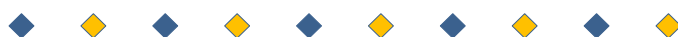


2015
Intermountain
Research and Extension Center
Field Day



2816 Havlina Road
Tulelake, California
August 5



University of California
Agriculture and Natural Resources

Research and Extension Center System

Welcome to our Annual Field Day. This event is a collaborative effort involving all of the Center Staff, visiting researchers and many growers and grower groups in the region. The general purpose of the tour is to allow participants a chance to see research being conducted on our Center and interact with Center researchers. We sincerely appreciate the opportunity to share our research programs with members of the community, many of whom have helped sponsor the research and this event.

During the tour, please ask questions freely. If you would like additional information on any project, please seek out a side conversation with the researcher during breaks or over lunch. Additional information on all our research projects is available at the office.

Please enjoy the tour, the lunch and the conversation.

Thanks for coming!

Sincerely,

The IREC Staff

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Intermountain Research & Extension Center
Current Staff

Rob Wilson	Center Director / Farm Advisor
Darrin Culp	Superintendent of Agriculture
Shanna Renner	Business Officer
Laurie Askew	Cooperative Extension Coordinator
Kevin Nicholson	Staff Research Associate II
Skyler Peterson	Staff Research Associate II
Greg McCulley	Senior Farm Machinery Mechanic
Tom Tappan	Farm Machinery Mechanic
Seferino Salazar	Senior Agricultural Technician
Josefina Vallejo	Seasonal Farm Worker
Leopoldo Reyes Pedroza	Seasonal Farm Worker
Robert Carver	Seasonal Farm Worker
Jacob Walden	Student Intern

<http://irec.ucanr.edu>

We've redesigned our website! Below is a list of some information available.
Thanks for bookmarking!

Home:

Welcome to IREC and Tulelake
Stay current with upcoming IREC events
Subscribe to and read our blog
Make a Gift

About Us:

Learn about the history of IREC
Get to know the IREC staff
Check out our facilities
Get directions to IREC

Research:

Learn how to submit a proposal
Keep up on current research
Read results of past research

Extension, Outreach & Education:

Read about the Center activities
Peruse our newsletters and Field Day booklets
Watch IREC videos
Study our cost studies

Weather, Physical & Biological Data:

Check out Tulelake weather and CIMIS
Use the Crop Water Use Table

Current Research Projects at IREC

Alfalfa Research

Evaluation of Sharpen (saflufenacil) Use in Established Alfalfa

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka.

- Evaluate the safety of Sharpen to alfalfa.
- Determine whether crop phytotoxicity could be reduced with different application timings.
- Evaluate the efficacy of Sharpen for controlling the spectrum of weeds encountered in Intermountain alfalfa fields.

Alfalfa Variety Evaluation in Mountain Valleys of Northern California

Principle Investigator: Dan Putnam, Extension Agronomist, Dept. of Plant Science, UC Davis; Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka; Craig Giannini, UC SRA, UC Davis

- Evaluate certified cultivar differences in alfalfa forage yield, quality, and persistence, and to communicate these results to clientele
- Develop and provide forage yield and performance data on alfalfa experimental germplasm to public and private alfalfa scientists

Characterizing N Fertilizer Requirements of Crops Following Alfalfa

Principle Investigator: Dan Putnam, Extension Agronomist, Department of Plant Sciences, UC Davis; Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka.

- To determine the impacts of rotation with alfalfa on the N fertilization needs of wheat, to develop an “N Credit” recommendation for management of N fertilizers in non-legumes rotated with alfalfa. Since wheat is a highly responsive crop to N fertilizers, estimates will be made on wheat that can be extrapolated to other crops.

Cutting Schedule Effects on Reduced Lignin & Conventional Alfalfa

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka; Dan Putnam, Extension Agronomist, Department of Plant Sciences, UC Davis

- Determine the effect of a 3-cut versus 4-cut harvest schedule on rate of forage quality change of genetically engineered low lignin alfalfa compared to the null that does not carry the trait and compared with a commercial standard
- Determine the appropriate cutting management schedule for low-lignin alfalfa compared with conventional non-genetically engineered alfalfa

Assessment of Alfalfa Irrigation Needs in the Klamath Basin

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka; Daniele Zaccaria, Extension Water Management Specialist, UC Davis.

- Determine the effect of irrigation quantity on alfalfa yield in the Klamath Basin.
- Evaluate the need for one versus two irrigations per cutting.
- Measure the contribution from dew to alfalfa ET over the growing season.
- Compare soil moisture readings with Watermark sensor versus newer technology from Acclima.

Alfalfa Germplasm Evaluation-Fall Dormancy

Principle Investigator: Charles Brummer, Director, Plant Breeding Center, UC Davis; Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka; Dan Putnam, Extension Agronomist, Department of Plant Science, UC Davis.

- To develop a measurement method to assess dormancy in swards.
- To evaluate fall dormancy of the standard check cultivars and selected other modern cultivars in both swards using the new protocol and in spaced plants using the current protocol.

Onion Research

Management of White Rot of Onions with Fungicides

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research & Extension Center.

- Demonstrate the effectiveness of DADS in lowering soil levels of white rot sclerotia.
- Demonstrate fungicidal control of white rot in onions and garlic in plots with reduced soil sclerotia levels.

Onion Weed Control

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research & Extension Center.

- Evaluate crop and weed response to varied rates and timings of pre-emergence applications of Prowl H2O and Dacthal.
- Develop UC recommendations and California specific herbicide labels for weed control in onions.

Evaluating Onion Irrigation Practices in Tulelake

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research and Extension Center.

- To determine the distribution uniformity and efficiency of current Tulelake irrigation systems used in processing onions.
- To determine the difference in onion growth and onion yield in good growth and bad growth areas caused by poor irrigation distribution uniformity.
- To determine the current pumping time and irrigation amounts used by Tulelake onion growers.

Peppermint Research

Weed Control in Peppermint

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research & Extension Center.

- Investigate winter dormant herbicides for control of groundsel in peppermint.
- Investigate winter dormant herbicides efficacy for providing pre-emergent control of summer annual weeds.
- Investigate spring post-emergent herbicides for control of emerged pigweed.

Potato Research

Potato Variety Selection Evaluation & Development

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research & Extension Center; David Holm, Professor of Horticulture, Colorado State University; Julian Creighton Miller, Professor of Horticulture, Texas A & M University; Brian Charlton, Cropping Systems Specialist, Oregon State University, Klamath Basin Research and Experiment Center.

- Evaluate new russet, specialty, and chip cultivars developed by public and private breeding programs for adaptation and suitability to Tulelake's unique soil, climate and marketing conditions.

Cultural Management of New Potato Varieties

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research & Extension Center; Joe Nunez, Farm Advisor, Kern County, Bakersfield; David Holmes, Professor of Horticulture, Colorado State University; Julian Creighton Miller, Professor of Horticulture, Texas A & M University; Brian Charlton, Cropping Systems Specialist, Oregon State University, Klamath Basin Research and Experiment Center.

- Develop cultivar-specific cultural management recommendations appropriate for the successful introduction of new cultivars in Northern California. For 2014, the research focus will be evaluation of new varieties yield and bruise response to different vine kill durations.

Influence of Nematicides on Root-Lesion Nematode and Potato Early-dying

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, UC Intermountain Research and Extension Center; Becky Westerdahl, Cooperative Extension Specialist, Dept. of Nematology, UC Davis; R. Michael Davis, Cooperative Extension Specialist, Dept. of Plant Pathology, UC Davis.

- Determine nematicide treatments' efficacy for suppression of potato early-dying and root lesion nematode.
- Compare the efficacy of nematicides to metam sodium (Vapam) fumigation for suppression of potato early-dying.
- Evaluate nematicides when growing potato varieties with varied susceptibility to potato early-dying.
- Conduct a simple economic analysis comparing costs and revenue for tested nematicide and fumigation programs.

Comparison of Nitrogen-Fixing Cover Crops and Organic Amendments for Nitrogen Fertilization in Organic Potatoes

Principle Investigator: Rob Wilson, Center Director/Farm Advisor, Intermountain Research and Extension Center; Darrin Culp, Principal Superintendent of Agriculture, Intermountain Research and Extension Center; Brian Charlton, Cropping Systems Specialist, Oregon State University, Klamath Basin Research and Extension Center.

- Determine which nitrogen-fixing cover crops are best suited for Northern California potato production.
- Estimate the nitrogen credit to spring-planted potatoes from nitrogen-fixing cover crops.
- Estimate the nitrogen credit to spring-planted potatoes from fall-applied chicken manure, steer manure and compost.
- Determine the influence of fall-incorporated manures and fall-incorporated nitrogen fixing cover crops on potato yield and potato quality.

Small Grain Research

Building the Oregon Malting Barley Brand in the Klamath Basin

Principle investigator: Richard Roseburg, Research Agronomist, Dept. of Crop & Soil Science, Oregon State University, Klamath Basin Research Center.

- To generate agronomic, malting and brewing performance data for spring 2-row varieties in order to establish the Oregon malting barley variety "brand."

Wheat Genetic Resources & Mapping Experiments

Principle Investigator: Calvin O. Qualset, Professor Emeritus, Department of Plant Sciences, UC Davis; Shiaoman Choa, USDA/ARS Research Geneticist, Fargo ND; Bryce Falk, Department of Plant Pathology, UC Davis.

- To grow and make observations on agronomic and disease resistance on advanced breeding and genetic lines
- To make the genetic resources available to any researchers who have interest for their breeding or research
- To genetically characterize two populations of recombinant inbred lines for morpho-physiologic and agronomic traits
- To host the annual meeting of wheat workers in the Western Region, if the group is interested, for discussions of various current research topics and to view the field plantings of widely diverse wheat genetic materials

Planting Date and Cultivar Effects on Winter Wheat Yield

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka.

- Compare the yield potential of several leading cultivars of soft white winter wheat and hard red winter wheat.
- Determine the effect of four different planting dates on the yield of eight different winter wheat cultivars.

Improving Spring Barley for Northern Intermountain Areas

Principle Investigator: Lynn Gallagher, Researcher, Department of Plant Sciences, UC Davis; Dr. Pat Hayes, Barley Breeder, Dept. of Crop & Soil Science, OSU Corvallis, Oregon.

- The project objective is to increase grain yield and disease resistance in spring barley adapted to the Klamath Basin.

Seeding Rate & Planting Date Effects on Spring Wheat

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka.

- Determine the effect of seeding rate on the yield of four commonly grown hard red and soft white spring wheat
- Assess the impact of planting date on productive tiller production, kernel number, bushel weight and yield
- Quantify the interaction between seeding rate and planting date

Evaluation of Small Grain Species and Varieties Under Dryland Conditions

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka.

- Compare the performance of different small grain species and varieties under drought conditions.
- Evaluate the economics of harvesting small grains for grain versus hay under non-irrigated conditions.

Nitrogen in Wheat

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka; Steve Wright, Farm Advisor–Tulare/Kings Counties; Rob Wilson, Center Director, UC Intermountain Research & Extension Center.

- Compare the protein content of the most popular hard red spring wheat varieties
- Assess the effectiveness of late-season N applications to increase protein in different spring wheat varieties
- Evaluate controlled-and slow-release N fertilizers for improving both grain yield and protein
- Evaluate N application practices and soft white wheat varieties to obtain high yield with low protein content (approximately 10 percent)

Development of Wheat Varieties for California

Principle Investigator: Dr. Jorge Dubcovsky, Assistant Professor, Department of Plant Sciences, UC Davis; Oswaldo Chicaiza, Research Assistant, Department of Plant Sciences, UC Davis; John Heaton, Department of Plant Sciences, UC Davis; Lee Jackson, Extension Agronomist, Department of Plant Sciences, UC Davis.

- To produce new varieties & improved germplasm and distribute them to growers, breeders and other researchers. A multi-objective project will be conducted which:
- Introduces new germplasm for evaluation and breeding
- Develops breeding populations through hybridization, selection and evaluation
- Develops information on the inheritance of characters important to quality and yield in California production environments and finds molecular markers to assist the introgression of these characters into adapted breeding lines, and finally
- Produces Breeders Seed for multiplication as new varieties and germplasm for distribution to breeders and researchers. Specific goals are to introduce and maintain disease resistance, maintain or increase grain yield potential and improve end-use characteristics

Other Research

Determining Efficacy & Cost of Pocket Gopher Control Practices in Alfalfa

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County; Roger Baldwin, Vertebrate Pest IPM Advisor, Kearny Agricultural Center.

- Compare the effectiveness of four different gopher control measures including trapping, baiting with strychnine using an artificial burrow builder, fumigation with aluminum phosphide, and carbon monoxide injection using the PERC unit
- Quantify the time, labor requirement and material cost associated with each control practice
- Estimate the overall cost effectiveness for each control measure

Influence of Fall Defoliation Height on the Productivity of Three Perennial Grasses

Principle Investigator: Steve Orloff, County Director/Farm Advisor, Siskiyou County, Yreka; David Lile, County Director/Farm Advisor, Lassen County, Susanville.

- Compare the yield potential of the three most commonly grown perennial grass species in the Intermountain Region.
- Evaluate the effect of three different fall herbage heights on the subsequent growth of tall fescue, orchardgrass and Timothy.
- Determine the effect of fall herbage height on water soluble carbohydrates the following spring and determine the relationship between water soluble carbohydrates and pasture growth.
- Estimate the biomass and nutritive value of fall/winter harvested forage of each treatment (using #1 as benchmark) to demonstrate how much fall forage producers would have to forego to implement higher stubble-height management strategy.

Oilseed as Alternative Crops for California

Principle Investigator: Stephen Kaffka, Extension Agronomist, Dept. of Plant Sciences, UC Davis; Nicholas Alexander George, Visiting Assistant Project Scientist, UC Davis.

- Identify the best oilseed species and varieties for California in diverse locations and cropping systems
- Conduct agronomic experiments to determine regionally-specific best management practices
- Use trial data and eco-physiological measurements to validate the crop model APSIM and use the model to estimate the productivity, water and nitrogen use of the oilseeds under different rainfall and irrigation regimes, locations throughout the state, and alternative future climate scenarios
- Use variety performance and agronomic data to parameterize a previously-developed whole farm economic model to evaluate the potential for increased oilseed production in California. The model will help identify price and yield goals for new oilseed crops in diverse regions in the state
- Use yield and agronomic data to create California oilseed production guides
- Carry out extension and outreach activities at the county and regional level to support adoption of new crops
- Create publications for California Agriculture



CLB adult,
photo by C. H. Pickett

Biocontrol of Cereal Leaf Beetle

August 5, 2015

UC Intermountain Research and Extension Center
Tulelake Cooperative Extension Field Station
C. H. Pickett¹, R. Wilson², and D. Culp²
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Tetrastichus julis, photo by C. H. Pickett

Background

Cereal leaf beetle (CLB), *Oulema melanopus* (Chrysomelidae) is a serious pest of wheat, oats, barley and other small grains and forage grasses. Both larvae and adults feed on the growing leaves of grasses and can cause up to 25% yield loss if left unchecked. European in origin, the beetle was first reported in the United States in 1962. The cereal leaf beetle rapidly became a serious pest in Michigan then spread throughout the Midwest and into Canada. A chemical eradication effort by the USDA failed to stop its spread to other grain producing, neighboring states. By 1984 the beetle had spread to Utah, Montana, and Idaho. It was first reported in Washington in 1999, then was soon found in Oregon. CLB was first reported in California at the UC Tulelake Intermountain Research and Extension Center in 2013.

