil
Small grain plot area = 3661/250 g soil **74% YIELD LOSS**

In many similar fields such as ours, yield loss may be obvious in spots; but the field average may show minimal yield loss.

Wheat and Barley Fertilization Update

Crop and fertilizer prices have changed dramatically. Unheard of changes have occurred in both commodity prices and for fertilizer prices. Both have nearly doubled. The ratio of prices hasn't changed much at all. And, the ratio has to change drastically to change the most profitable fertilizer level. Nitrogen requirements remain the same:

Barley = 1.1-1.3 lbs nitrogen per bushel expected.
SWS Wheat = 1.5 lbs N per bushel
HRS Wheat = 2.0 lbs N per bushel
Durum Wheat = 2.0 lbs N per bushel
Winter Wheat = 1.75 lbs N per bushel

For increased grain protein; add N after heading.
Consider all possible sources of nitrogen.

a. N in irrigation water
b. N in soil
c. Soil organic matter releases 10-15 lbs for each one percent OM.
d. Add N for high crop residues

Canola Fertilization Update

An updated nutrient management guide is made available on the back table with the handouts, **"Irrigated and Dryland Canola".**

Canola = 6.5-7.5 lbs N per 100# yield goal.
Example: 2500 #/ac would require 175 lbs N
Example: 3000 #/ac would require 210 lbs N
Adjust N for high crop residue
Consider all possible N sources

Alternative Rotation Crops for Potatoes

1. Sunflower
   a. Sunflower is drought tolerant, maxiumum yield probably 3000 #/acre.
   b. Jack Kuntz had limited irrigation water, planted 60 acres.
      i. 2200 #/acre at 20 cents.
      ii. Current prices higher yet.
   c. Replicated Trial with limited irrigation
      i. 6.7 inches irrigation
      ii. 800 #/acre yield in plots
      iii. 1200 #/acre yield in best part of the field.
2. Sorghum-sudan Green Manure
   a. Drought Tolerant
      i. Will use 2.0-2.5 inches per week; apply 1 inch per week.
   b. Reduces CRKN
   c. Hay possible; still reduces CRKN somewhat.
3. Corn Silage
   a. Not Drought tolerant
   b. 22 ton / acre possible in warm year (2007)
4. Cash crop (Barley, Wheat)

3 Year Rotation

Potato / Barley / Sudan Rotation Protects Soil

1. Barley after potatoes. Barley planted Apr vs June (TWO MONTHS PROTECTION). Since potatoes leave very little residue, there is an advantage to planting barley in April instead of waiting until June to plant Sudan. Wind erosion protection is provided for two important months by planting April instead of June.
2. Sudan after Barley. Barley residue should be left standing in order to protect soil. Barley residue left upright will provide good wind erosion protection the following spring prior to planting sudan in June.
3. Potatoes after Sudan. Sudan residue should be chopped and lightly disked. Some residue should remain on the surface to protect the soil the following spring prior to planting potatoes.

Enhancing Protein in Wheat and Barley

Optimal grain protein is sometimes given premium prices. Malting barley is preferred between 10.5-12% protein. Hard wheats are preferred with protein content over 13%. Usual recommendations for wheat are to fertilize prior to heading for growth and yield. For improving protein content in wheat, nitrogen should be applied after heading. Similar research has not been conducted on malting barley. Only recently have cultivars been developed which produce low protein. Low protein had not been considered a problem until recently. What would happen if nitrogen were applied to malting barley after heading? Would the protein jump wildly and result in a protein content that was too high? Would added nitrogen not increase the protein of malting barley as it does in wheats? A field trial was established with Coors C69 malting barley. Two rates were applied at planting and 4 rates were applied after heading. This was a split plot, randomized and replicated trial with all combination of these treatments. Results are shown in the table. Nitrogen at planting increased both grain yield and protein content. Nitrogen after heading increased grain protein but did not increase grain yield. It seems that applying nitrogen to malting barley results in similar results as when applying nitrogen to hard wheats.

Nitrogen Treatment	Grain Yield [1/]	Grain Protein
	Bu/acre	%
At Planting N		
80	144.9 a	11.1 a
120	170.8 b	12.1 b
At Heading N		
0	--	10.8 a
30	--	11.5 b
45	--	11.7 b
60	--	12.5 c
Average	157.8	11.6

[1/] Yields followed by the same letter are not statistically different (Tukey's Test).

Three small replicated, randomized trials were conducted on hard red spring and hard white spring wheats. Results are shown in the tables below. Applying nitrogen after heading increased protein in 2 of 3 trials. 30 # N per acre usually increased grain protein about 1%.

Nitrogen Treatment	Grain Yield [1/]	Grain Protein
	Bu/acre	%
Lolo, Hard White Spring Wheat		
0	--	10.1 b
30	--	11.5 a
60	--	11.6 a
Average	99.2	11.1
Jerome, HRS Wheat		
0	--	10.8 b
30	--	11.8 a
60	--	12.6 a
Average	113.7	11.7

Nitrogen Treatment	Grain Yield [1/]	Grain Protein
	Bu/acre	%
Lochsa, Hard White Spring Wheat		
0	96.4	12.1
30	97.0	12.6
45	102.9	12.6
60	96.3	12.2
Average	98.1	12.4

[1/] Yields followed by the same letter are not statistically different (Tukey's Test).
Results were not statistically significant for applying nitrogen after heading on Lochsa, HWS wheat.

10:20 am Thursday, February 14

Alfalfa Growth Responses to Water and Partial Season Irrigation

Brad Lindenmayer, Dr. Neil Hansen, Dr. Joe Brummer, and Mark Crookston

Water in the West:

Competition for limited water resources in the Western U.S. has long been a critical issue and, in recent years, has reached a breaking point with water allocations reduced to fractions of historical allotments. Agriculture is competing against municipal and industrial users that continue to grow.

As is well known, the majority of the water in the West, including Colorado, is held under the Prior Appropriations System of water allocation, which is often referred to as, "first in time, first in right". Unfortunately, the system is not quite that simple and has been complicated by the effects of sub-surface pumping of water from aquifers on surface water flow. Currently, any sub-surface user must have a plan on file with the state of Colorado as to how they will augment the hydrologic system to replace what they depleted. Further complicating the matter, according to the Colorado Division of Water Resources, most of the hydrologic systems have been over-appropriated since the 1890's, leaving many junior water users with no water and unable to fulfill senior water users rights some years.

Interestingly, while there is high demand for water in the municipal and industrial sectors, it is the agricultural sector that legally holds and controls most of the water in the state of Colorado. This puts agriculture in a powerful position to create balance among the competing water interests.

Partial Season Irrigation:

Many people may understand the principle of limited or deficit irrigation. This irrigation practice limits the irrigation applied to a crop to only a fraction of what is demanded by the crop for normal growth without water stress, leaving the crop growing under a deficit of water for the entire growing season. Partial irrigation is similar to limited or deficit irrigation in that irrigation is limited and water stress may occur but only for part of the growing season. The goal of partial season irrigation is to keep the crop growing without water stress during critical growth periods and allow water stress to occur during less critical growth periods.

Alfalfa was thought to be a good candidate for partial season irrigation for several reasons. First, alfalfa consumes large quantities of water during the growing season, leaving a large potential for water savings. Also, alfalfa has drought and water stress tolerance mechanisms such as a deep root system and the ability to go into dormancy during drought periods. Finally, alfalfa has the management flexibility to withstand partial season irrigation. Harvest timing and irrigation can be adjusted easily.

What is ET?

ET or evapotranspiration is the water actually used by the plant either through root uptake and transpiration through the water conducting tissue to the plant cells throughout the plant or water lost to evaporation (Fig. 1). ET, often also referred to as consumed water, is sometimes confused with applied water. The difference is in the losses associated with water application. Applied water is the total amount of water applied through rain or irrigation, which is subject to several losses (Fig. 1). First, the water could run off the surface away from the plant becoming unusable. Also, the water could leach or percolate deep in the soil beyond the root zone and eventually reach the water table, also unusable to the plant. Since water in Colorado is billed on the basis of ET, it is important to understand this concept.