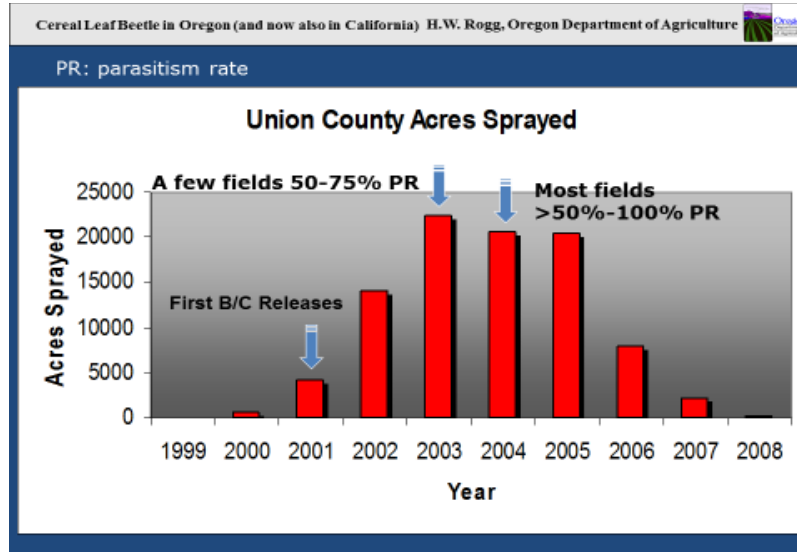
Solution:

In the early 1960's there were no known, effective natural enemies attacking CLB in the Midwest therefore exploration for parasitoids coevolving with the beetle in its native home was initiated. Three hymenopterous parasitoids (stingless wasps) were found attacking the larval stage of this pest in various countries in Europe and imported into the United States. The most successful parasitoid attacking CLB in Washington and Oregon is *Tetrastichus julis* (Eulophidae). We know that this parasitoid is highly specific for CLB. *Tetrastichus julis*, when given a choice of attacking and reproducing on 6 different beetles in North America, failed to reproduce on any. A biological control program to rear and spread *T. julis* in Northwestern United States has been extremely successful. An economic analysis by the Oregon Department of Agriculture shows a clear correlation between spray applications (lack of) and the buildup of *T. julis* in grain fields (Fig. 1).

¹CDFA, Sacramento

² University of California Intermountain Research & Extension Ctr, Tulelake

Fig. 1. Spray applications on grains in Oregon from 1999 to 2007



A similar effort to establish and spread *T. julis* throughout the Klamath Basin and south is currently underway. A field insectary designed after those used in Washington and Oregon was planted last year at the Tulelake Field Station. With help from the state of Oregon and the USDA APHIS, *T. julis* was collected in northern Oregon in 2014 and released into plots of wheat and oats. The field insectary is designed to maximize the production of CLB, the food for *T. julis*. A series of four adjacent plots were planted beginning with winter wheat, followed by three plots of oats planted sequentially beginning in mid-April. Planting dates for oats were roughly 3 weeks apart (Fig. 2). By providing a constant, optimal food source to the beetles, their highest survivorship, and egg production is achieved. The more food for the parasitoids, the more beetle-killing, off-spring they produce. Fifty to 100 percent of larvae (CLB worms) collected in the insectary over the last month have been attacked by this parasitoid. From each larva will emerge 5 to 15 new parasitic wasps (*T. julis*). We have released parasitized beetle larvae into three commercial farms within 10 miles of the station.

The population of CLB in the field insectary begins with the winter wheat. Adults move into wheat the following spring then into the first planted oats. Beetle eggs are deposited primarily into the first and second plantings of oat, which are directly adjacent to the wheat (brown in color) in Fig. 2, below.



Fig. 2. Field insectary at UC Tulelake Field Station, 2015. Arrow indicates movement of CLB from winter wheat to last planted oats.

The changes in CLB densities measured in the insectary plot (Fig. 3) shows that the adult CLB are pulled towards the greener, younger oats where they lay their eggs. The high number of CLB larvae in plots labeled Oat2 and Oat3 allowed for a high production of parasitoids, expressed as percent parasitism (Table 1).

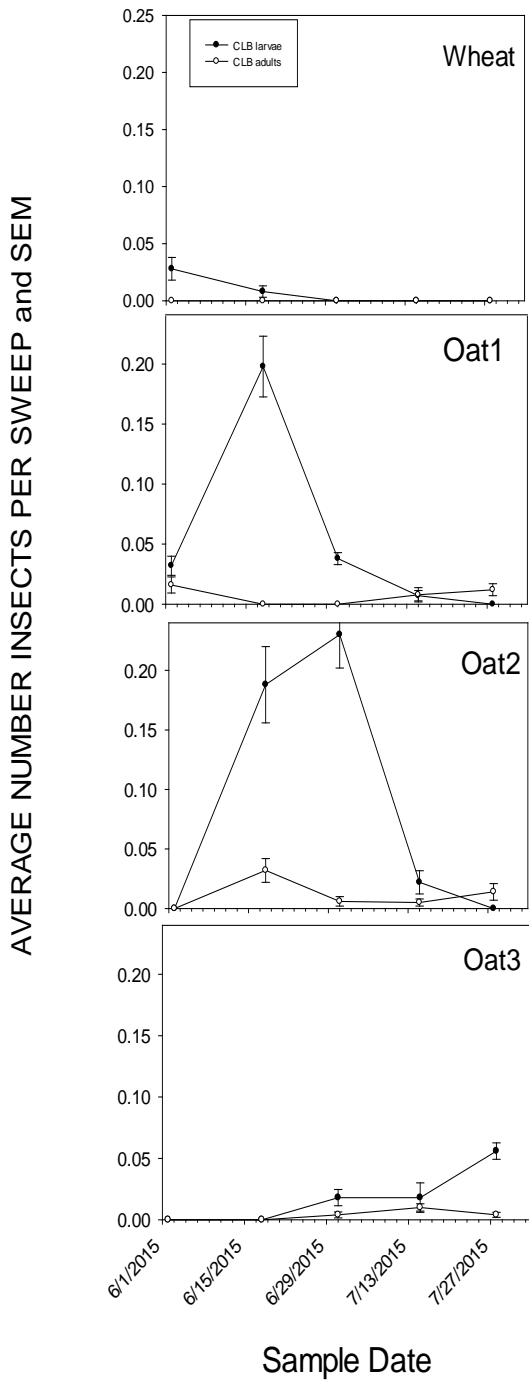


Fig. 3. CLB larvae and adults numbers in field insectary. Oat1, oat2, and oat3 refer to three separate plantings of oats, spaced by 3 weeks, with the first (Oat1) planted April 17th.

Table 1. Percentage of CLB larvae parasitized in UC Tulelake Insectary. Summer 2015.

Date	Wheat	Oats1	Oats2	Oats3	Average
6/2/15	25	19	.	.	22
6/18/15	.	7	20	.	13.5
7/1/15	.	53	85	56	65
7/15/15	.	75	70	100	81.3
7/28/15	.	.	.	78	78

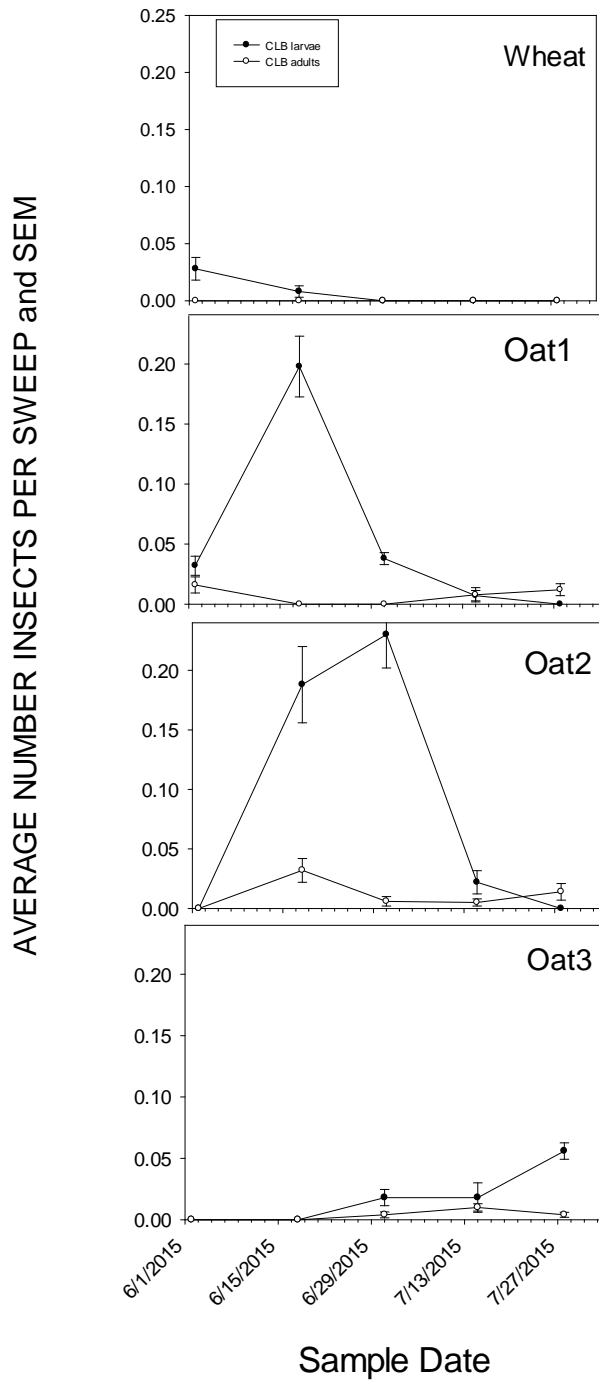


Fig. 3. CLB densities in the UC Tulelake Field Insectary, 2015. Graphs represent 4 plots of separately planted small grains. Oat1, Oat2 Oat3 refer to oats planted on three dates, spaced three weeks apart, with the first on April 17th.

The following tables is for making pest management decisions for CLB

cereal leaf beetle model - Fulton et al 1975 OSU

Location: 2013 KLMT Klamath Fls Int

Date	DDs	Event
4-10-13	93	OW gen. ca. 1st adult emerge
4-26-13	150	1st egg laying
5-10-13	270	50%/peak egg laying
5-12-13	303	1st egg hatch
5-14-13	325	early/10% larvae
6-2-13	436	50%/peak egg hatch
6-14-13	619	90% egg laying
6-17-13	659	peak larvae
6-28-13	774	end (90%) egg hatch
7-3-13	915	90% larvae/end larvae
7-4-13	938	end OW adults
7-7-13	999	1st summer adult emerge
7-22-13	1321	50% summer adult emerge
8-2-13	1539	90% summer adult emerge

Action Threshold (Washington State University, Cooperative Extension)

- **Pre-boot:** until flag leaf fully emerged: 3 eggs and or larvae per tiller
- **Boot:** after flag leaf emerged but grain head not emerged: 1 larva per flag leaf

Cutting Schedule Effects on Reduced Lignin and Conventional Alfalfa

Steve Orloff, Steve Orloff, UCCE Siskiyou County and
Dan Putnam, Forage Specialist, UC Davis

For years we have been talking about the *Yield/Quality Tradeoff* in alfalfa and have conducted numerous research trials to find ways to maximize profitability by finding the optimum cutting frequency to strike the best balance between high yield and high quality. Unfortunately, this continues to be an ongoing challenge for alfalfa producers. As the alfalfa plant matures, yield increases but forage quality decreases. Much of the yield increase and quality decrease with advancing maturity is attributed to increased stem yields. Stems are not nearly as nutritious and digestible as leaf material (Figure 1). An increase in stem yield increases the concentration of lignified cell wall material in the whole plant and greatly reduces digestibility. Past efforts to improve the forage quality of alfalfa through plant breeding have only had moderate success. For example, multi-leaflet alfalfa varieties (with more than three leaflets per stem) were promoted at one time, but oftentimes did not result in a significant increase in leaf:stem ratio and a measurable improvement in forage quality. However, a new trait, reduced lignin, shows promise for a dramatic enhancement in alfalfa forage quality.

The Effect of Lignin

Lignin is a structural component of the cell wall. It is analogous to the rebar in a concrete building strengthening the plant and allowing the vascular system of the plant to transport water without leakage. The drawback with lignin is that it is indigestible and reduces the ability of ruminant animals to digest fiber. This is because lignin molecules fill the spaces between the cellulose, hemicellulose and pectins in the cell wall and as the plant matures it binds to the cellulose. This then reduces digestion of the cellulose in the rumen. Lignin content of alfalfa increases greatly with advancing alfalfa maturity.

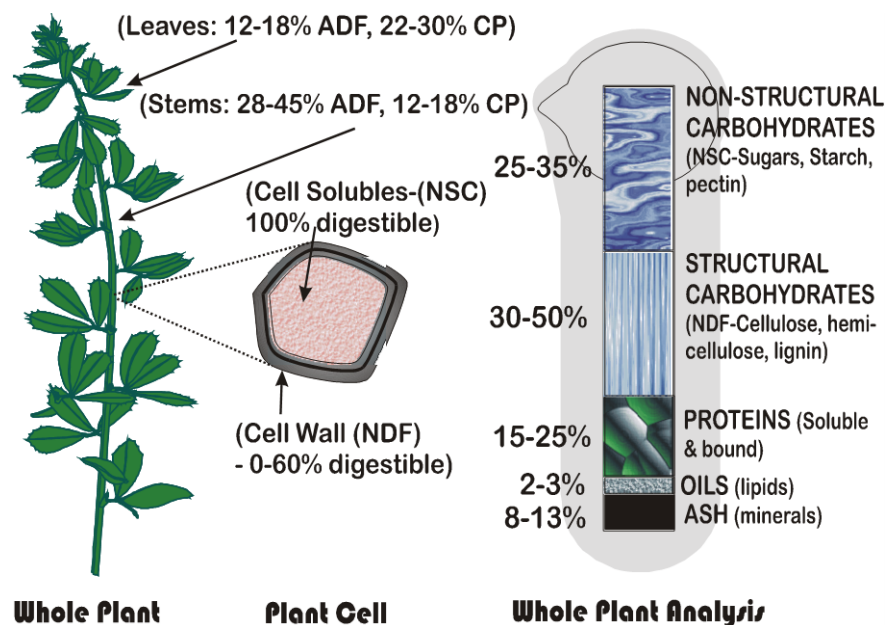


Figure 1. Alfalfa plant components and cell constituents (Figure developed by Dan Putnam).

Previous Research with Reduced Lignin Alfalfa

Previous research conducted at IREC and other locations in the US have demonstrated the advantages of low lignin alfalfa. The low lignin alfalfa lines had consistently higher fiber digestibility—lower Acid Detergent Lignin (ADL) and significantly higher Neutral Detergent Fiber Digestibility (NDFD). A trial just completed at IREC over the past two years involved the evaluation of four advanced reduced lignin lines compared with four standard varieties under two cutting regimes (an **Early** cutting regime with 4 cuts per year and a **Late** cutting regime with 3 cuts per year). We found no difference in yield between the reduced lignin and standard alfalfa varieties. When it comes to forage quality, it is no surprise that the shorter cutting interval resulted in improved quality for all the parameters evaluated. Averaged over all four alfalfa varieties of each type (standard and low lignin), there was no statistical difference in Crude Protein (CP), Acid Detergent Fiber (ADF which is used to calculate TDN), or Neutral Detergent Fiber (NDF). However, there was a dramatic improvement in lignin concentration (ADL or Acid Detergent Lignin) and Neutral Detergent Fiber Digestibility (NDFD). Note that the lignin concentration for the late-cut reduced lignin varieties on average was the same as the standard varieties cut on the four cut-schedule (Table 1). And, the NDFD percentage (higher is better) was actually higher for the reduced lignin varieties cut on the *Late* schedule than the standard varieties but on the *Early* cutting schedule (Table 1). Expressed as a percentage, the reduced lignin varieties resulted in 17.2 percent decrease in lignin concentration and an 8.5 percent improvement in NDFD (Figure 2).

The potential practical ramifications of these results are that when these reduced lignin varieties become available, producers may be able to cut on the same cutting schedule they currently use and have improved forage quality. Or, alternatively, they may be able to delay harvest and maintain forage quality (as measured by NDFD but not ADF or NDF). Delaying harvest will increase the yield for that cutting and potentially it may be feasible to reduce the number of cuttings per year from 4 to 3, improving yield while hopefully still producing a fair amount of dairy-quality alfalfa. A longer interval between cuttings may also increase the level of carbohydrate root reserves improving plant vigor and stand persistence.