Previous Work:

There has been much work done in the past to determine the relationship in alfalfa between ET and yield. Studies have been conducted across a range of climates and geographic areas in the U.S. stretching from Minnesota and Nebraska to New Mexico and Utah and from North Dakota to Texas. When the ET and yield data from these studies are plotted on a graph, one can immediately see a linear relationship (Fig. 2). The slope of this line indicates the water-use-efficiency (WUE) or the amount of yield in tons/ac produced per inch of consumed water or ET. The slope of 0.18 tons/ac/in could also be thought of as 5.5 in/ton. This is very close to the old "rule of thumb" of 6 in/ton.

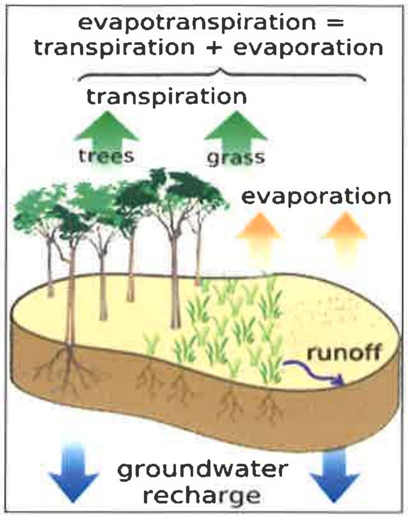

Figure 1. ET (http://en.wikipedia.org)

However, there is noticeable variability within that relationship, suggesting that other variables have an effect on alfalfa's yield and ET relationship. One of the studies included above took a look at yield and ET relationships for each cutting across a growing season and found that the relationship changes depending on the cutting (Fig. 3). The first and fourth cuttings had relatively steep slopes when the ET and yield data was graphed indicating higher WUE, while the middle two cuttings had flatter slopes indicating a lower WUE. This makes sense with what we know about alfalfa. Being a C3 plant, it prefers cooler temperatures and would therefore perform better and be more water efficient during the cooler spring and fall cuttings, while loosing efficiency during the hotter summer cuttings.

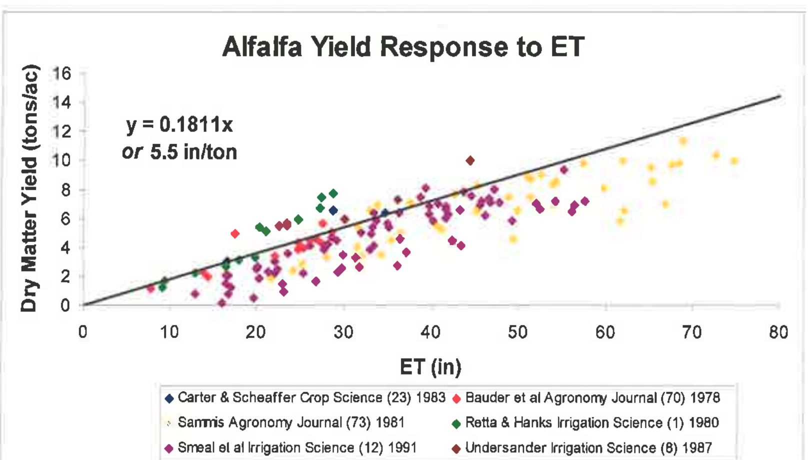

Figure 2. Alfalfa Yield Response to ET

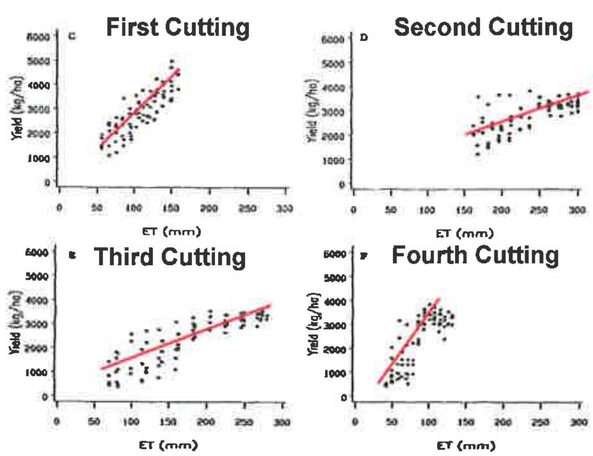

Figure 3. WUE Variability by Cutting (Adapted from Undersander, 1987)

CSU Study:

The objectives of the study conducted by CSU were to quantify alfalfa growth responses and consumed water (ET) under four different partial season irrigation regimes. The study site was located at the Northern Colorado Water Conservancy District (NCWCD) headquarters in Berthoud, CO. Average rainfall at this site is 13-15 inches and the soil type is a clay loam. The elevation is about 5,000 feet above sea level. The plots were irrigated with a state-of-the-art linear sprinkler that had drop valves controlled by GPS and water supplied from a holding pond on the site. Dairyland Magna Graze alfalfa from AgLand was planted in August of 2004 and overseeded in 2005 to establish a 92% stand. Irrigation treatments began in 2006. The four irrigation treatments were as follows:

Full Irrigation – No water stress. Crop was irrigated to fully meet ET demands.

Stop Irrigation After 2nd Cutting – Crop was irrigated to meet ET demands through the 2nd cutting then received no irrigation for the rest of the season.

Spring and Fall Irrigation – Crop was irrigated to meet ET demands through the 1st cutting and received one more pass of the sprinkler after then resumed irrigation after 3rd cutting to meet ET demands during the 4th cutting.

Stop Irrigation After 1st Cutting – Crop was irrigated to meet ET demands through the 1st cutting then received no more irrigation for the rest of the season.

Yields samples were collected fresh by weighing a 20 ft. section of windrow. Sub-samples were taken to determine percent dry matter as well as for forage quality analysis. Once dry matter was determined, that percentage was applied to the total fresh weight and then extrapolated to an acre.

ET was determined using a water balance method. This method balances all of the water inputs and losses according to the following formula:

$$ET = \Delta\Theta + I(Irr.Eff.) + P - R - D$$

Where: $\Delta\Theta$ is the change in soil moisture during a period of time (ie: cutting).
I is the amount of irrigation applied times an efficiency factor.
(Irr. Eff.) is an irrigation efficiency factor (95%).
P is the amount of precipitation.
R is run-off (assumed to be zero)
D is the deep percolation (also assumed to be zero)

The $\Delta\Theta$ value was determined by taking soil samples down to 8 feet in 1 foot increments. The samples were weighed wet, then oven-dried at 105°C, then weighed dry to determine the moisture in each foot. The moistures for each foot were summed to get an 8 foot profile total. Run-off was assumed to be zero because the irrigations were small (~0.75 in) and the field was fairly flat. Deep percolation was also assumed to be zero because of the small irrigations, the heavy soil type being able to hold large amounts of moisture, and the deep root system of alfalfa.

Stand density was also assessed in April 2007 by counting the crowns/ft^2 by randomly sampling in each plot four times.

Results:

The results from this study are summarized below in graphical form. Figures 4 and 5 depict yields for the two years by cutting according to irrigation treatment. Figures 6 and 7 illustrate the accumulated ET for each year highlighting the soil's ($\Delta\Theta$), irrigation's, and precipitation's contribution. Figure 8 shows the WUE for both years. Figure 9 confirms that the yield response to ET is the same as previous work. Figure 10 reveals some surprising differences in stand density. Figure 11 shows how the relative feed value (RFV) increases as the irrigation decreases. Finally, Table 1 lays out how the water savings compare to the loss in yield.