A key point to keep in mind is that using the alfalfa forage quality assessments currently used in California for alfalfa marketing (i.e. ADF, TDN, or CP), we will not be able to detect the improvement in forage digestibility that the reduced lignin alfalfa varieties can offer. How we measure alfalfa forage quality in California will need to change before we can fully capture the difference between reduced lignin and standard varieties. We will need to move toward a different digestibility measurement like NDFD or an index like Relative Forage Quality (RFQ) that incorporates digestibility measurements.

Table 1. Effect of alfalfa type (reduced lignin or standard) and early or late cutting schedule on the Crude Protein (CP), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Acid Detergent Lignin (ADL) and Neutral Detergent Fiber Digestibility (NDFD).

		CP	ADF	NDF	ADL	NDFD
Early	Red. Lignin	24.4	26.1	31.4	3.8	52.2
	Standard	24.0	27.1	32.2	4.6	47.5
Late	Red. Lignin	23.0	29.0	34.8	4.6	49.1
	Standard	22.8	30.3	35.7	5.6	45.9
	Cutting schedule	***	***	***	***	***
	variety	ns	ns	ns	***	***

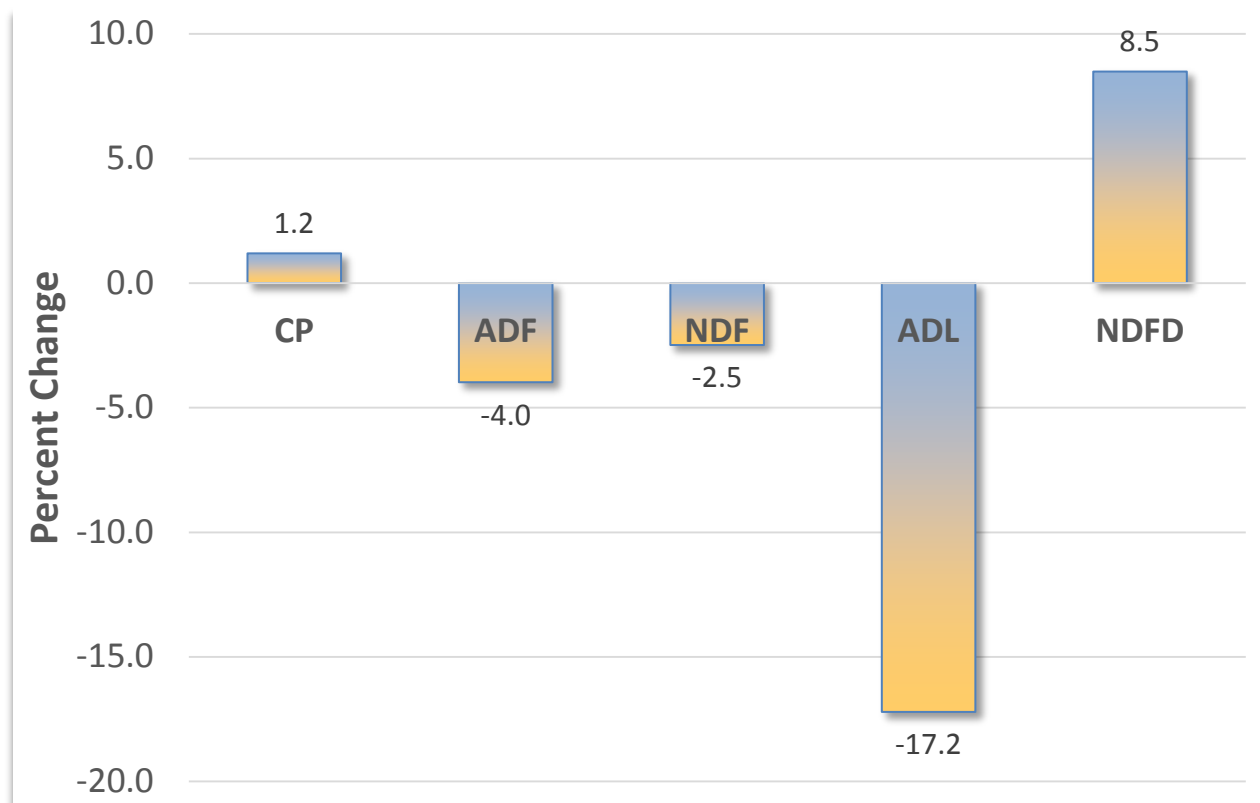


Figure 2. Percent change in Crude Protein (CP), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Acid Detergent Lignin (ADL) and Neutral Detergent Fiber Digestibility with reduced lignin alfalfa varieties compared with standard varieties averaged over 4 varieties of each type.

Current Research Effort

New trials were established this year in cooperation with Forage Genetics International (FGI) and researchers in Wisconsin, Pennsylvania, Michigan, and Kansas to compare the performance of a low lignin variety, HarvXtra, with two standard varieties, WL 355RR and 54R02. This research involves two separate trials.

Cutting Schedule Trial. Varieties are harvested on 3 different cutting schedules (28, 33, and 38 days between harvests) and the yield and forage quality are determined at each harvest.

Quality Changes over Time Trial. The varieties listed above are compared as well as an additional variety developed by Alforex called HiGest. (This new variety was developed using conventional plant breeding techniques and there aren't university data evaluating its forage quality or lignin content.) Each individual plot is sampled twice per week over a 3 week period. In so doing we will be able to assess the rate of change in forage quality of alfalfa over a period of 20 to 37 days since the last harvest. Each plot will only be sampled once and then we move on to another plot for sampling at a different time period. We will assess changes in forage quality for the summer and fall period in 2015 and the spring, summer and fall period of 2016.

Current Status

This technology has been talked about for years and growers are curious when these varieties will actually be available. The HiGest variety developed by Alforex is currently available but seed was very difficult to come by this year. As mentioned earlier, the performance and quality improvement with this

variety has not be evaluated by independent research to my knowledge. This current trial at IREC will help provide some initial data. The genetically engineered reduced lignin alfalfa developed by Forage Genetics International was deregulated by USDA this past fall and commercialization is expected in late 2016 with limited availability with greater supplies in 2017. Indications are that initial marketing efforts will focus more on the Midwest first. Initially, the reduced lignin trait will only be available with Roundup Ready alfalfa varieties and perhaps may be available in non RR varieties at a later date.

Low-lignin alfalfa varieties could have a dramatic effect on alfalfa harvest management and transform our understanding of the yield quality tradeoff as it currently exists. Data on yield and quality changes with advancing maturity for new low-lignin alfalfa cultivars is needed to understand the impact this technology might have on alfalfa production as well as animal nutrition.

Evaluation of Small Grain Species and Varieties Under Dryland Conditions

Steve Orloff, UCCE-Siskiyou County Director and Farm Advisor, Yreka, CA

Water availability for irrigation is undoubtedly the most significant issue for agricultural producers in the Klamath Basin. Water shortages due to drought and endangered or threatened species protection make water availability uncertain. Some years growers are faced with a decision of what to do with their land when insufficient irrigation water is available to irrigate all fields. Soil erosion is a significant concern when land is left completely idle so some kind of crop cover is highly desirable. Small grain crops are the usual choice, but which species (wheat, barley, oats, triticale or rye) and which varieties for each species are best suited for dryland conditions is not known. In addition, small grains can be grown as a forage crop or for grain production. Information is needed to compare the yield and profit potential of a grain crop harvested for grain versus hay under dryland conditions. *Are growers better off growing a grain crop or hay crop?*

A small grain variety evaluation program has been conducted at IREC for decades by UC Davis researchers. The results provide valuable information for producers, but only under the high-yielding conditions of full irrigation. A sustained effort to evaluate small grain species/variety performance over several years under dryland conditions with varying weather and rainfall is needed. We plan to conduct this research for approximately 5 years.

Objectives

1. Compare the performance of different small grain species and varieties under dryland conditions.
2. Evaluate the economics of harvesting small grains for grain versus hay under non-irrigated conditions.

Twenty-four entries including cultivars of wheat, barley, oats, triticale and rye were evaluated (Table 1). One of the entries, Solar barley, was specifically developed by Arizona State University, for performance under water-limiting conditions. It is less prone to lodging and has higher test weight than its predecessor Solum barley.

Separate blocks were established for awnless forage-type cultivars and for cultivars to be harvested for grain. Some varieties were included for both forage and grain harvests (Triple IV wheat, WB 9904 wheat and Cayuse oat), which would allow the grower the option of deciding which type of harvest was preferable during the growing season. All entries were seeded on March 31, 2015 at 70 pounds per acre. Fifty pounds of N was applied preplant as urea and was mechanically incorporated prior to planting. There was no rainfall after planting and it was decided to apply half an inch of irrigation to the plot to simulate a rainfall event. This may be considered “cheating” by some, but without the half an inch of irrigation, the stand would have been poor and it would have been difficult to collect any useful data from the trial.

Table 1

No	Variety	Species
1	Cereal rye	rye
2	Twin wheat	wheat
3	Triple IV	hard red wheat
4	Patron	wheat
5	1404	wheat
6	Stockford	barley
7	Charisma	oat
8	Cayuse	oat
9	Merlin	triticale
10	WB 9904	hard red wheat
11	Alpowa	soft white wheat
12	WB 6430 SWS	soft white wheat
13	WB 6341 SWS	wheat
14	Yecora rojo	hard red wheat
15	WB 9668	hard red wheat
16	WB 9518	hard red wheat
17	Triple IV	hard red wheat
18	Copeland	barley
19	Champion	barley
20	Steptoe	barley
21	Solar	barley
22	Eureka	barley
23	Cayuse	oat
24	WB 9904	hard red wheat

	Forage harvest
	Grain harvest

Initial Results

Forage yield was determined on July 6, 2015 (Table 2). The two-row forage barley variety Stockford was heavily attacked by red-winged blackbirds despite efforts to discourage them (sound device). Yield of this variety would have been higher if not for the heavy bird feeding consuming almost all the grain. Average forage yield for the ten entries ranged from 3.15 to 4.26 tons per acre, a respectable yield for dryland. The highest yielding entry was cereal rye. Rye is known to be very drought tolerant but typically has low forage quality. Rye is also known to become weedy in other crops. Personally, I am not a big fan of cereal rye for the reasons stated above and am not ready to recommend it. It is interesting to note that Merlin, a spring triticale variety (triticale is a wheat x rye cross) ranked second in the trial. Several other species/varieties were not far behind. To eventually perform an economic analysis of the different options, one must also consider the anticipated market value of the different forage hays.

Table 2

Entry	Yield Tons/A
Cereal rye	4.26
Merlin	4.19
Twin wheat	4.11
Charisma	4.10
Triple IV	3.82
1404	3.72
Cayuse	3.55
WB 9904	3.49
Stockford	3.46
Patron	3.15
LSD 0.05	0.51
CV	9.24%

These are only initial results showing the forage harvest in the first year of the study. Grain harvest will occur later this month. It is not recommended to make a variety decision with a single year of data because conditions, especially in a dryland trial, vary considerably from year to year. As mentioned, we hope to continue this trial for approximately 5 years. The eventual expected outcome of this research is a better understanding of the yield potential of different grain species and varieties under drought conditions to help growers decide on the best approach in drought years—which small grain type to produce and whether it is more profitable to harvest for grain or hay.

Comparison of Nitrogen Fixing Cover Crops and Organic Amendments for Meeting the Nitrogen Requirement of an Organic Potato Crop

Rob Wilson, Director & Farm Advisor, IREC
Daniel Geissler, Nutrient Management Specialist, UC Davis

Certified organic potato acreage in the Tulelake Basin has increased rapidly in recent years. Organic production offers growers a niche market and price premiums. On the flip side, successful organic production is full of challenges including very limited fertilization and pest management options. A major fertilization challenge is supplying adequate nitrogen to the potato crop. Organic nitrogen fertilizers including manure, compost, and fish emulsion cost substantially more than conventional nitrogen fertilizer. It is also difficult to determine how much organic fertilizer to apply as a significant portion of the nitrogen in the organic amendments is not immediately available for plant uptake.

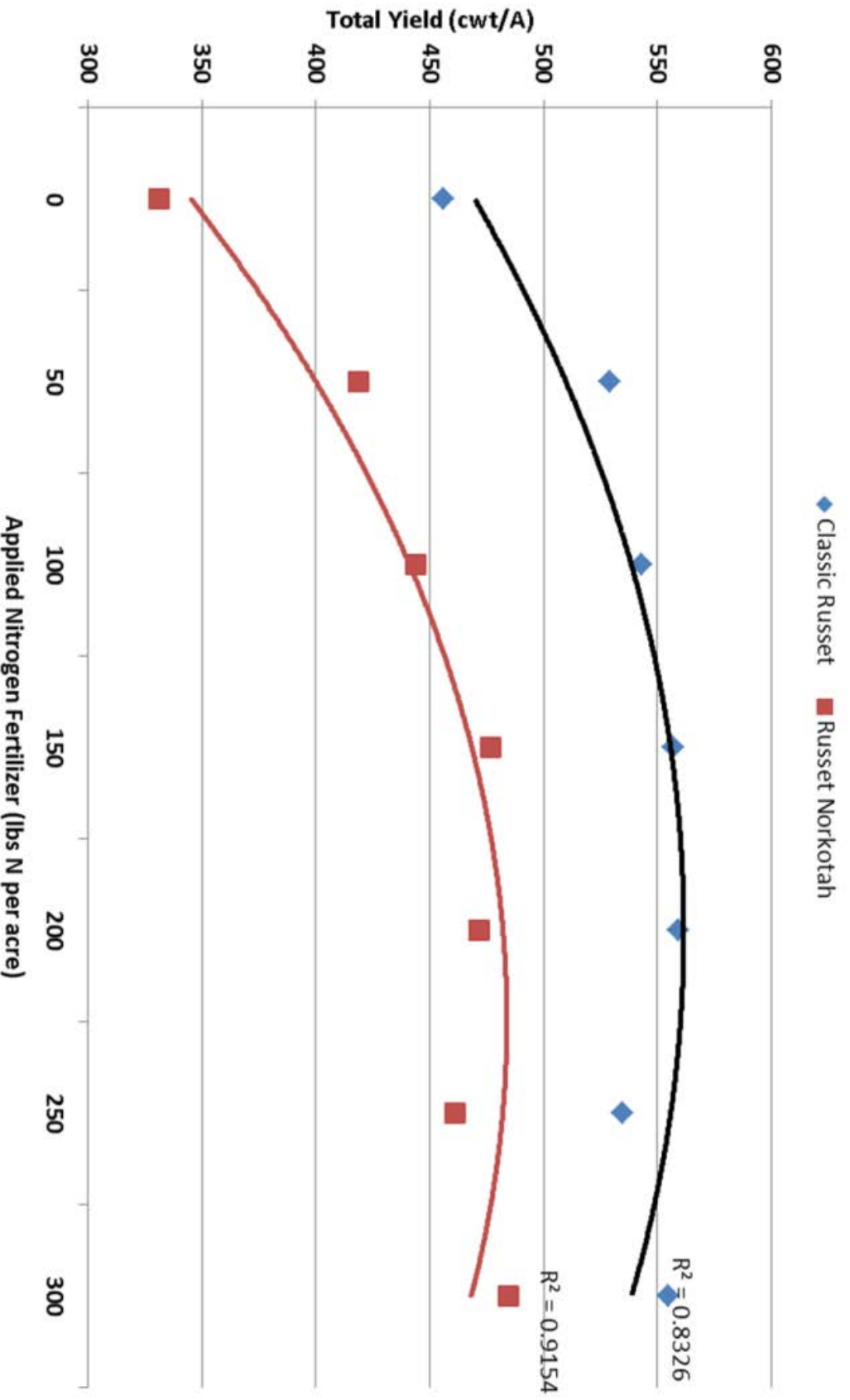
This study compared soil nitrogen, crop nitrogen uptake, potato yields, and potato quality for different organic fertilizer sources including manures, compost, and nitrogen-fixing cover crops. Objectives include determining which nitrogen-fixing cover crops are best adapted to the Klamath Basin and estimating the nitrogen credit for cover crops and organic amendments.