Figure 4. *2006 NCWCD Average Alfalfa Yields by Cutting*

Figure 5. *2007 NCWCD Average Alfalfa Yields by Cutting*

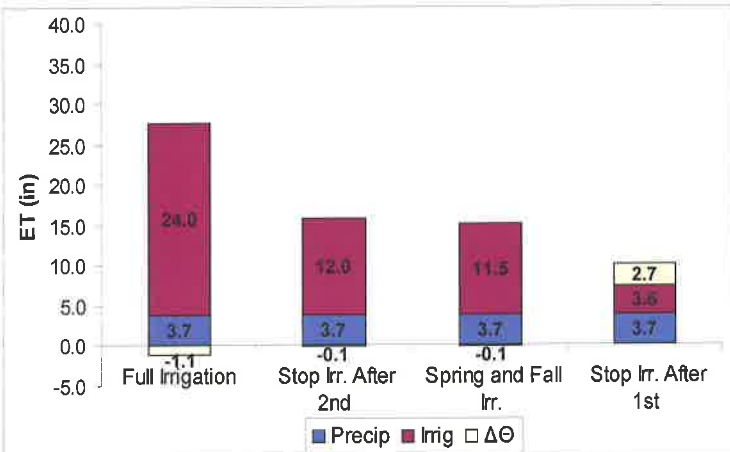

Figure 6. *2006 NCWCD Average Total Season ET by Contribution*

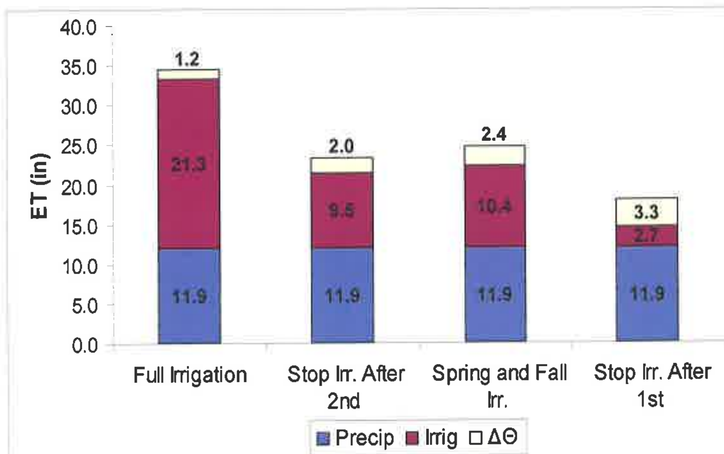

Figure 7. *2007 NCWCD Average Total Season ET by Contribution Figure*

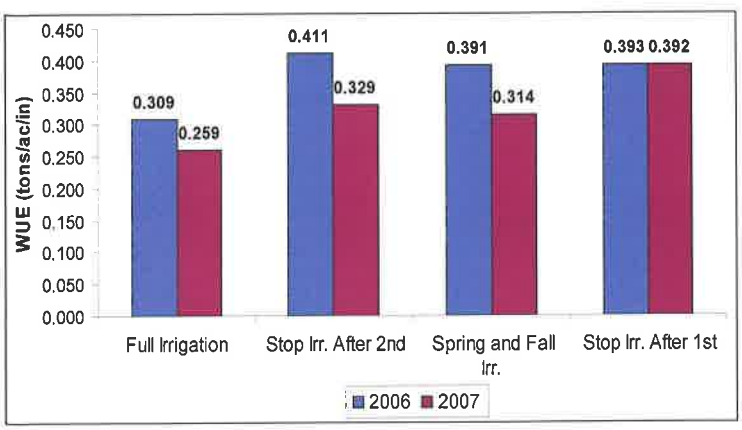

Figure 8. *2006-07 NCWCD Average Total Season WUE*

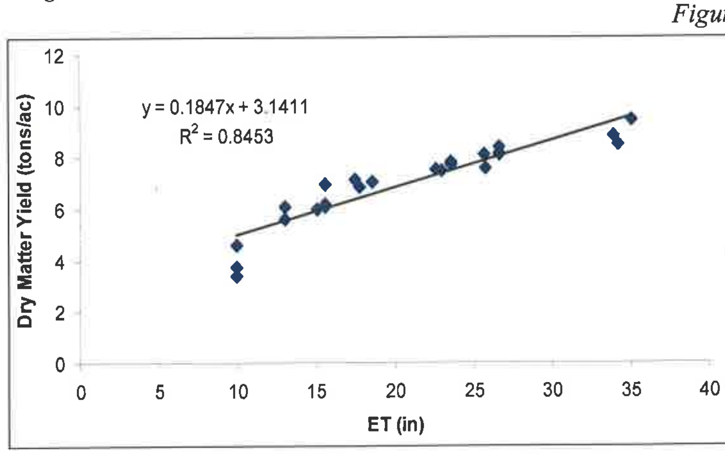

Figure 9. *2006-07 NCWCD Total Season Alfalfa Yield Response to ET*

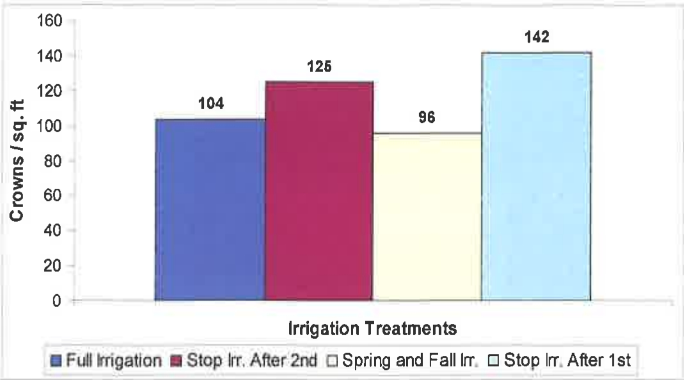

Figure 10. 2007 Average Crown Density

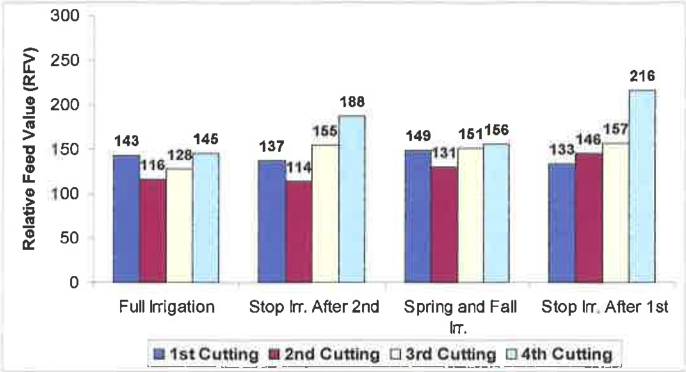

***Figure 11.** 2007 Average RFV*

Treatment	Seasonal Consumptive Water Savings (ET in/ac)	Seasonal Yield Reduction (tons/ac)
Full Irrigation	0	0
Stop Irr. After 2nd	11.0	1.2
Spring and Fall Irr.	10.6	1.6
Stop Irr. After 1st	16.5	3.1

***Table 1.** NCWCD Summary (2006-07 Averaged)*

Conclusions:

From this information, several principles can be learned. First, alfalfa yield exhibits a linear relationship with ET but the slope of that line can change during the season. Second, alfalfa producers can capitalize on that change through partial season irrigation and concentrate irrigations during periods of higher WUE (i.e.: spring and fall). Third, alfalfa has the ability to grow under partial season irrigation conditions as indicated by similar 2007 first cutting yields after a whole season of water stress and similar fourth cutting yields between the Full Irrigation and Spring and Fall Irrigation treatments after in-season water stress. Fourth, partially irrigated alfalfa may also exhibit higher stand density over time as indicated by more crowns per ft^2 after one season partial irrigation. This may be due to lower propensity for disease in the drier treatments. Alfalfa producers may also be able to capitalize on higher RFV hay under partial season irrigation. Finally, water savings from partial season irrigation may be able to create balance among competing water users in Colorado and the rest of the water-limited West.

11:10 am, Wednesday, Feb 13, 2008

Potential Soil Erosion: Various Potato Rotation/Tillage Plans

Cindy Crist, *NRCS DC, and* **Richard Sparks**, *NRCS Regional Agronomist*

BALANCING CROP CONSUMPTIVE USE WITH OUR WATER SUPPLY is a critically important goal for the SLV. No one can argue the logic. ***Crop rotations can be planned that will help balance supply with consumptive use.***

We often tend to think that ***"We have too many wells and too much cropland acreage under irrigation!"*** There is, however, a break in logic here. This statement is not necessarily true, unless you presume the past crop rotations are the only potential rotations available.

Long term retirement of cropland carries an unnecessary risk that our crop rotations will be tightened up even more to maintain our potato industry. For example, idling cropland for 15 years under the envisioned **CREP** program (Conservation Reserve Enhanced Program) would obviously reduce consumptive use directly by replacing some cropland acreage with non irrigated native grasses. But, there are other options that should be evaluated prior to making this type of long term commitment to retiring cropland acres.

We MAY NOT have too many acres under irrigation! We do have too little water to maintain our past rotations.