Cover crop experiments started in summer 2014 at IREC. Cover crops included multiple vetch species, clover, field peas, and two grasses. Cover crop treatments were no-till planted in July shortly after spring wheat was harvested for hay. Cover crops were irrigated until fall and then chopped and disked under shortly after the first killing frost.

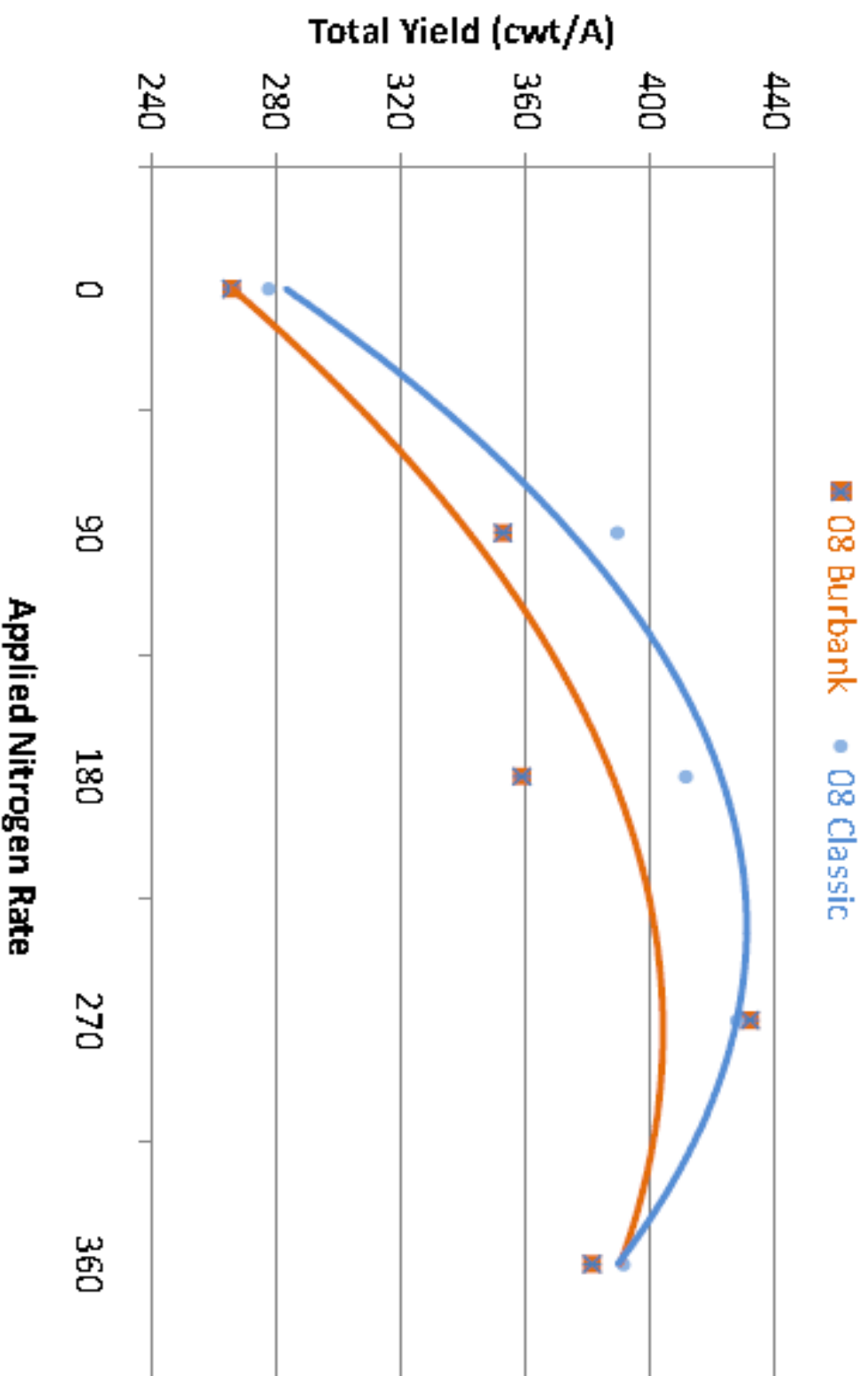
Amendment experiments started in fall 2014. Spring wheat was harvested for grain in September, and in October, manure and compost treatments were applied to grain stubble and then disked into the soil. Manure and compost application rates were based on the material's nitrogen content with the goal of achieving 150 lbs N per acre across treatments. Soy meal and blood meal were also included in the amendment trial as a stand-alone spring-applied fertilizer or compliment spring fertilizer at reduced rates in combination with fall-applied manure. Urea, a conventional nitrogen fertilizer source, was included at multiple rates as a standard to compare with organic fertilizer sources.

In spring 2015, Russet Norkotah potatoes were planted over treated areas. Shortly before planting, soil samples were collected from each plot to determine pre-plant available nitrate, ammonium, and total nitrogen. Preliminary results are presented in the figures below. Crop vigor and petiole N are being measured through the growing season, and whole plant nitrogen and residual soil nitrogen will be measured shortly before harvest. Each plot will be harvested and graded to determine tuber yield and tuber quality.

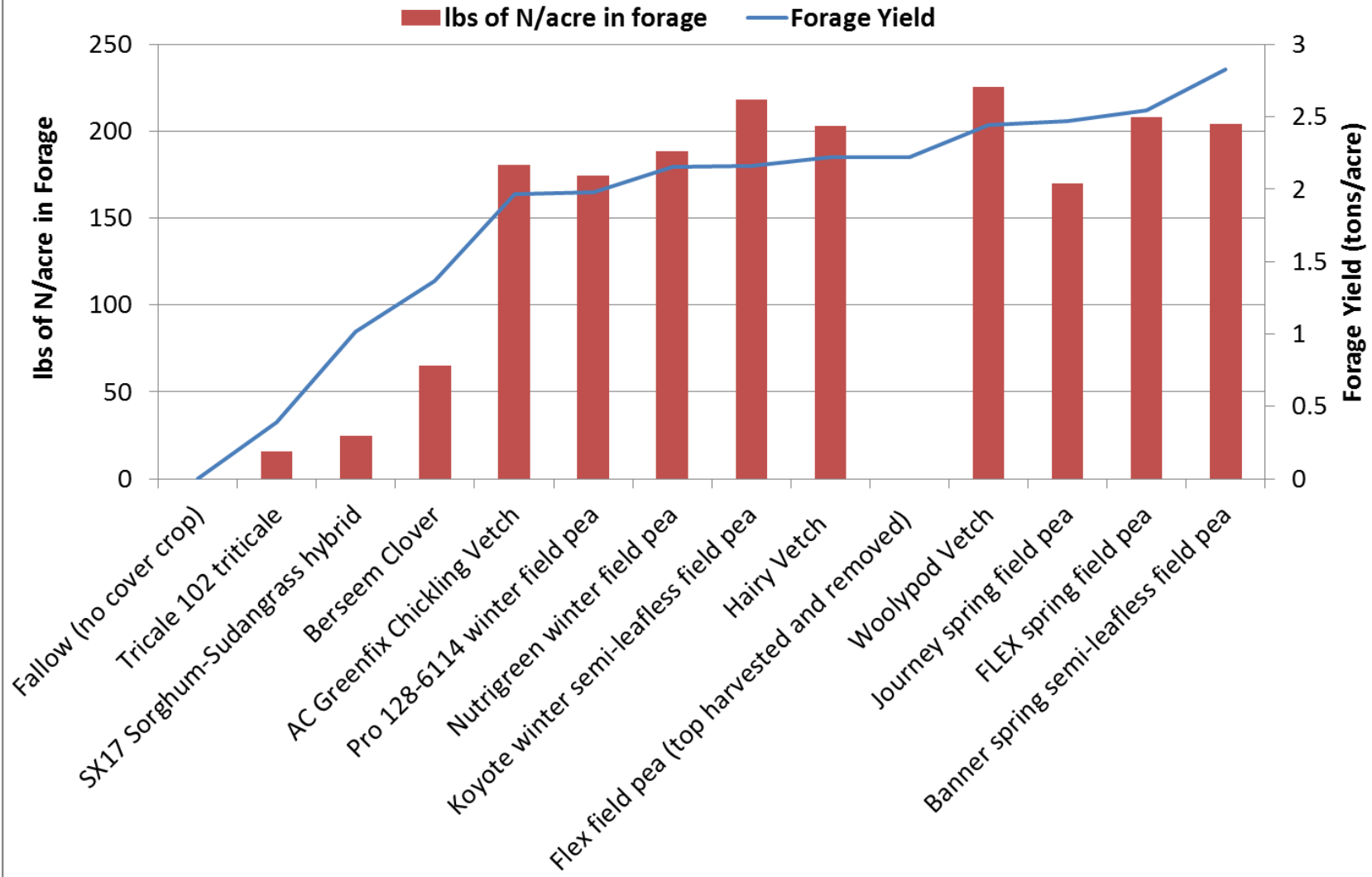
Influence of Split-Applied Nitrogen on Total Potato Yield at IREC in 2012.



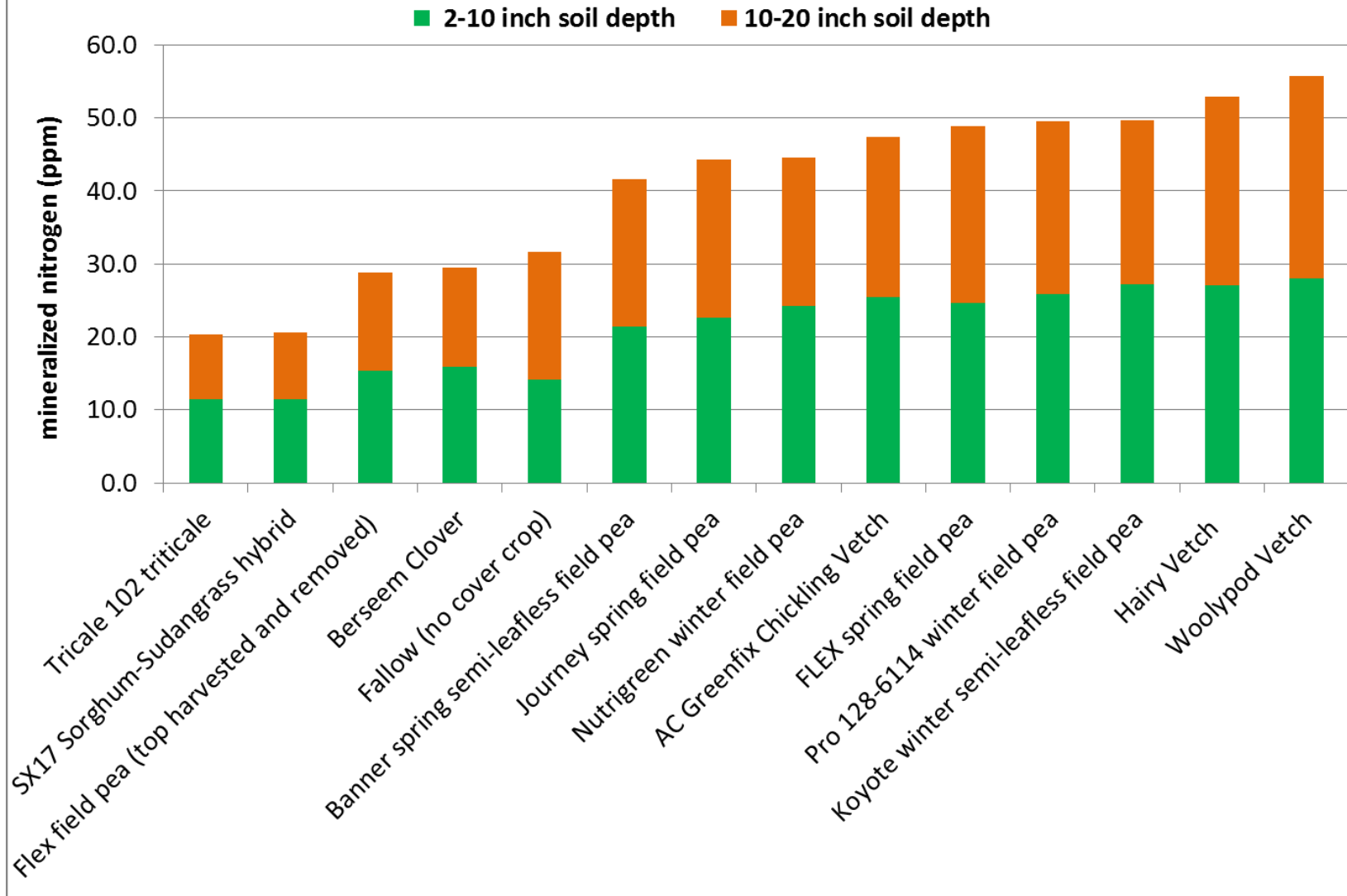
2008 Total Yield Response to N Rate of Classic Russet vs. R Burbank



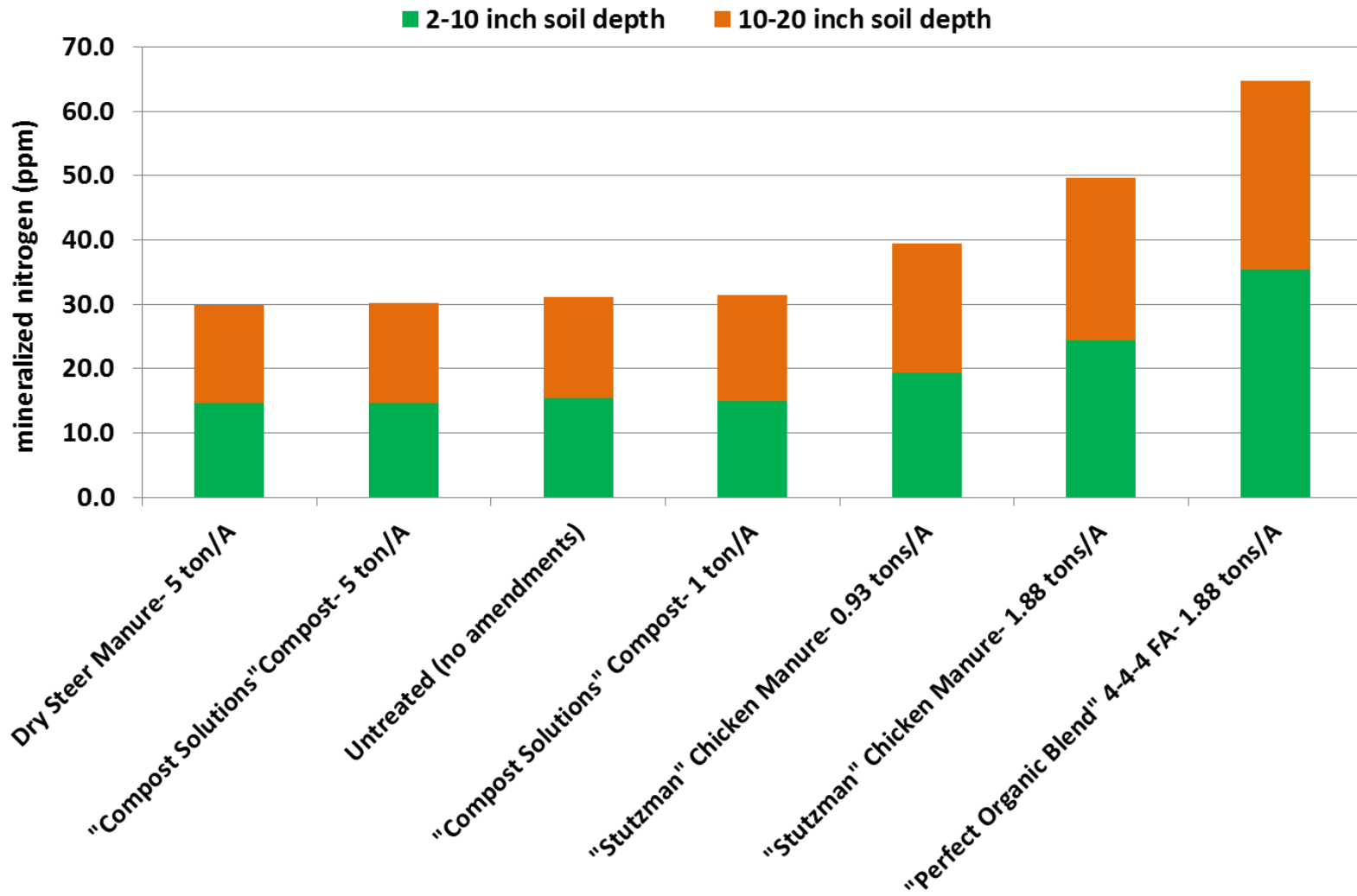
Forage Yield and Nitrogen Content for Cover Crops Planted in Mid-summer and Harvested in the Fall



Mineralized Nitrogen in the Soil at the Time of Potato Planting for Fall Cover Crops

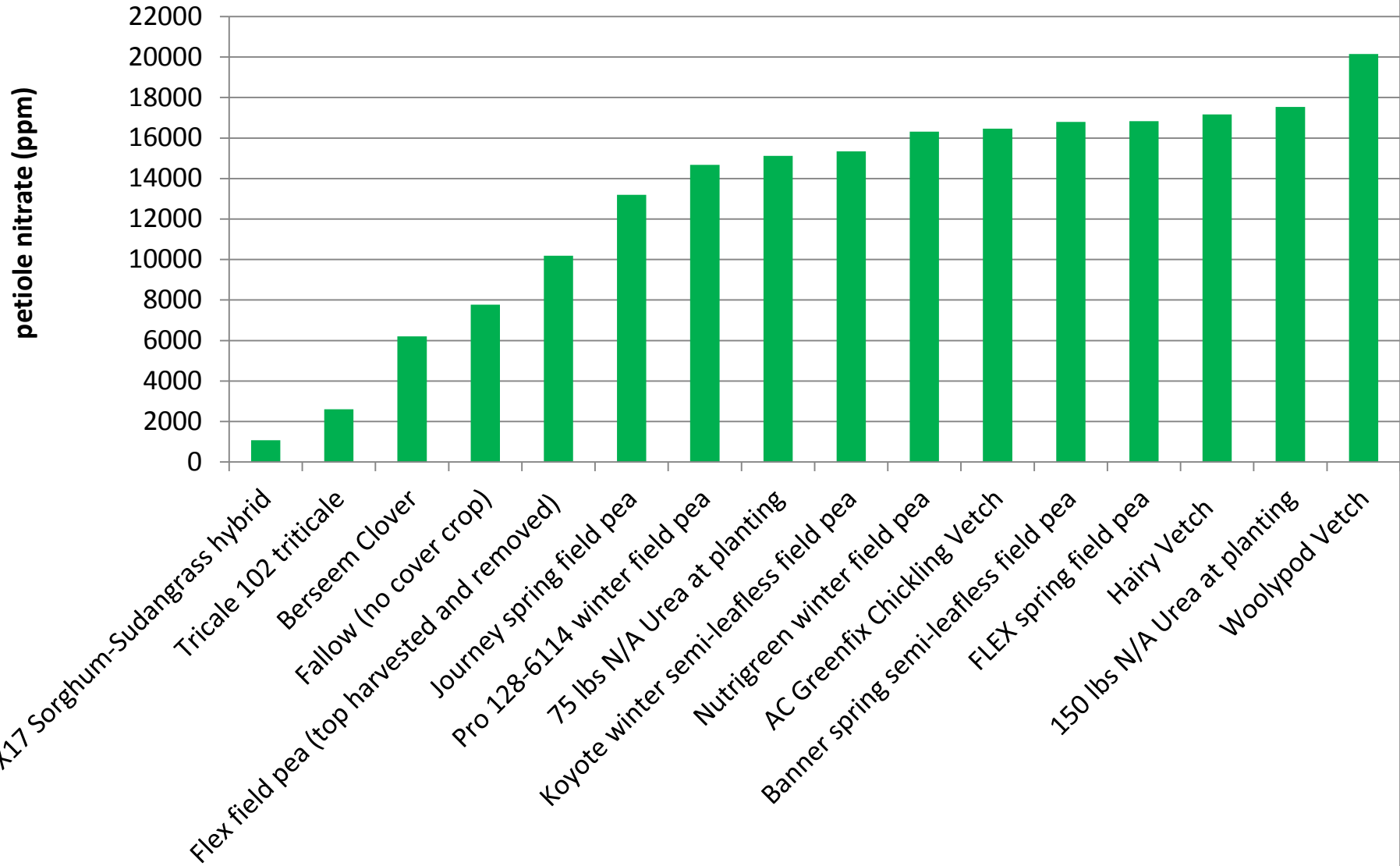


Mineralized Nitrogen in the Soil at the Time of Potato Planting for Fall Applied Organic Amendments



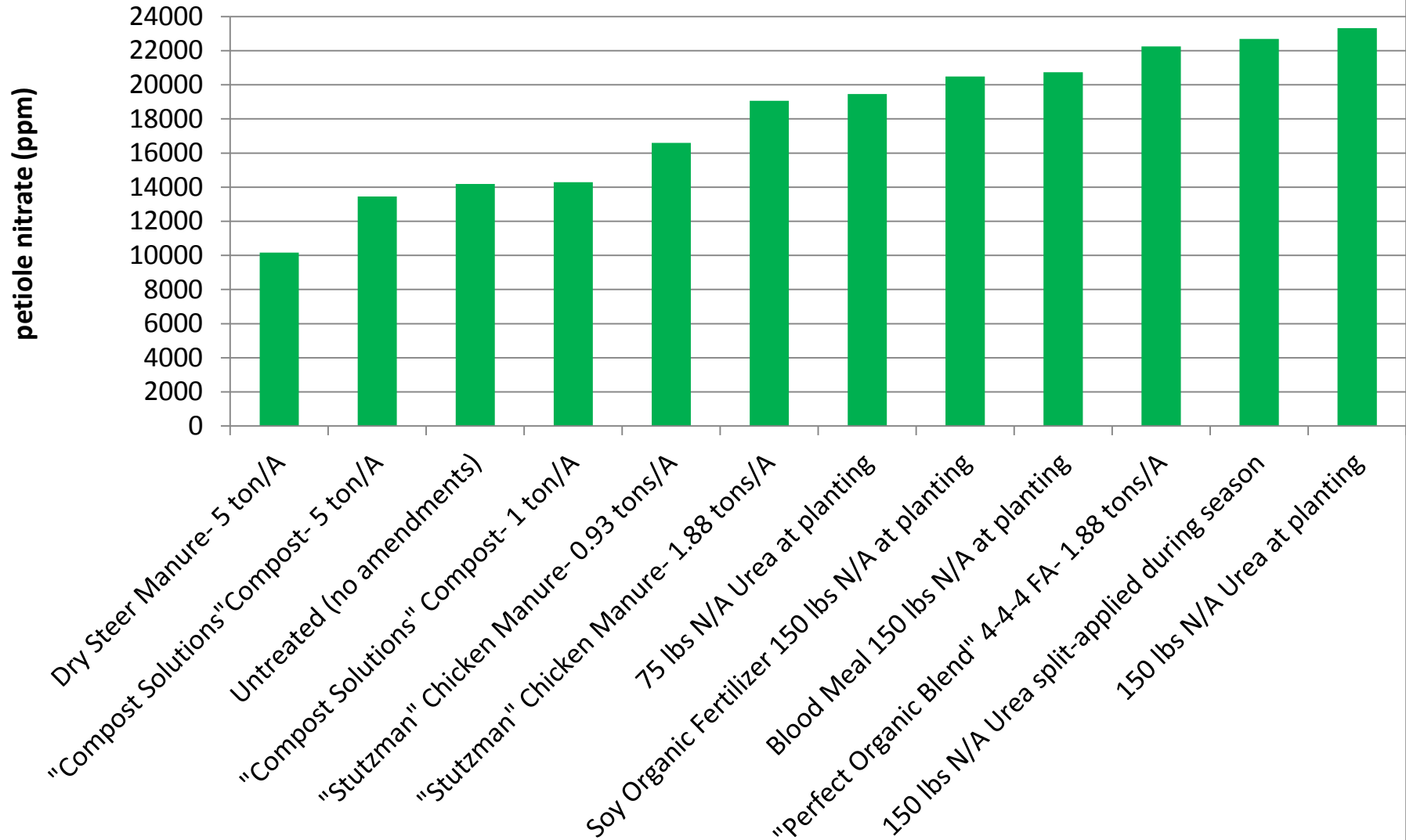
Petiole Nitrate at Tuberization to Early Bulking for Fall Cover Crop Treatments

Recommended Petiole Nitrate for R. Norkotah is 17,000 - 19,000 ppm



Petiole Nitrate at Tuberization to Early Bulking for Fall and Spring Applied Organic Amendments

Recommended Petiole Nitrate for R. Norkotah is 17,000 - 19,000 ppm

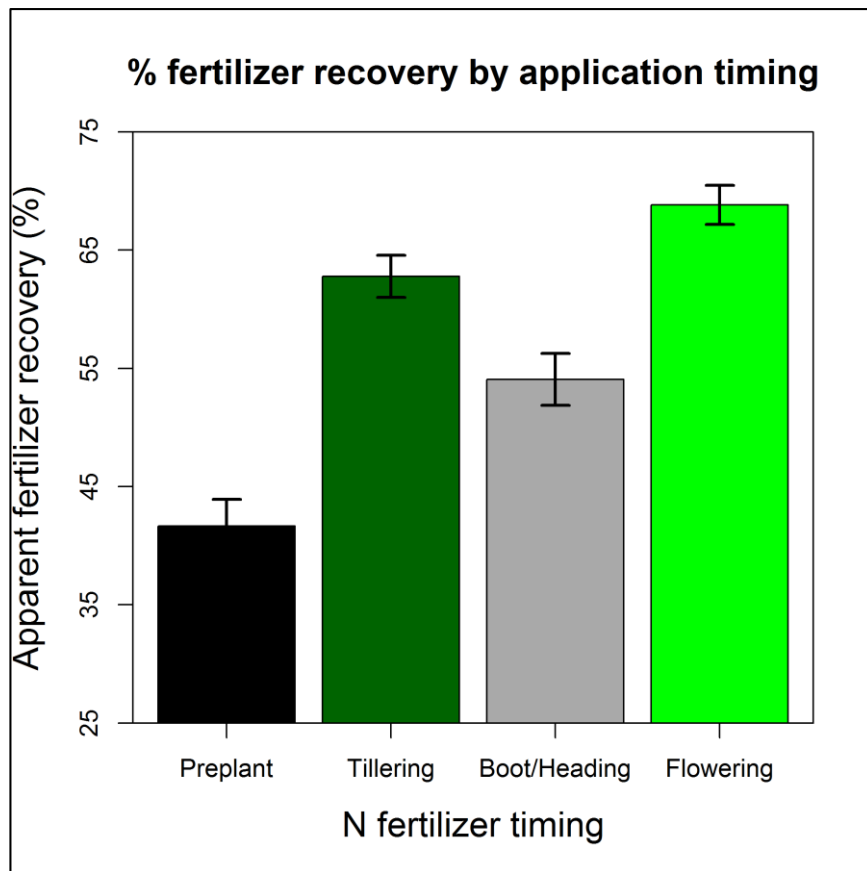


TIMING NITROGEN SUPPLY TO MATCH WHEAT DEMAND IMPROVES N USE EFFICIENCY

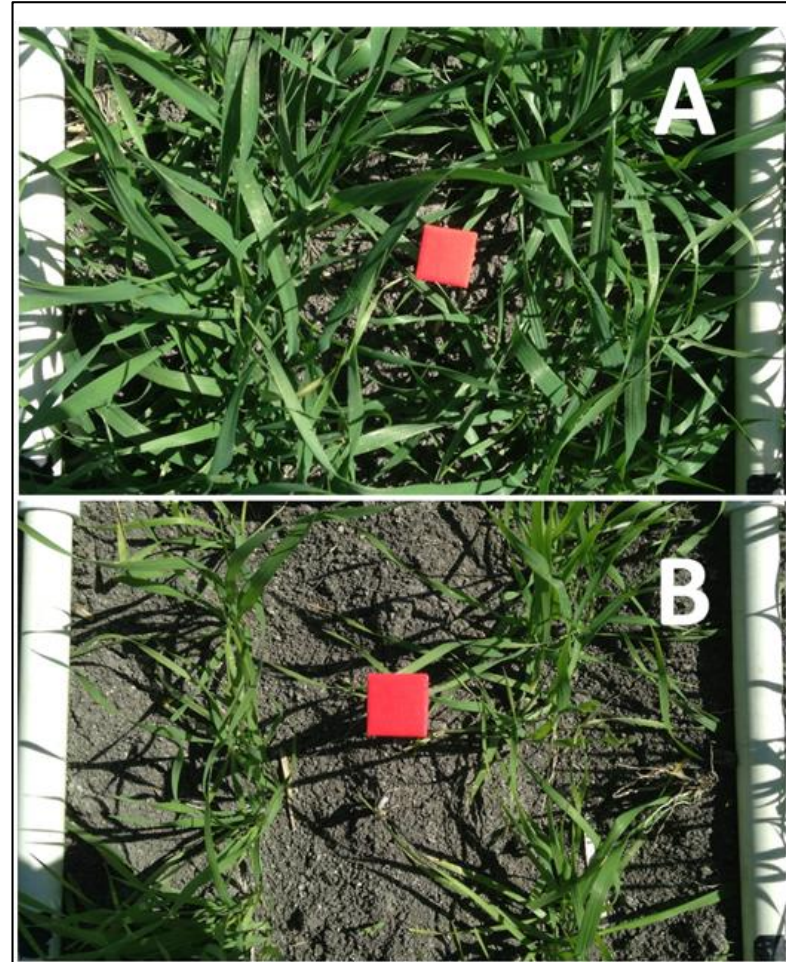
M. Lundy, S. Orloff, S. Wright, R. Hutmacher; UCCE

KEY POINTS [TIMING MATTERS!]:

- The rate of fertilizer N demand varies across the growing season.
- Timing of N application affects fertilizer use efficiency
- Applications of N at tillering and flowering boost fertilizer use efficiency relative to other application timings
 - *assuming sufficient water follows N application*



Relative change in apparent fertilizer recovery for N applied pre-plant, at tillering, at late boot/early heading or at flowering in 2014 at Tulelake CA. Change is relative to the mean N recovery (%).



The above image depicts wheat (Yecoro Rojo) at mid-tillering in two of the experimental treatments at the Intermountain REC in 2014. Crop A received 100% of its N pre-plant. Crop B received none until the day this photo was taken, when it received 80% of its total N; it then received the other 20% at flowering. On average, Crop B yielded 16% higher than Crop A and had more than 1 percentage point higher protein, despite its relative N deficiency at the tillering stage of growth. In the end, because so much more of the uptake occurred after this stage of growth, the tillering-flowering applications better matched the overall timing of N demand by the crop and allowed it to stage a “come from behind” victory relative to the crop that received all of its N pre-plant.