SOIL QUALITY IS ANOTHER BALANCING ACT! Tight rotations (Potatoes every other year) and tillage intensity have had the SLV in a strangle hold for years. Tight rotations can result in the following:

1. Increased wind erosion - the irreversible loss of fine soil particles
2. Tillage losses of soil moisture and organic matter
3. Decreased microbial activity and diversity
4. Increased soil born pathogens: nematodes, pink rot, Verticillium wilt
5. Increasing nightshade & possible Eptam resistance
6. Increased nitrate leaching
7. Increased fossil fuel use
8. Reduced infiltration and water holding capacity of the soil.

The NRCS Soil Condition Index **(SCI)** is a good measure of organic matter losses and wind erosion. Increased pathogen pressure, annual weeds, and nitrogen leaching directly reduce crop yields and quality.

The economic impacts of going to three year rotations must be evaluated in the context that we have no choice but to reduce consumptive use.

This presentation focuses on changing our normal two year Potato/Grain rotation to three year rotations, e.g. Potato-Grain-Sordan. Three year rotations can reduce average consumptive use and at the same time significantly improve soil productivity. Annual potato yield would likely increase by 10%.

Crop Rotation Systems

System Descriptions	Duration (yrs)	CU (in/ac/yr)	Wind E (t/ac/yr)	SCI	Diesel ($/ac/yr)	OM sub-factor
Barley Potato	2	16.6	21.6	-1.6	14.99	-0.055
Potato-Rye Sordan	2	13.7	9.2	-0.68	17.45	-0.25
Potato-Rye Sordan Barley	3	14.6	8.4	-0.59	15.95	-0.13
Winter Grain Sordan Potato	3	13.9	6.1	0.23	12.99	0.99
Barley Sordan Potato	3	13.4	12.8	-0.77	12.57	0.21

CU – Consumptive Use average, inches per acre per year
Wind E – Average tons per acre per year
SCI – Soil Condition Index, **+ = improving**, **- = declining**
Diesel – Dollars per acre per year at $3 per gallon
OM – Organic Matter trend that impacts soil condition

Two Year Potato Grain Rotations

Potato - barley rotation: Our standard rotation requires careful effort to keep small grain residues at high levels going into potatoes to reduce wind erosion. Chiseling following potatoes is critical to eliminate compaction and leave a ridged seedbed. Soil erosion, however, is still massive in the spring during barley establishment. **Soil Condition Index at negative 1.6 indicates a declining trend in soil quality**. **Consumptive use averages 16.6 inches per year**.

Potato-Rye Sordan: If sordan is grown instead of barley to reduce consumptive use and decrease nematodes, soil erosion exceeds 30 tons per acre on loamy sand soils. Winter rye is essential if soil erosion losses are to be kept below levels acceptable for USDA eligibility. Both the decomposing rye cover crop and sordan cover crop will decrease nematode pressures. The reduced consumptive use benefit from deficit irrigated sordan, however, is partially sacrificed irrigating the rye. Also, extra tillage is needed to kill the rye. **SCI is improved, but still negative 0.68.** **Consumptive use averages 13.7 inches per year.**

Three Year Potato Grain Rotations

Potatoes grown every third year will allow deficit irrigated sordan to reduce average consumptive use. Annual tillage intensity can be decreased. Soil born pathogens will be decreased significantly due to increased time in non host crops, and the decomposition of incorporated high residue crops.

Potato-Rye Sordan Barley: If rye and sordan are planted prior to going to barley, the risk exists that nematodes may increase with the barley host, so this rotation should be used only where nematode pressures are low. **SCI is improved, but still negative 0.59. Consumptive use averages 14.6 inches per year.**

Winter Grain Sordan Potato: The best to reduce erosion damage and from a soils quality standpoint, but requires a little more consumptive use. **SCI is a Positive 0.23. Soil quality will definitely improve due to less erosion and more crop residue returned. Consumptive use averages 13.9 inches per year.**

Barley Sordan Potato: We consider this rotation a good balance of tradeoffs! Erosion losses are still a cost of growing spring grains, but consumptive use is less than growing a winter crop. Organic matter is improved. Fuel use averages less than other rotations. **SCI is a negative 0.77. Soil quality is much better than the standard two year rotation, but a little less than the other three year rotations. Consumptive use averages 13.4 inches per year.**

Potential Soil Erosion

Wind Erosion is a function of the climate, soil erodibility, protection from snow cover and growing crops, residue protection on the soil surface, correctly oriented ridges, tillage roughness, and the unsheltered distance across the field.

The following practices should be carried out regardless of the rotation followed.

Mulch Tillage of the Crop Residues: Avoid baling small grain straw. This is an excellent resource to maintain high levels of protection on the soil surface, and to build soil organic matter. Avoid moldboard plowing or other aggressive inversion implements. Leave high amounts of residue on the surface during early spring.

Tillage intensity and timing can be managed to leave plenty of sordan residue to reduce wind erosion the following spring. Green manuring crops does not require complete incorporation. Moldboard plowing green manure crops would be a waste of energy and less effective than mulch tillage.

Ridging: Ridges should be 3 or 4 inches high, 12 to 16 inches apart, and perpendicular to our prevailing south west winds. Ridges should be constructed with chisels or harrows, not cultipackers, to leave a roughened surface. Adequately roughened ridges can be built with chisels or harrow teeth on planes

Soils in the San Luis Valley are often too sandy to effectively reduce wind erosion from ridging. Smooth ridges, as shown above, are much less effective at controlling wind erosion especially on soils that do not crust.

Minimize exposure: Growing crops or crop residue should be present at high levels as long as possible. Minimize the time between final seedbed preparation and planting. Irrigate immediately after planting small grains.

Chiseling barley fields prior to sordan, leaves high amounts of residue from August until May. Sandhill cranes and other waterfowl benefit from waste grain.

Reduce Unsheltered Distance: Leave mowed annual weeds or other cover in the corners of pivots. Bare soil left by disking weeds on corners increases unsheltered distance. Consider splitting fields in half and stagger high residue crops with low residue crops.

Presentation at 3:45p Wednesday, Feb 13
Demonstration at 4:30 Wednesday, Feb 13 (Social Hour at 4-H Barn)

Producing Biodiesel On-Farm

Raph Shay, Outreach Coordinator, ICAST, Lackwood, CO.

The following information is provided as a collaboration of i-CAST and CSU Extension who together developed the small scale biodiesel production plant which is trailer mounted. It will be demonstrated in the 4-H Barn during the Social Hour. Biodiesel should actually be produced during the demonstration at the Social Hour.

Equipment Cost Estimates

Oil Seed Expeller

Oil Production from Seeds

Expellers can generally extract ***14%***, by weight, oil from Soy beans and ***32%,*** by weight, oil from Oilseeds such as Sunflower, Mustard, Camelina or Canola. The oil, with minimal processing can be used as a biofuel – SVO or straight vegetable oil.

100 lbs of Seed	Gallons of Oil
Soybean	1.9
Oilseed – canola, etc.	4.4

Equipment	Capacity	Costs
Expeller	***175 - 225*** lbs./hour of seed	$950-$3,000
Filter Press	***175 - 225*** lbs./hour of seed	$650-$1,000
Biodiesel Processor Kit	***40-80*** gallons/batch	$3000-$3700
Expeller	***500 - 600*** lbs./hour of seed	$1,500-$8,100
Filter Press	***500 - 600*** lbs./hour of seed	$1,700-$2,000
Biodiesel Processor Kit	***125-175*** gallons/batch	$4,400-$7,000

** The cheaper suppliers are typically out of China, the medium range suppliers are out of India and the higher cost suppliers are typically from the USA.*

Biodiesel Production from Oil

Biodiesel Reactor Kit

One gallon of oil mixed with approx. 0.2-0.3 gal of methanol and sodium hydroxide (lye) will yield approx. 0.85 gallons of biodiesel.

Additional Costs (varies case by case):

1. Shipping/transportation
2. On site installation- foundations and installer fees
3. Taxes/Duty depends on supplier and customer location
4. Storage tanks/bins/barrels for oil, seed, meal, biodiesel
5. Raw ingredients such as seed, methanol and Lye (NaOH)
6. Miscellaneous parts such as pipes, filters, pumps, replacement parts... etc.
7. A 50,000 gallons/year biodiesel plant will cost between $40,000 and $125,000.