Support for this research was provided by **CDFA-FREP**,
California Wheat Commission, and **UCD Agricultural**
Sustainability Institute's Russell Ranch

University of California
Agriculture and Natural Resources

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Mark Lundy melundy@ucanr.edu

IN-SEASON MEASUREMENTS CAN HELP TO DETERMINE CROP N DEMAND

M. Lundy, S. Orloff, S. Wright, R. Hutmacher; UCCE

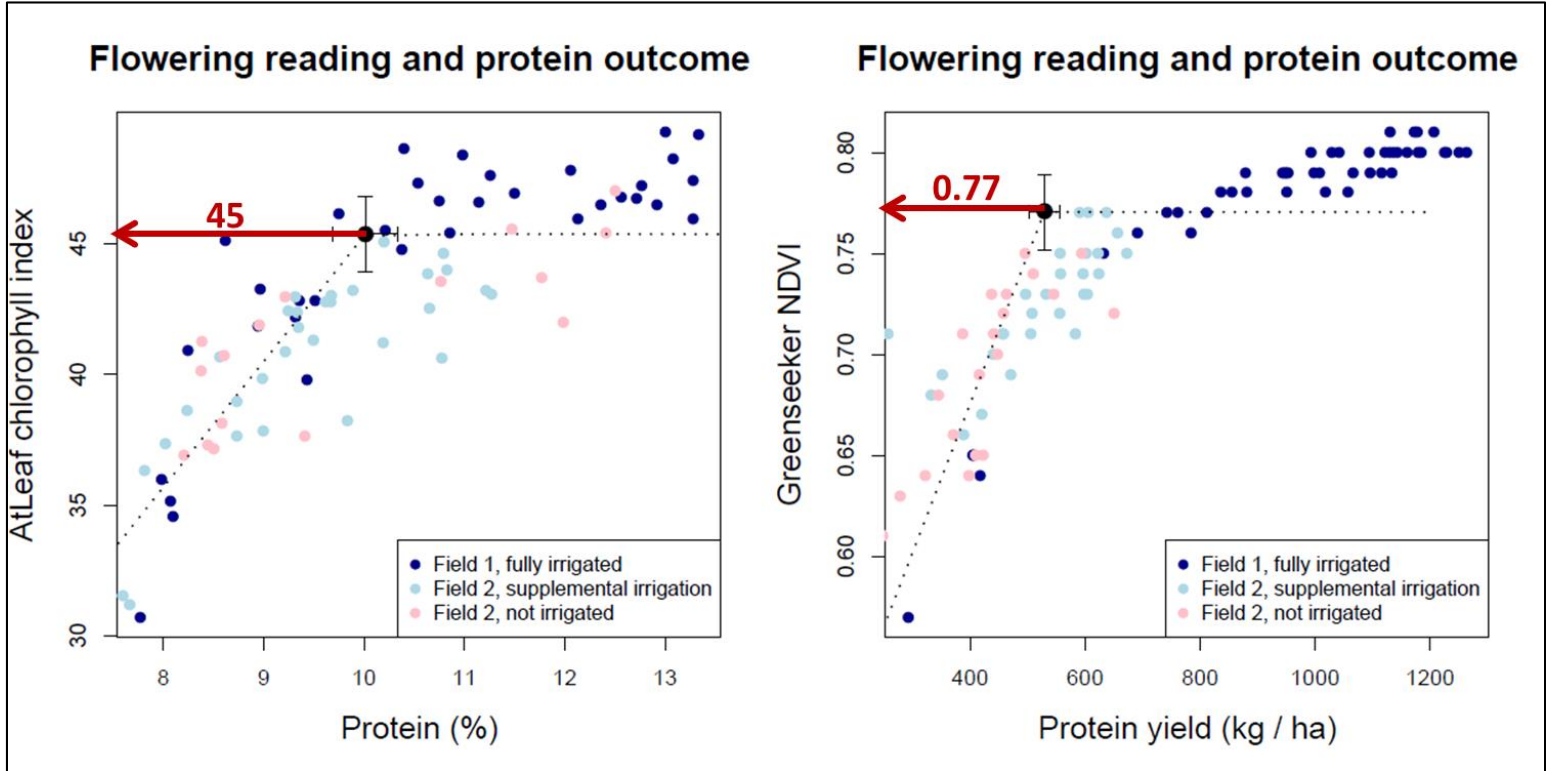
atLEAF chlorophyll meter

- SPAD proxy (660 and 940 nm)
- proxy for leaf N concentration
- Retail: ≈ \$250

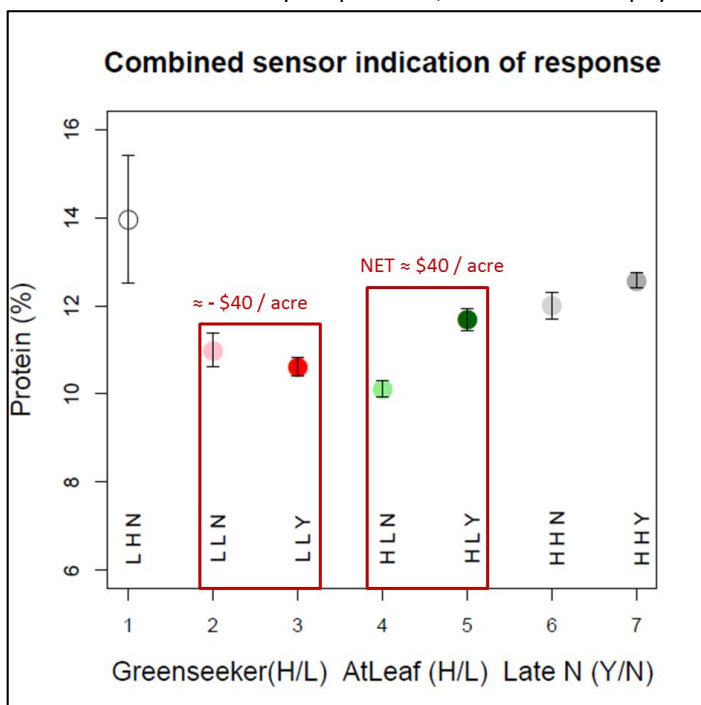


Trimble Greenseeker handheld

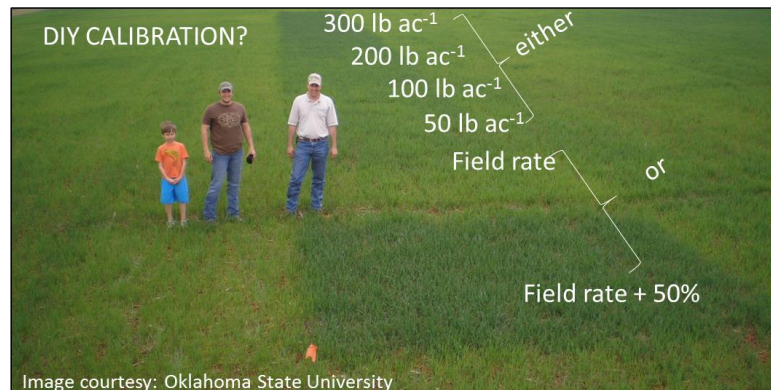
- NDVI (660 and 770 nm)
- Suitable proxy for yield potential?
- Retail: ≈ \$500



The two sensors provide distinct pieces of information. Both are needed to best determine whether an in-season application of N will add value to the crop. H/L indicate whether the measurements were above (H) or below (L) the sufficiency thresholds we developed in N rate trials. Y/N indicate whether N was added at flowering. If the leaf is "L" and the canopy is "H" you will see the most dramatic response because there is sufficient yield potential, while leaf chlorophyll indicates that the plant may be low in N. Whereas, if the leaf is "L" and the canopy is also "L", there is not sufficient yield potential to make use of the added N. The protein response has been translated to per acre value based on a 4 ton crop with a \$0.50 / cwt premium/discount per % above or below target (11%).



The best way to determine N sufficiency/deficiency under the conditions at your site is to set up a DIY calibration (see below) and use the combined information from these tools (and perhaps a soil nitrate quick-test?) to figure out whether/how much N to add at any given point in the season.

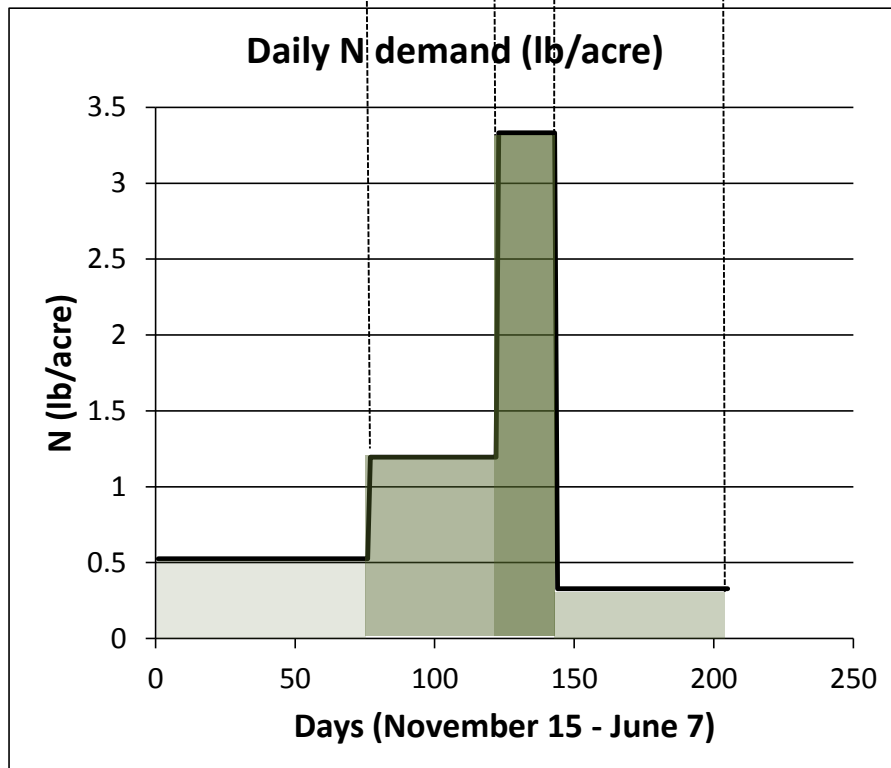
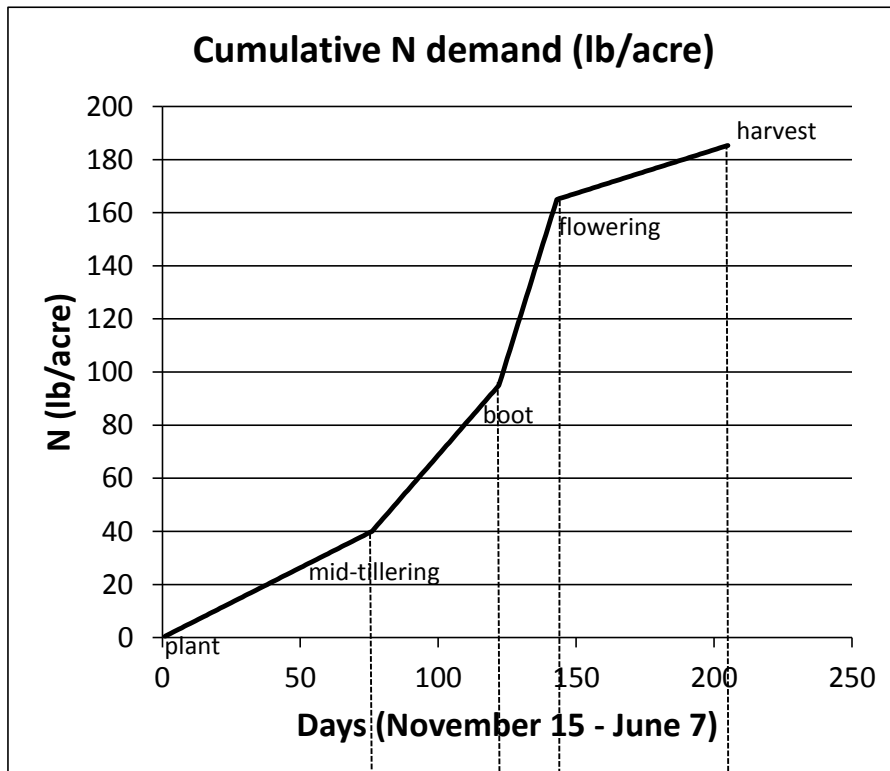


Questions? Contact:
 Steve Orloff sborloff@ucanr.edu
 Mark Lundy melundy@ucanr.edu

University of California
 Agriculture and Natural Resources

Support for this research was provided by **CDFA-FREP**; **California Wheat Commission**, and UCD Agricultural Sustainability Institute's **Russell Ranch**

Demand for N by irrigated wheat in the Sacramento Valley



Produced by Mark Lundy, UCCE Agronomist; melundy@ucanr.edu; 530-902-7295

Changes in N demand across the season for irrigated wheat in the Sacramento Valley grown on soil with low residual nitrate-N (<10 ppm) and yielding 7500 lb acre⁻¹ with 11.5% protein.

Assessment of Alfalfa Irrigation Needs in the Klamath Basin

Steve Orloff, Farm Advisor, Siskiyou County and Daniel Daniele Zaccaria, Irrigation Specialist, UC Davis

Historically, alfalfa has not been nearly as important in the Klamath Basin as it is today. In recent years according to Tulelake Irrigation District (TID) data, alfalfa acreage has climbed to nearly four times what it was in the 1960's and the majority of that increase has occurred in the last 20 years (nearly a 3 fold increase). This is due to the potential profitability of the crop and the stable market with less volatility and risk compared with of other crops—especially vegetable crops.

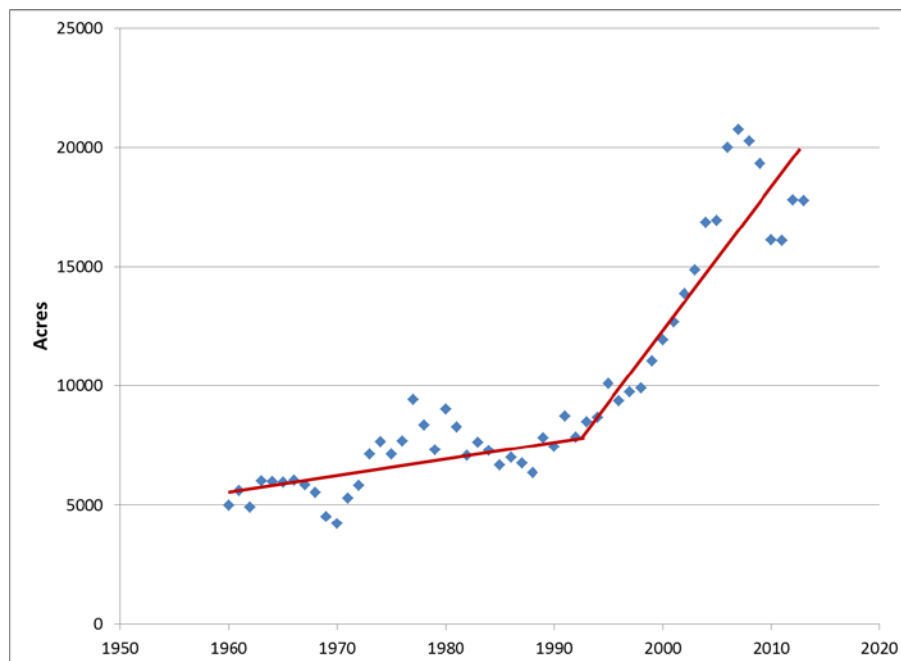


Figure 1. Alfalfa acreage in the Klamath Basin [data from Tulelake Irrigation District (TID) and only represents the area serviced by TID in California)

However, a concern associated with the increase in alfalfa acreage is a potential increase in water use. Alfalfa evapotranspiration (ET) is greater than that of grain crops and many of the vegetable crops produced in the region. Water scarcity for irrigation is an ongoing concern in the Klamath Basin and the Intermountain Region as a whole.

While alfalfa water use or evapotranspiration (ET) is fairly well understood, irrigation needs are not well understood for several reasons.

- Extreme differences in soil types encountered in the Klamath Basin (loamy sands with very low water holding capacity to organic clay loams with phenomenal water holding capacity).
- A relatively high perched water table (oftentimes within 3 feet of the soil surface) at many locations can contribute to the water demands of alfalfa reducing irrigation needs.
- The contribution of dew to meeting alfalfa ET is not well understood
- Current irrigation practices vary widely between growers and locations including different nozzle sizes, irrigation set lengths (12 or 24 hours) and number of irrigations between cuttings (one or two).

Practical information regarding the irrigation needs and the best irrigation strategy is important, especially as water pricing and delivery framework in the Klamath Basin is being reevaluated. This research should help growers know the proper irrigation rate to maximize efficiency and possibly conserve water.

Research has been conducted in cooperation with UCD Biometeorology Specialist Rick Snyder and Irrigation Specialist Blaine Hanson to quantify alfalfa evapotranspiration (ET) rates using Surface Renewal methodology. Seasonal alfalfa ET averaged approximately 37 inches per year for the years ET was measured. This is a good starting point but does not define the irrigation needs of the crop. It indicates the total water need but does not account for the contribution from different sources in addition to irrigation water. The contribution from soil moisture, shallow groundwater, in-season rainfall and dew all need to be factored in to determine the irrigation needs of the crop. In addition, ET or the net water needs of the crop is customarily adjusted for the non-uniformity of irrigation systems to determine the gross amount of water required since no irrigation system is 100 percent uniform.



Figure 2. Instruments were installed at IREC alfalfa field to monitor ET. Surface renewal instruments to the left and commercial Tule unit to the right between the flags (Photo: Laurie Askew).

Our recent research in the Scott Valley shows that growers in that area of the Intermountain Region are applying significant less irrigation water over the season than what would be assumed using ET data and assumed irrigation application efficiency. We found that growers are typically applying between 18 and 22 inches of irrigation water over the season in contrast to the 34 or more inches of applied water that are reported by agencies using ET values and assumed soil moisture storage and other assumptions. Knowing how much water should be applied to alfalfa in the Klamath Basin is even more difficult to determine because of the high

soil moisture holding capacity of many of the soils, the perched water table at many/most sites and most likely heavier dews due to cooler nighttime temperatures. Therefore, a 3-year trial was initiated this year to better assess alfalfa irrigation needs in the Klamath Basin.

Objectives of this research are to:

1. Determine the effect of irrigation quantity on alfalfa yield in the Klamath Basin
2. Evaluate the need for one versus two irrigations per cutting
3. Measure the contribution from dew to alfalfa ET over the growing season

Project Description

This project is being conducted in two alfalfa fields, one at IREC and another in a commercial field in the Copic Bay area owned by King Productions. The trials consist of four irrigation treatments which are achieved by varying nozzle orifice size and the number of irrigations per cutting.

Estimated Applied Water for 3 and 4 Cut Schedules

Irrigation Treatment	No. Irrigations between Cuts	Nozzle Orifice Size	Seasonal Water Application 3-Cut	Seasonal Water Application 4-Cut
1	1	11/64	11.0	13.7
2	1	13/64	15.0	18.7
3	2	11/64	16.5	22.0
4	2	13/64	22.4	29.9

The precise application amount will vary somewhat due to differences in system operating pressure and exact irrigation set time at the different locations, but should be close to these values. Plots will be established by varying the size of three to four consecutive nozzles on a wheel-line to achieve the treatments described above. Selected nozzles will be shut off completely on the second irrigation set per cutting in order to achieve the single irrigation per cutting treatments. Yield is being measured at each cutting. Surface Renewal weather instruments were installed at the IREC site in cooperation with the Department of Water Resources. A commercial unit (called Tule) that operates on the same principles was installed in both fields to quantify alfalfa ET (Figure 2). Leaf wetness sensors were installed at the IREC site to quantify dew. Watermark soil moisture sensors were installed in each plot to monitor the soil moisture status over the season.

Since this is the first year of this research we don't have results to report to date, however, when this research is completed it should better define the irrigation needs of alfalfa grown in the Klamath Basin. Ultimately, this could improve the profitability of alfalfa for some operations and possibly reduce irrigation application rates in some cases.

Evaluating Onion Irrigation Uniformity in Tulelake

Rob Wilson, IREC Director/Farm Advisor

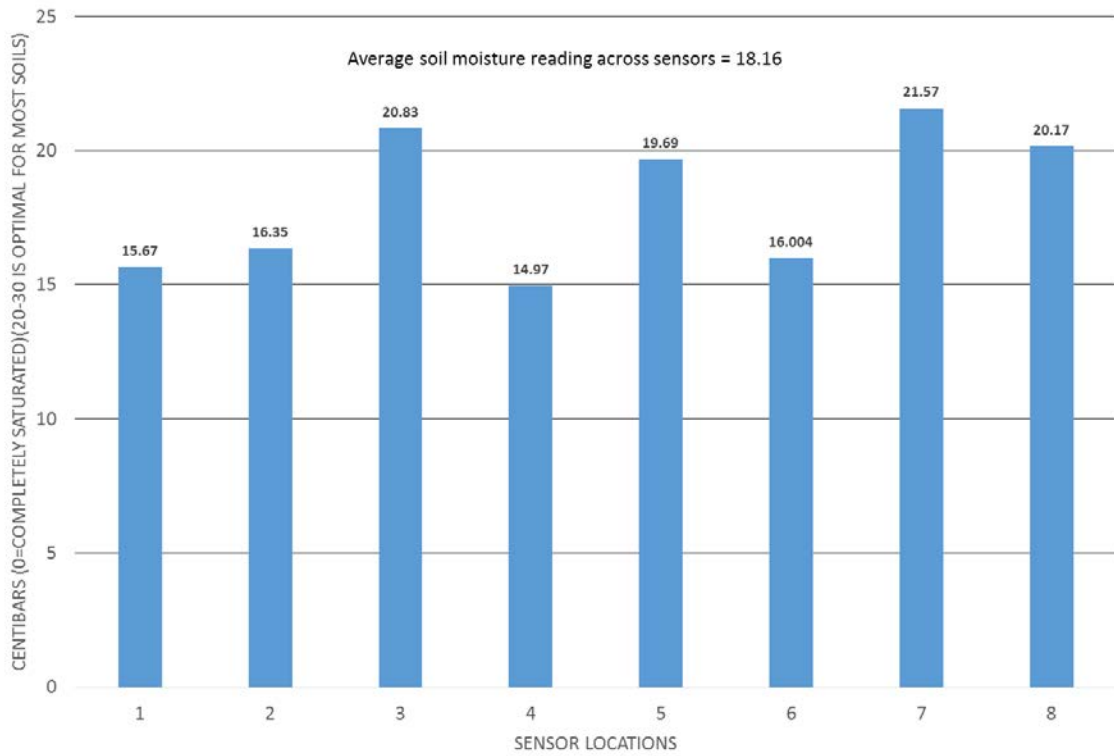
Solid set sprinkler irrigation is the predominant irrigation method for onions in Tulelake. Solid set sprinklers offer several advantages including early season wind protection, high irrigation frequency, and the ability for growers to chemigate fertilizer and pesticides. On the flip side, solid set irrigation is stationary in the field throughout the growing season and uneven water distribution patterns in the field can cause wet and dry spots. For many years research at IREC documented the distribution uniformity for different sprinkler spacing, nozzle sizes, and pressures. The distribution uniformity for solid set sprinkler configurations in Tulelake ranged from 80% to 85% under calm conditions and often below 60% in windy conditions during the tests.

Onions are one of the most sensitive crops grown in Tulelake when it comes to moisture stress. Studies in Oregon have documented large yield losses if onions receive too little or too much water. This study was established to document differences in soil moisture and onion yield caused by non-uniformity in sprinkler coverage. The study is unique in that it is monitoring soil moisture differences over the entire growing season unlike many studies that measure sprinkler distribution uniformity for a single irrigation event. The study is also trying to quantify yield differences within the field to measure financial gain or loss caused sprinkler patterns.

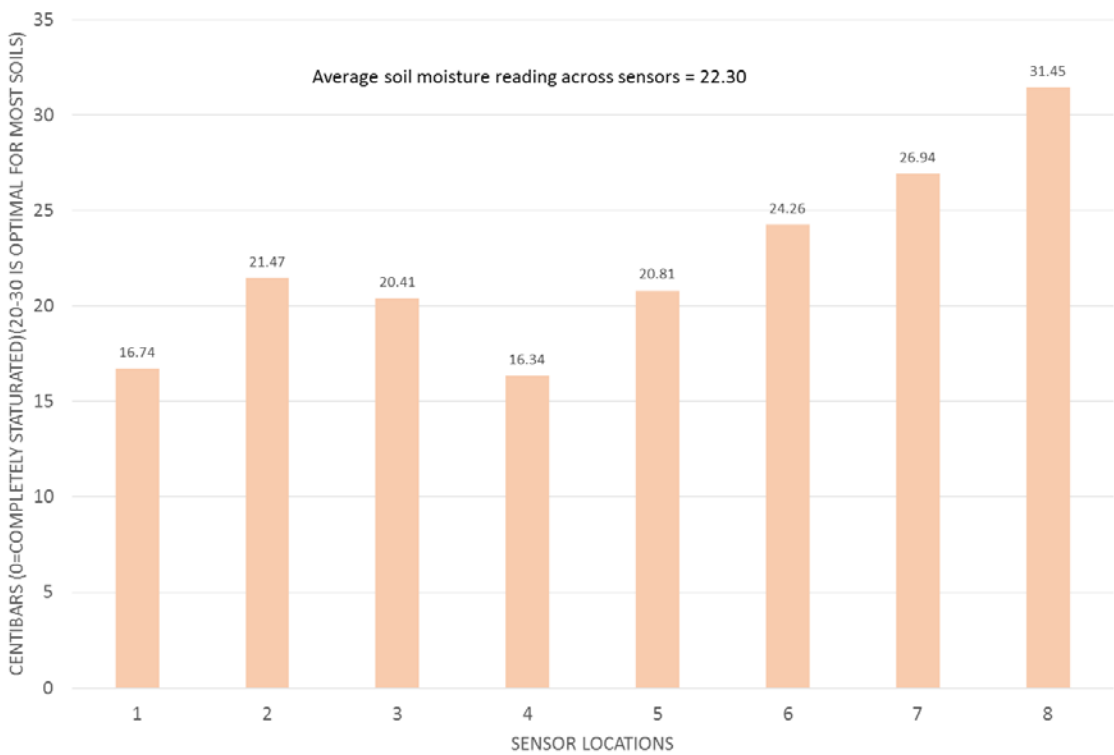
Six study sites were established in cooperation with several onion growers. The sites encompass most sprinkler configurations and soil types found in Tulelake. Data being collected at the sites includes soil moisture measurements every two hours using Watermark sensors, monthly onion vigor and height evaluations, and onion yield. Monitoring locations are placed in a 6 X 6 ft grid pattern to document differences in soil moisture and onion growth within the sprinkler spacing.

Average soil moisture for each grid location at all sites (up until the 3rd week of July) is shown in the graphs below. Preliminary data suggests a consistent soil moisture pattern developing at all sites due to uneven sprinkler distribution uniformity. Final soil moisture results and onion yield results will be available in early winter. The final graph shows a side-by-side comparison of Watermark Soil Moisture Sensors and Decagon Soil Moisture Sensors in alfalfa in 2015 at IREC. Overall changes in soil moisture were similar for both sensor types and both sensors appear to adequately track changes in soil moisture. It should be noted there were small differences in the actual soil moisture estimate between sensors and growers should always confirm soil moisture in the field by frequently digging in several locations.

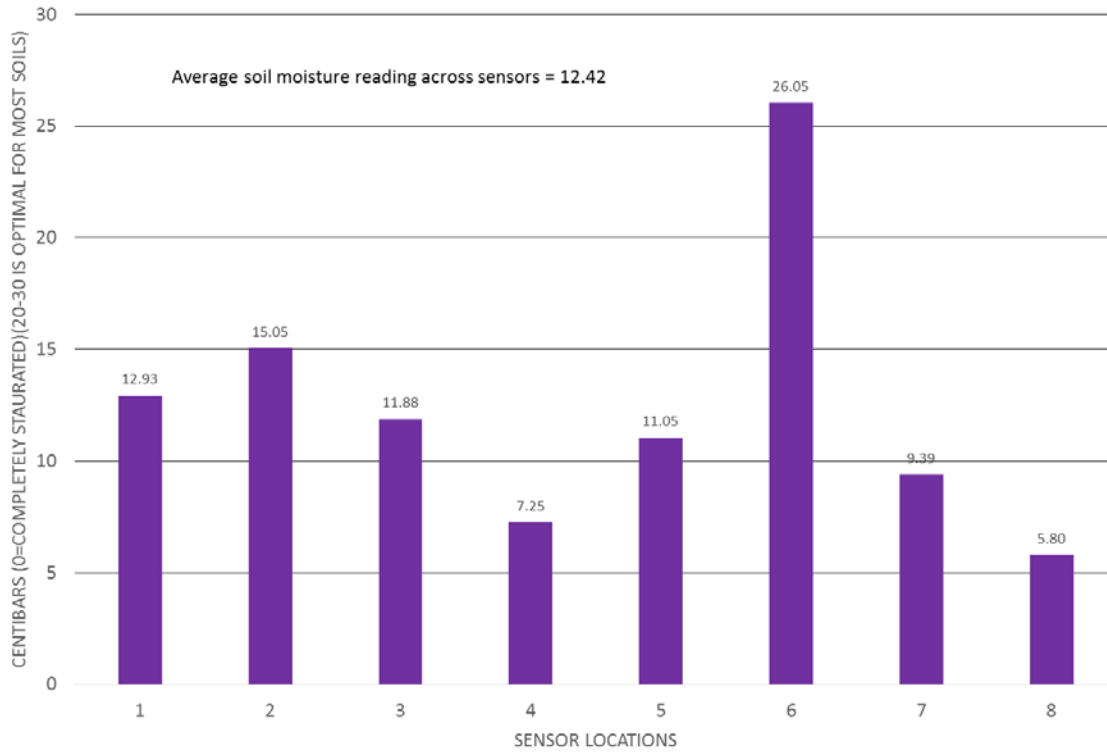
Site 1- 48 x 30 Sprinkler Spacing- 3/32" Windfighter Head



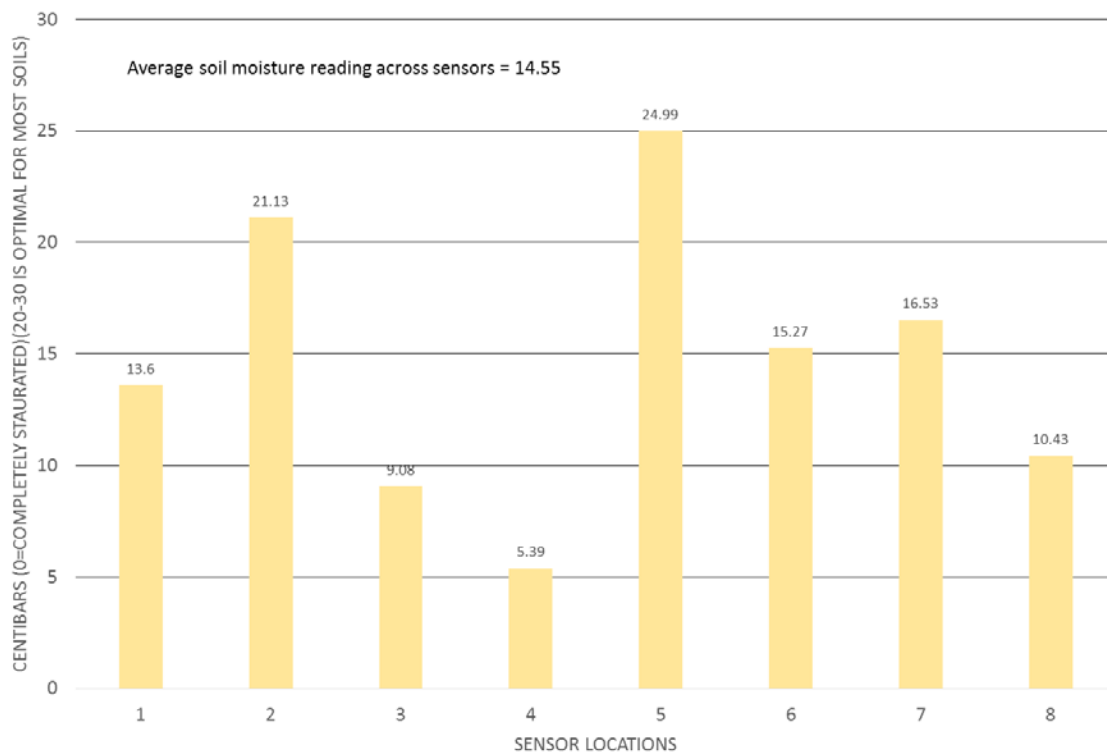
Site 2- 40 x 54 Pipe Spacing- 7/64" Windfighter Heads