Uses of Biodiesel Co-products

• The biodiesel production process produces two co-products: meal and glycerin;

Meal

1. Meal can be fed to your livestock which could save you money;
2. Generally, oilseed meals sell lower than soy due to their slightly lower protein content - Soybean (52.9%), Sunflower without hull (50%), Sunflower with hull (42.8%), Canola (40.9%), Safflower (25.4%).
3. Meal produced with a cold press is sold at a premium because it does not contain hexane, which is used in the chemical oil extraction process.
4. Meal produced with a cold press has the additional benefit of higher oil content, which increases its energy value.
5. If there is no livestock in the area to use meal as feed, it can be burned for bioenergy;

Crude glycerin

6. Can be composted if mixed with dry matter in order to maintain oxygen supply to the bacteria. It is possible to contract a composting company to take the glycerin for composting;
7. Crude glycerin may also be spread onto fields for nutrients if mixed with water. This has been shown to add nutrients back into the soil.
8. Crude and refined glycerin is proven safe and nutritious as ruminant feed. It can constitute up to 15% of the ruminant's feed. Lactating cow energy balance was improved when glycerin comprised 2% of the diet. Some researches show that glycerol is better used when mixed with a low-starch diet;
9. Refined glycerol can replace up to 10% of the fermentable starches in the diet of livestock; this includes cattle hogs and poultry;
10. Burned at temperatures above 1100-1800°F for heat and power, burning at lower temperatures will produce carcinogenic compounds;
11. Purified to produce propylene glycol (a non-toxic anti-freeze);
12. Refined by removing the methanol and water making it suitable to sell on the market while reusing the methanol. Unfortunately, biodiesel's popularity has saturated the glycerin market and it now sells for 1 to 2 cents per gallon. Nonetheless, refined glycerin can be used in soap making and other manufactured goods.

iCAST Role

- *iCAST* provides technical and business assistance to rural communities and producers.
- *iCAST* projects are collaborative efforts involving local community members, organizations, government, industry partners and universities.
- *iCAST* projects create new economic opportunities associated with energy autonomy through sustainable use of local resources.

***i*CAST** (International Center for
Appropriate & Sustainable Technology)
www.iCASTusa.org
info@iCASTusa.org
303.462.4100

What Can iCAST Offer You?

iCAST works with rural communities and individuals to implement cost-effective projects that lead to community scale businesses with sustainable technology.

iCAST specializes in:

- Feasibility Analysis
- Cost/Profit/Savings Estimates
- Business Plan development
- Detailed Process Design
- Project Management
- Grant/Funding Application
- Project Implementation

info@iCASTusa.org
(303) 462-4100
www.iCASTusa.org

On a variety of technologies, including:

- Biofuels
- Wind Turbines
- Energy Efficiency Designs and Retrofits
- Biomass utilization
- Solar Thermal Systems & Photovoltaics
- Waste utilization

iCAST evaluates the technical and economic feasibility of business ideas by establishing a collaborative effort involving local community members or individuals and organizations, government, industry partners and universities.We would like to hear about your potential project and answer any questions you may have about sustainable technology, renewable energy or business development.

More Information

www.BiodieselCommunity.org
Wide variety of information; good for basic biodiesel education

www.PlanetBiodiesel.com
Information on biodiesel including supplies and production

www.CUbiodiesel.org
CU Biodiesel department; provides list of web pages addressing biodiesel

www.JourneytoForever.org
Information on all aspects of diesel biofuels; great starting point

	No. 2 Diesel	Straight Vegetable Oil (SVO)	Biodiesel
What it is	Refined petroleum oil	Filtered plant oil - either new or used	Refined and filtered plant oil (ethyl ester)
Energy Ratio (energy output vs. energy input)	0.75:1	6:1	3:1
Vehicle Usage	Any vehicle made for diesel fuel	Vehicles made for diesel fuel with conversion of engine	♦ B20 or lower: any vehicle made for diesel fuel ♦ B20 or higher: vehicles made for diesel fuel with conversion of engine
Vehicle Maintenance Issues	♦ Fuel gelling in cold weather– plugs filterAdditives can fix gelling issue	♦ Fuel gelling in cold weather– plugs filter ♦ Additives can fix gelling issue ♦ Fuel is naturally thick– creates problems with flow and injection ♦ Conversion kits heat fuel to increase flow ♦ Mixed with oxygenated fuels to fix injection issues	♦ Increases engine longevity due to higher Lubricity ♦ Problems with biodiesel use are fixable ♦ Fuel gelling in cold weather– plugs filter ♦ Additives can fix gelling issue ♦ Biodiesel acts as a solvent– can cause hose degradation (typically in vehicles made before 1985)
Cloud Point (Point at which solids start to form in fuel; this is beginning of the gelling process, at this point the fuel can still be used)	3° F	Varies depending on the type of oil used, However it is generally higher than biodiesel	Depends on Fuel Blend: (B10=10% biodiesel in mix) ♦ B10: 5 F ♦ B20: 7 F ♦ Pure Biodiesel: 32 F
Storage Issues	None	Short Shelf Life	6 month shelf life
Environmental impacts	Not biodegradable High toxic emission levels	♦ Biodegradable ♦ Reduces most emissions: Similar to biodiesel ♦ Produces more particulate matter than biodiesel	♦ Biodegradable Compared to Diesel: ♦ Reduces: CO_2 by 100%, SO_2 by 100%, soot by 40-60%, CO by 10-50%, HC by 10-50%, PAHs by up to 97% ♦ Increases: NOx emissions by 10%

About Biofuels

- Biofuels, made from oil-bearing seeds, include **straight vegetable oil (SVO)** and **biodiesel**
- These fuels work in engines that would otherwise use petroleum diesel
- Can be produced on a farm or commercial scale
- Can provide local jobs and allow for greater independence of rural farms and towns
- More environmentally friendly than diesel (zero net carbon impact)

Straight Vegetable Oil (SVO)

- Heated SVO can be used in diesel engines
- Works best in indirect injection diesel engines
- SVO can be made from a variety of crops and used cooking oil
- Can be the least expensive alternative fuel option for diesel engines

Biodiesel

- Used as a pure fuel or mixed with diesel
- Government tax credits are offered for those making biodiesel
- Fuel consumption rates proven to be similar to those of petroleum diesel
- Its use will not void engine warranties
- Can be stored in the same types of tanks as diesel
- Shelf life is 6 months

Colorado State University
Extension

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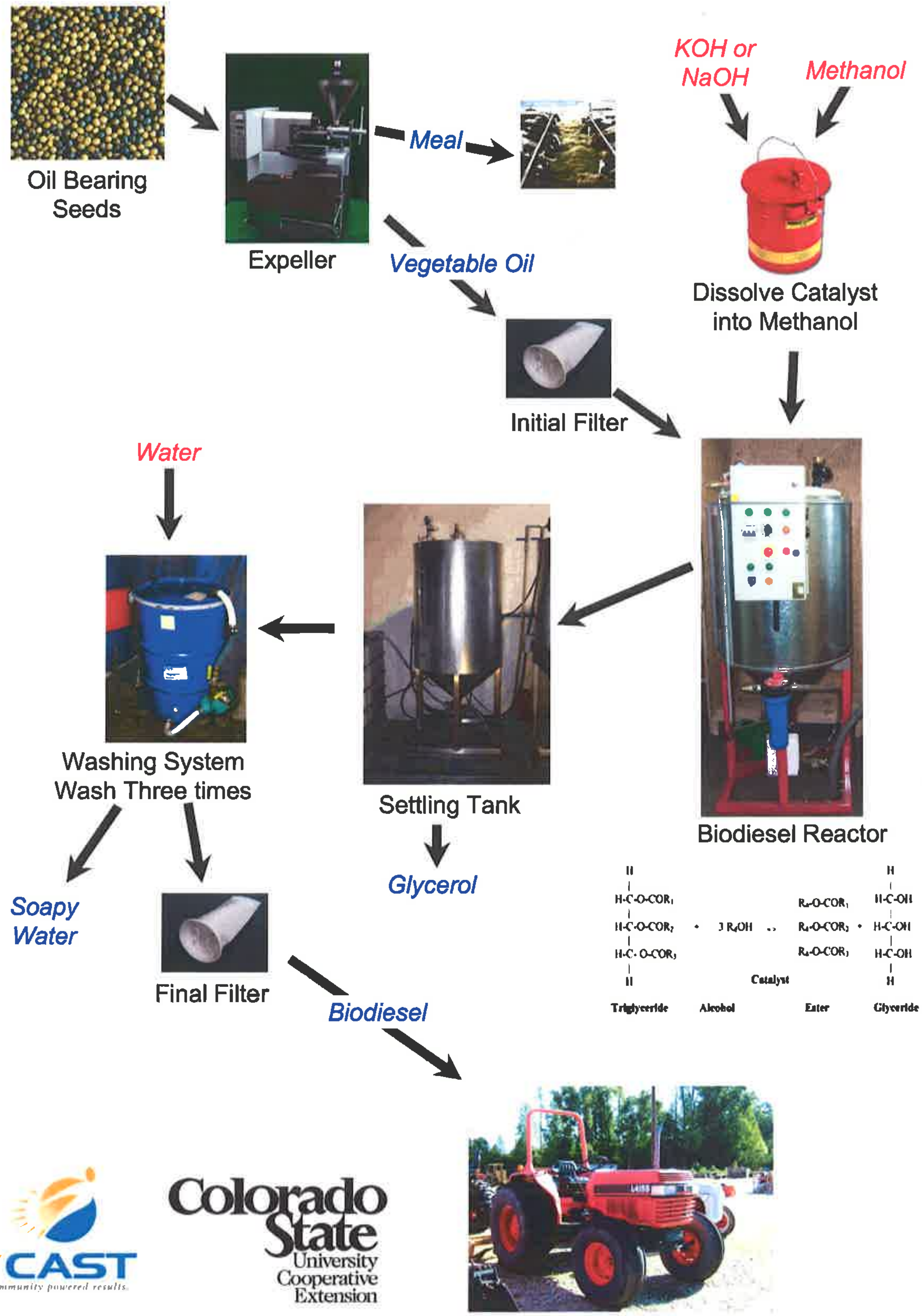
Biodiesel Process Flow



8:50 am Thursday, Feb 14

Alfalfa Production: Missteps to Avoid

Michael Velde, Alfalfa Breeder
Dairyland Seed Company

With grain commodity prices at record highs and input costs continuing to escalate; getting the maximum value from every acre planted should be on the forefront of every producer. Production missteps can be very costly whether you are producing alfalfa or potatoes. This discussion is to highlight some missteps that could be limiting your alfalfa production in the San Luis Valley of Colorado.

Misstep #1: Field selection and autotoxicity.

You are limited to the fields in your farming operation, however, how you rotate your acres will determine the maximum forage yield potential available. Very short rotations, or not rotating out of alfalfa, will limit the forage yield potential due to autotoxicity. Autotoxity is the harmful effect caused by residual toxic compounds left in the soil from a previous alfalfa crop. These toxic compounds are primarily located in the stems and leaves of the plant, so removing as much of the forage from the previous crop will help reduce the risks of a problem. Soils that are sandier are able to leach the autotoxic compounds faster than heavier clay soils which can be more problematic. Lower rainfall areas can also tend to retain these compounds longer. More aggressive tillage can aid in the breakdown of the autotoxic compounds. Younger alfalfa stands will have less effect on rotating back to alfalfa. Stands greater than one year or more are showing significant stand and forage yield reduction when rotated back to alfalfa. The recommended time interval to re-establish alfalfa varies by rainfall and soil type. In Michigan, a three week interval showed no yield reduction while in Wisconsin 2 and 4 week intervals showed a 70-30% reduction, respectively. The best way to reduce

Inter-seeded alfalfa into one year old winterkilled stands the risks of autotoxicity is to rotate to a grass crop like barley or a small grain that will utilize the nitrogen credits alfalfa provides before planting alfalfa in the same field. Attempts to thicken old alfalfa stands by interseeding with alfalfa have not worked well because of autotoxicity.

Misstep #2: Variety selection.
To capture the full potential of each acre, plant the best genetics available for your farm. The hybrid alfalfa varieties have allowed growers to maximize the forage yield potentials of their farm. There have been reports of better water utilization with hybrid alfalfa over conventional varieties. Each field is unique in regard to soil type, drainage, hardpan and irrigation potential. In soils that have a hardpan or irrigation water does not penetrate, a branch rooted variety will be more persistent and productive. Through plant breeding, we have been able to overcome many of the barriers of fall dormancy and persistence. Excellent persistence can be bred into fall dormancy 2's through 5's.

Misstep #3: Weed Control
Weeds should be controlled in the rotation crop. Pre-plant herbicides are available, however, seedling stunting may result with the use of these products. Post emergence herbicides can be used to control grasses and broadleaf weeds. Harvesting usually controls broadleaf weeds. Winter annuals and perennials can be controlled with an early spring application of herbicides.

Branch root alfalfa

Misstep #4: Seed bed preparation
The most common mistake that I have observed is that the seed bed has not been prepared well. A firm, weed free seed bed is needed to get good seed to soil contact. Over working the field can create a hardpan and/or a crust layer that will not allow the seedling to emerge.

Prepare a firm, weed free seed bed

Misstep #5: Planting

Alfalfa seed should be placed about ¼ inch deep. In lighter soils seed placement can go up to ½ inch deep. Alfalfa seed placement is as important as seed placement in other high value crops. Planting too deep or shallow is often the first mistake in alfalfa production. Always take the time needed to insure proper seed placement.

Plant ¼ inch deep

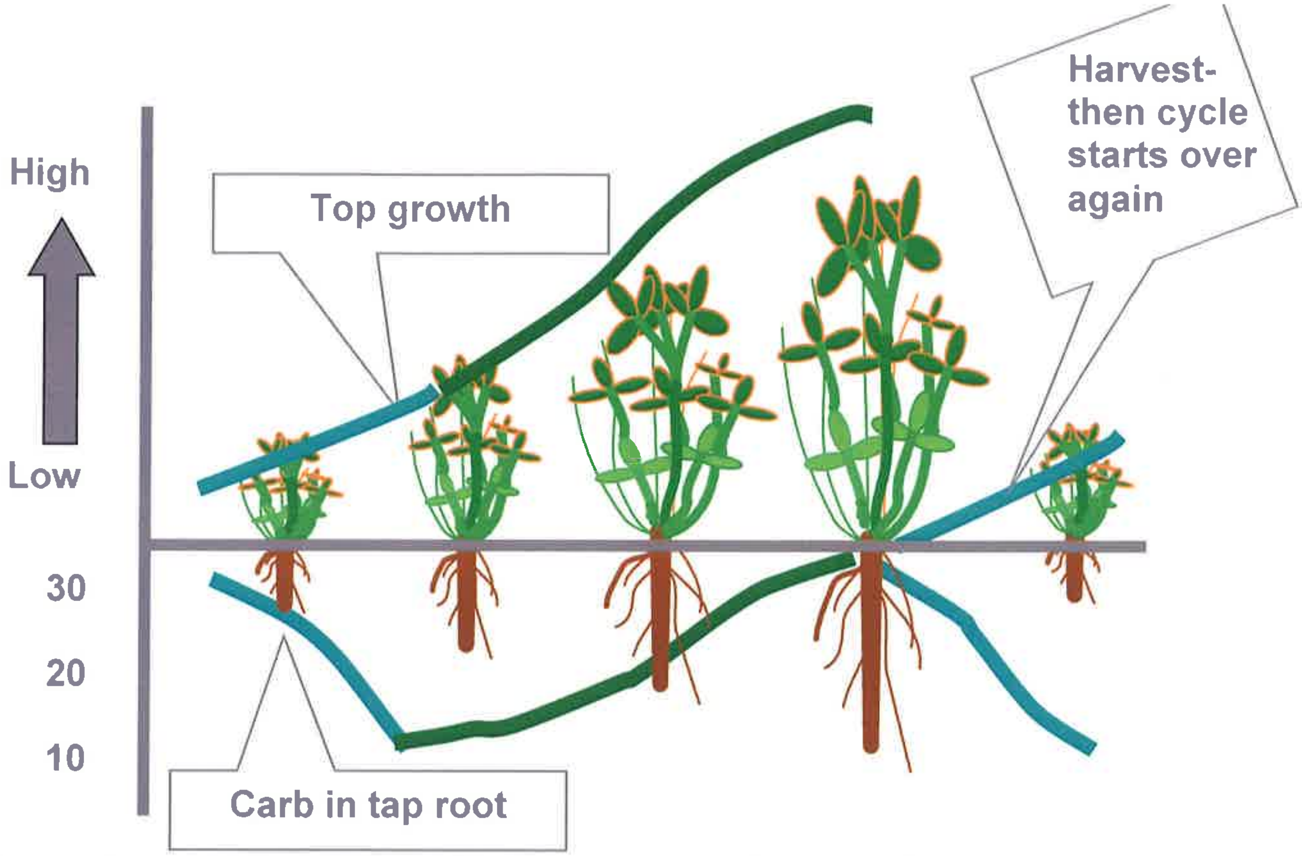
Thick stands with proper seed placement

Misstep #6: Alfalfa Plant Population

Begin with high plant populations to insure full, weed free stands. I have yet to visit a farm where the grower is proud of his stand when he only used 10#/acre. Farmers who boast about their stands are usually seeding at 20-25#/acre.

Misstep #7: Harvest Management

Understanding the plant growth cycle will help manage the health and persistence of the plant. Alfalfa will use stored carbohydrates to initiate growth in the spring and after every cut. The plant will use these carbohydrates until the regrowth is 6-8 inches tall. Only after this height is achieved will the plant then begin to recharge the roots and crowns. The stored root nutrients are fully charged when the plant is at late bud stage. Late bud stage is an ideal time to harvest in order to maximize plant health and balance forage yield and quality. If you see that new regrowth has initiated before harvest, the plant was ready to cut before that time.



Set up a harvest schedule that will allow you to produce a product to meet your customer's demands. Forage quality declines the fastest during the first crop when harvesting late and declines slower at later summer harvests. For dairy quality forage, target harvesting the first crop at early to mid bud stage. Later cuttings can be delayed to late bud stage to maintain the same quality and improve yield and persistence.

Mowing and conditioning the forage will affect drying times. Spreading the windrow wide will help speed the drying of the forage. Narrow windrows will delay drying time. Tedders are available to spread out the hay to dry, but its use will often cause leaf loss. Windrow inverters are popular in that it gently turns the windrow to allow the bottom to dry before baling.

Misstep #8: Fall Harvest Management
Alfalfa needs at least 6 weeks of growth before a killing frost to store enough nutrients to go through the winter months and initiate spring green up. If this time is shortened, spring green up will be slower or could result in winterkilled stands. Harvesting after hard freeze or after 6 weeks of fall growth is possible. A decision about whether to fall cut should be based on how much winterkill risk you are willing to accept. In the Midwest, in 4 out of 5 years, harvesting after a killing frost is a good decision. The fall cut after frost will produce very high forage quality forage.

There are controllable and uncontrollable factors that can affect the winter survival of your alfalfa stand. Uncontrollable factors are snow cover, freezing rain that seals the ground, mid-winter thaws, extremely cold temperatures, and lack of or excessive moisture going into the winter. Factors that you can control are the variety you plant, soil fertility, harvest strategy, stand age and cutting height of last harvest.

Misstep #9: When should I rotate my stand?
Forage yield declines over years due to environmental stress, wheel traffic, diseases, and management. The decision take out a stand should be based on the forage yield productivity of the stand. The encroachment of weeds is a good indicator of stand decline. Short rotations may be more profitable because forage yields are highest in the first and second years of production. Average forage yield drops 10% in year 4 and 25% in year 5. The risk of winter damage decreases with shorter rotations. Shorter rotations also provide additional nitrogen credits to the following crop.

Every growing season and management style is different. Being aware of some simple missteps can help you increase productivity and profitability and insure a continuous supply of forage that you and your customers are depending on.

11:10 am Thursday, Feb 14

Grasses for Forage Production

Richard Sparks NRCS 2008 (719) 588-1121

Long Term Reduction of Consumptive Use on Idled Cropland

No grazing or haying is normally permitted under the Conservation Reserve Enhanced Program (CREP). Limited grazing potential. Best results in a 7 inch or greater rainfall zone or with a 1 inch annual maintenance irrigation.

Loams & sandy loams - non-sodic soil: (Norte, Graypoint)

Seed Recommendations:		Approximately $56			Drilled
Species	**Variety (table 6: PMTN 59)**		**PLS/Ac to use (100%)**	**% in mix**	**Rate (PLS lb/ac)**
Indian ricegrass	Nespar		6.0	20	**1.2**
Thickspike wheatgrass	Critana		5.0	25	**1.3**
Blue grama	Hachita		1.5	35	**0.5**
Bottlebrush squirreltail	Wapiti or Pueblo		4.5	10	**0.5**
Sand dropseed			0.5	10	**0.1**

Sandy more sodic soils: (Gunbarrel, Mosca, San Luis)

Seed Recommendations:		Approximately $48			Drilled
Species	**Variety**		**PLS/Ac to use (100%)**	**% in mix**	**Rate (PLS lb/ac)**
Indian ricegrass	Nespar		6.0	35	**2.1**
Thickspike wheatgrass	Critana		5.0	25	**1.3**
Alkali sacaton	Salado		1.0	20	**0.2**
Blue grama	Hachita		1.5	10	**0.2**
Sand dropseed			0.5	10	**0.1**

Establishment: Plant 20 lbs per acre oats for cover in May. Apply glyphosate in early June. Pre-irrigate soil (1 to 2 inches) and **drill 3/4 inch deep in late June or early July**. Apply two 0.5 inch irrigations the first week after planting. Apply light irrigation as grass seed emerges and again when secondary roots start. The following spring, apply two one inch irrigations in May as spring emergence of the native grasses continues. Monitor and apply herbicide to control annuals and biennials. Note: Rabbitbrush and greasewood will gradually invade the grass stand.

Short Term Reduction of Consumptive Use in a Crop Rotation

To be used f… **CREP 15 Year Cropland Retirement Envisioned** …r. This mix will withstand several years…

Loams & sandy loams - non-sodic soil: (Norte, Graypoint)

Seed Recommendations:		Approximate Cost - $33			Drilled
Species	Variety		PLS/Ac to use (100%)	% in mix	Rate (PLS lb/ac)
Pubescent wheatgrass	Luna		9.0	25	2.3
Intermediate wheatgrass	Tegmar		10.0	35	3.5
Western wheatgrass	Arriba		8.0	20	1.6
Blue grama	Hachita or Lovington		1.5	20	0.3

Nine inches of water applied in April, May and June would yield two or three tons per acre of grass hay with adequate nitrogen. With only 2 inches of water applied, introduced wheatgrasses will decline, and grass stand will eventually be dominated by blue grama.

Short Term Reduction of Consumptive Use in a Crop Rotation

Crested wheatgrass is an excellent option for on temporarily idled cropland to split pivots that are very water short. After 5 years or so, rotate grass acreage into annual cropland; seed the annually cropped portion into crested wheatgrass.

Most cropland soils:

Seed Recommendations:		Approximate Cost $15			Drilled
Species	Variety		PLS/Ac to use (100%)	% in mix	Rate (PLS lb/ac)
Crested wheatgrass	Ephraim or Nordan		3.0	100	3.0

Three inches of irrigation water applied in April and May will keep the stand healthy and productive (two to three AUM's). If irrigation is completely eliminated, stand would likely deteriorate over a 5 year period. Crested wheatgrass provides excellent weed control during set-aside years.

NRCS Set Aside for Reduced Consumptive Use Envisioned

Grasses for Pasture and Hay Production

These grasses should yield 4 – 5 tons / acres with adequate nitrogen and irrigation water (23 inches per year). Deficit irrigation will reduce consumptive use, but yields will be reduced. Mixture to be used as straight grass with nitrogen fertilizer added, or ideally mixed with alfalfa. Reduce grass rates by 50% if 4 lbs of alfalfa is included.

Loams & sandy loams & loamy sands - non-saline soil: (Norte,Graypoint, Mosca, Gunbarrel, San Luis)

Seed Recommendations:		**Approximate cost $60**			**Drilled**
Species	**Variety**		**PLS/Ac to use (100%)**	**% in mix**	**Rate (PLS lb/ac)**
Meadow brome	Regar		17.0	40	**6.8**
Smooth brome	Manchar		13.0	30	**3.9**
Intermediate wheatgrass	Tegmar		15.0	30	**4.5**

Caution: Avoid using timothy or orchard grass in mixtures on these soils. Limited water holding capacity and winter freezing prevents them from surviving in the valley floor.

Meadow brome comes on earlier and should be hayed early to avoid loss of protein and digestible nutrients. Its re-growth is excellent. Intermediate wheatgrass is later, but will re-grow fairly well if cut at an early stage.

Heavy loam, saline soils: (Alamosa, Hagga, Zinzer)

Seed Recommendations:		**Approximate Cost $39**			**Drilled**
Species	**Variety**		**PLS/Ac to use (100%)**	**% in mix**	**Rate (PLS lb/ac)**
Tall fescue	Fawn		8.0	15	**1.2**
Smooth brome	Manchar		13.0	25	**3.3**
Slender wheatgrass	San Luis		11.0	20	**2.2**
RS Hybrid wheatgrass	Newhy		14.0	40	**5.6**

Caution: Endophyte free fescue is better for livestock performance, but is less productive and does not survive as well. Slender wheatgrass comes on quickly but declines after the third year. Use Jose tall wheatgrass for severe salinity.

NRCS Regular P&H Production Envisioned

Heavier textured loam soils with high water table & with NO salt problems: (Big Blue, Shawa)

Seed Recommendations:		Approximate cost $36			Drilled
Species	Variety (table 6: PMTN 59)		PLS/Ac to use (100%)	% in mix	Rate (PLS lb/ac)
Creeping meadow foxtail	Garrison		3.0	50	**1.5**
Smooth brome	Manchar		13.0	25	**3.3**
Hybrid wheatgrass	NewHy		14.0	25	**3.5**

Cautions:
Alfalfa is not well adapted to high water-table; consider Alsike Clover. Reduce grass seeding rates up to 50% if 2.0 lbs/ac of alsike is included. If coated Garrison meadow foxtail is used, adjust to insure full PLS is planted.

Avoid the temptation of using orchard grass in the valley floor. Lack of dependable snow cover and severe cold will winterkill orchard grass. It does work well in areas near 8000 ft. elevation e.g. west of Del Norte.

Timothy may also winterkill. If it survives, it does not re-grow well in second cutting.

Rotation Grazing: Two cutting hay mixtures will work well under rotation grazing. Delay grazing until spring vegetative growth is 4 to 6 inches high. Graze lightly in the spring before tillers begin to joint, or re-growth will be slow. Allow 30 days rest between grazings.

Establishing Grasses: The best time to establish grasses in the San Luis Valley is late July; temperatures begin to decline, and clouds and precipitation increase. Establishing at this time avoids major problems with spring annual weeds. Pre irrigate to establish deep moisture. Drill grass species ½ inch deep and irrigate up. Double the seeding rate for broadcast seeding.

Companion Crops ?: Consider planting winter triticale the previous fall for a hay crop, rather than using any companion crop. Harvesting triticale in June gives adequate time to prepare a good seedbed for a July seeding. If quackgrass is a problem, irrigate triticale stubble to allow re-growth of quackgrass, and apply glyphosate before preparing a seedbed for grass seeding.

Substitutions or Changes: Variety or species availability may require minor substitutions. Excessive costs may warrant minor percentage changes in the mix. Contact NRCS for approval before drilling the mixture.

NRCS Regular P&H Production Envisioned

Regar Meadow Brome
Manchar Smooth Brome
Tegmar Intermediate Wheatgrass

In a three cutting system

Variety / Species	Production Tons per acre	Percent protein	Relative feed value
Regar meadow brome Regrowth excellent	5.2	17	107
Manchar smooth brome Regrowth fair to poor	3.7	21	123
Tegmar intermediate wheatgrass	4.2	18	115

Newhy – RS Hybrid Wheatgrass
Manchar Smooth Brome

Variety / Species	Production Tons per acre	Percent protein	Relative feed value
Newhy hybrid wheatgrass Fair regrowth	3.9	21	119
Manchar smooth brome Fair to poor regrowth	3.7	21	123

Newhy is a relatively new grass to SLV. It is very tolerant to salinity, but it's ability to survive winter is unknown. Unlikely to become sodbound like smooth brome.

UtahState

8:00 am Friday, Feb 15

SLV Drip Irrigation Initiative

Merlin A. Dillon, Area Extension Agronomist
Samuel Essah, Potato Research Scientist
San Luis Valley Research Center

Goal: Because of the loss of water in the underground aquifer, we wanted to develop a 'system' for using drip irrigation in a potato/barley rotation and our goal was to find if we could grow equal or better crops with less water.

A drip system was established on two farms with the $75,000 NRCS EQIP grant. At the SLV Research Center, a drip irrigation system was established in a dry corner by redrilling an irrigation well and putting in underground pipe (3400 ft.). Drip tape was installed at two depths, 3" temporary and 14" permanent and placed on 34 inch centers.
In the second year, the tapes were at 3" and 10 inch. Solid set sprinklers were set up to compare sprinkler vs. drip irrigation. Drip irrigated potatoes and barley were irrigated at 75% of ET. Sprinklers were irrigated at 100% ET. Drip plots were irrigated 3 times per week the first year. In late June of the second year, the control was automated to water daily. Plots planted to barley in 2006 were rotated to potatoes in 2007 and vice versa.

A drip system was also established at Farming Tech on a more sandy soil. This system was connected into the sprinkler so that it could only be irrigated when the sprinkler was running, estimated at 90% of the time. Potatoes and sorghum-sudan plots were established with drip tape at 3" and 14" depths. These plots were compared to adjacent sprinkler irrigation managed by Farming Tech.

Drip Findings

1. Barley Emergence Difficult with Drip.

In 2006, rainfall (.35") was not quite sufficient to get good barley emergence. We were not set up to use sprinklers on the drip area and the stand ended up being only about 50%. In 2007, we were then prepared to use sprinklers for barley germination; however, rainfall was sufficient for an excellent stand.

2. Spacing drip tape at 34" was too wide for barley.

In both years, the barley was taller directly over the tape and shorter between tapes. This was true regardless whether the tape was at 3" or the deeper tape.

3. Precision guided tractors are necessary for the permanent tape.

We were unable to perform deep tillage between the tapes because of fear of tearing out the permanent tapes at 10" or 14" depths.

4. Keep 'tape connector' area clean.

Our connectors were in the middle of potato plants or in barley plots. It was difficult to determine when we had leaks when the leaks were covered with potato or barley plots. The connector area should be kept clean with herbicides.

5. More residual Nitrogen after Drip.

Sorghum-sudan growing after potatoes showed differences in growth caused by carryover nitrogen.

Drip Irrigation Results -- Barley

Barley 2006. Small showers in May resulted in excellent barley emergence without sprinkler irrigation. Sprinkler and drip irrigation was not initiated until early June.

B1 = 4.85 in. irrigation + 4.39 in. rainfall = 9.24 inches total; yield = 30 bu/acre
B2 = 5.00 in. irrigation + 4.39 in. rainfall = 9.39 inches total; yield = 20 bu/acre
Solid Set Sprinkler = 9.26 in. + 4.39 in rainfall = 13.65in total; yield = 30 bu/acre

Barley 2007. Small showers in May resulted in excellent barley emergence without sprinkler irrigation. Sprinkler and drip irrigation was not initiated until early June.

B1 = 9.07 in. irrigation + 5.88 in. rainfall = 14.95 inches total; yield = 75 bu/acre
B2 = 9.60 in. irrigation + 5.88 in. rainfall = 15.48 inches total; yield = 75 bu/acre
Solid Set Sprinkler = 13.1 in. + 5.88 in rainfall = 19.0 in total; yield = 150 bu/acre

Drip Irrigation Results -- Potatoes

Samuel Essah will have results organized and prepared as a handout. In summary, potato yield and quality were excellent with the shallow drip irrigation in both 2006 and 2007. The deeper, more permanent treatment with drip tape installed at 14 in. in 2006 or 10 in. in 2007 produced slightly lower potato yields. See Handout.

Summary

Although barley production with drip irrigation was not successful; it should be possible to produce a successful barley crop. There is no reason that barley cannot be produced with drip irrigation. I cannot explain entirely why the barley production with drip irrigation was not successful. Shallow drip irrigations was very successful for potatoes.