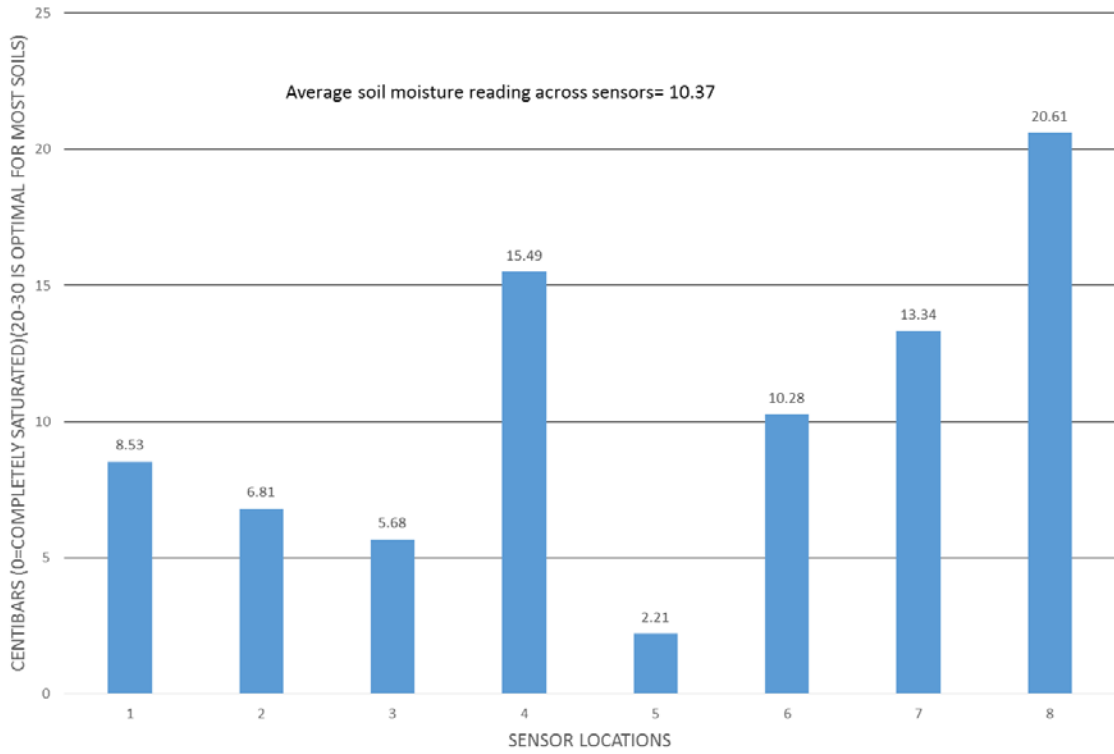
Site 3- 30 x 51 Sprinkler Spacing- 3/32" Windfighter Heads



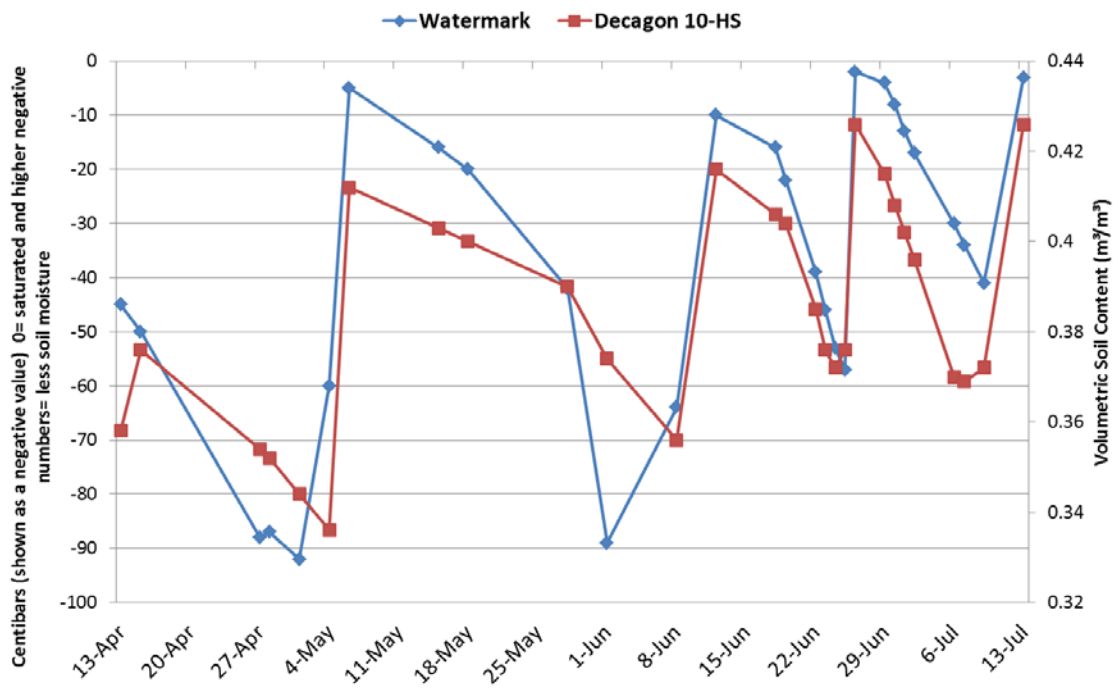
Site 4- 30 x 42 Sprinkler Spacing- 3/32" to 7/64" Windfighter Heads



Site 5- 30 x 51 Sprinkler Diamond Spacing- 3/32" Impact Heads



Comparison of Watermark Soil Moisture Sensors and Decagon 10-HS Soil Moisture Sensors in Alfalfa in 2015
Sensor Depth = 12 inches below soil surface



Planting Date and Cultivar Effects on Winter Wheat Yield

Steve Orloff, Farm Advisor

UCCE Siskiyou County

Introduction and Objectives

In contrast to the more temperate zones of California, both spring wheat and true winter wheat varieties are produced in the Intermountain Region. Spring wheat production is more common but winter wheat is gaining in popularity because winter wheat plantings have generally yielded a half to one ton higher than spring wheat. Spring wheat is typically seeded in April and warm/hot temperatures often follow within a couple of months after seeding limiting the potential yield.

In the past, winter wheat production in the Klamath Basin was often discouraged because of the possibility of winter kill or floret sterility caused by untimely spring frosts. To overcome this risk, winter wheat is sometimes planted in February. However, with this timing yield potential may be reduced because there is less time for tillering, and growers run the risk of there not being sufficient chill hours to satisfy the vernalization requirement of winter wheat. The actual timing of winter wheat plantings varies tremendously from October through November, ceases in mid-winter due to the severe cold and may also occur in late winter (February).

Research was needed to quantify the yield impacts associated with the wide variation in winter wheat planting dates and to determine the most advantageous planting window. Early fall planting (late September) is currently not done, but research was warranted to determine if an early fall planting followed by irrigation could improve root development and help plants get better established before the onset of winter. Some planting dates are more convenient for growers, primarily due to time limitations following rotation crops. Regardless, it is still advantageous to know the yield penalties associated with some planting dates so that growers can make informed decisions regarding planting date. There are several new winter wheat varieties, both soft white and hard red, which needed to be evaluated across a range of planting dates to better understand their potential for the Intermountain area.

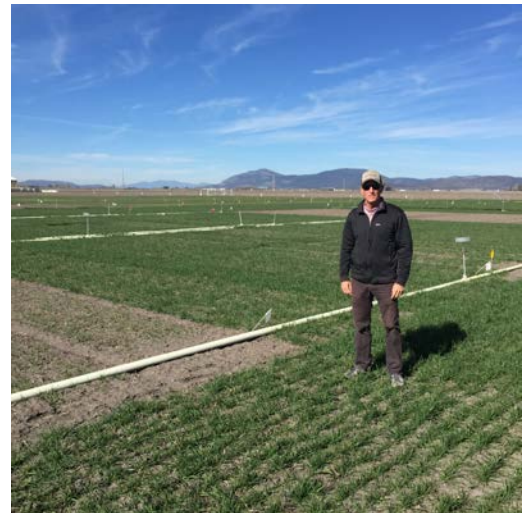


Figure 1. Winter wheat planting date trial with funny-looking researcher. Early planting date blocks could be independently irrigated for germination.

Winter wheat variety trials have been conducted for decades in Montague (central Siskiyou County) and more recently at IREC by the UC Davis small grains program in cooperation with local Farm Advisors. These variety trials have identified the top yielding winter wheat varieties in the Intermountain Region. The leading varieties from these trials were selected for inclusion in this research. However, the varieties have only been evaluated at a single planting date—typically late October.

Eight high yielding winter wheat varieties (5 soft white winter and 3 hard red winter varieties) were seeded at the Intermountain Research and Extension Center (IREC) in Tulelake at four planting dates (September 26, October 15, November 10 and February) in 2013/14 and again in 2014/15. Varieties were seeded at 120 pounds per acre using a cone seeder. Because soft white winter wheat has been more popular than hard red varieties, we selected 5 soft white varieties and three hard red varieties

(see table below). Sprinkler irrigation occurred after planting for the September and October planting dates. November and February planting dates were not irrigated after planting and relied on rainfall and soil moisture for germination.

Table 1. Winter wheat cultivars evaluated.

Cultivar	Description
Bruneau	Soft white winter (released by Idaho AES)
Mary	Soft white winter (released by OSU)
Tubbs	Soft white wheat (OSU in cooperation with USDA)
Bobtail	Soft white winter (released by OSU)
SY Ovation	Soft white winter (Syngenta)
Northwest 553	Hard red winter (developed by OSU and Nickerson International Research SNC in cooperation with USDA.
Azimut	Hard red winter (Limagrain Cereal Seeds (LCS)
Keldin	Hard red winter (WestBred)

Results

Winter wheat yields in the Klamath Basin were lower than normal in 2014 in this trial and in commercial fields as well. The reason is not fully understood but is likely due to a combination of extreme cold in December, low rainfall and a lack of deep soil moisture and hot temperatures in early summer. There was a highly significant difference in yield between cultivars (Table 2). The soft white winter wheats tended to yield higher than the hard red varieties (Table 3). Overall, Tubbs was the highest yielding variety, while Keldin was the highest yielding hard red variety. Planting date was found to have a highly significant effect on yield. As mentioned, the first two planting dates were irrigated after planting. November was not and had a poorer stand as a result because November was abnormally dry. SY Ovation was the most affected, which explains the poor yield at that planting date. Azimut was also affected but to a lesser degree. January was far drier than normal, allowing an early February planting date. Rain occurred shortly after planting.

Table 2. Analysis of variance evaluating the effect of planting date, variety, and the interaction of planting date and variety on plant height, yield, and bushel weight.

	Height	Yield	Bushel Weight
Planting Date	0.0016	0.0006	0.1199
Variety	<.0001	<.0001	<.0001
Planting Date x Variety	0.0194	0.0002	0.0001

Surprisingly, the September planting had the lowest yield. This was true for nearly every cultivar except for SY Ovation where the November planting date had the lowest yield due to a poor stand. Also, the variety Bobtail did not appear to be as affected by planting date as the other cultivars. For some cultivars the September planting was over half a ton lower yielding. It was also surprising that the February planting performed as well as it did. The yield was slightly lower than the October planting for some varieties yet higher for others, so the overall average yield for October and February plantings

across cultivars was very close. This is surprising in that there was almost a 4 month difference between those two planting dates.

Table 3. The effect of planting date and cultivar on the yield of winter wheat in the Klamath Basin. IREC 2014.

	Yield (tons/acre)				
	Sept 25	Oct 15	Nov 10	Feb 4	Mean
Bruneau	2.94	3.62	3.642	3.64	3.46
Mary	3.35	3.73	3.383	3.45	3.48
Tubbs	3.41	3.84	3.431	3.77	3.61
Bobtail	3.52	3.50	3.615	3.32	3.49
SY Ovation	3.02	3.46	2.683	3.77	3.23
Norwest 553	2.58	2.83	3.139	2.95	2.87
Azimut	2.48	2.92	2.663	3.12	2.80
Keldin	2.76	3.57	3.641	3.27	3.31
Mean	3.01	3.43	3.27	3.41	

There were significant differences in bushel weight between varieties (Table 4). The varieties Azimut and Bobtail tended to have the lowest bushel weight. The lowest yielding planting date (September) appeared to have the highest bushel weight. There was also a significant planting date x variety interaction effect on bushel weight.

Table 4. The effect of planting date and cultivar on the bushel weight of winter wheat in the Klamath Basin. IREC 2014.

	Bushel Weight (lbs)				
	Sept 25	Oct 15	Nov 10	Feb 4	Mean
Bruneau	57.0	56.5	57.2	56.6	56.8
Mary	57.6	57.3	57.4	56.6	57.3
Tubbs	57.0	57.1	56.5	57.1	56.9
Bobtail	54.4	54.9	54.7	55.7	54.9
SY Ovation	57.6	57.4	57.3	57.2	57.4
Norwest 553	58.6	58.9	58.1	59.0	58.7
Azimut	55.4	53.5	51.9	52.1	53.2
Keldin	59.2	59.6	59.5	59.0	59.3
Mean	57.1	56.9	56.6	56.7	

Discussion and Conclusions

These results were somewhat unexpected. A September planting performed poorer than I would have thought and February performed better. With a September planting the idea was that plants would be larger and more established going into the cold winter months. The plants are more mature going into winter but at that growth stage are actually more susceptible to injury from freezing temperatures. Planting grain in September would be a sacrifice anyway because it is difficult for growers to plant by that date due to harvest schedules for the preceding crop and the field would likely require more fall

irrigation. For most cultivars the September planting date was the lowest yielding of the four planting dates. It is interesting to note that the September planting date also resulted in the shortest plants (see Table 5), while the other three planting dates were all comparable.

Table 5. The effect of planting date and cultivar on the height of winter wheat in the Klamath Basin. IREC 2014.

	Plant Height (cm)				
	Sept 25	Oct 15	Nov 10	Feb 4	Mean
Bruneau	36	40	40	40	39
Mary	32	36	36	35	35
Tubbs	37	39	40	40	39
Bobtail	31	33	35	35	34
SY Ovation	35	37	34	37	36
Norwest 553	32	33	33	34	33
Azimut	29	30	30	30	30
Keldin	33	38	38	37	37
Mean	33	36	36	36	

Plant height and yield for the February planting date was as high as the October planting date nearly four months later. The November planting date would probably yield higher in most years than it did in 2014 had there been sufficient rainfall soon after planting for uniform emergence. The February planting was higher yielding than it would likely be in other years because January was so dry allowing an earlier February planting than might occur in some years and timely rain occurred immediately after planting. This allowed for earlier emergence and more time for vernalization to occur. It is interesting to note the heading date for the different planting dates. The heading dates for the February planting were nearly identical to the November planting (Table 6), actually slightly earlier in some cases. Perhaps wheat plants grow so little over the cold winter months of late November, December, January and early February that yield isn't reduced much if planting is delayed until February in some years.

Table 6. The effect of planting date and cultivar on the heading date of winter wheat in the Klamath Basin. IREC 2014.

	Heading Date			
	Sept 25	Oct 15	Nov 10	Feb 4
Bruneau	21-Jul	27-Jul	4-Aug	31-Jul
Mary	19-Jul	21-Jul	30-Jul	26-Jul
Tubbs	20-Jul	27-Jul	2-Aug	1-Aug
Bobtail	19-Jul	19-Jul	30-Jul	3-Aug
SY Ovation	19-Jul	24-Jul	8-Aug	27-Jul
Norwest 553	21-Jul	27-Jul	3-Aug	28-Jul
Azimut	19-Jul	22-Jul	1-Aug	27-Jul
Keldin	19-Jul	19-Jul	24-Jul	21-Jul

The 2014/15 trial has not yet been harvested. Results this year appear to be different. The November planting date looks very similar to the October planting date and had an excellent stand because rainfall occurred soon after planting. Visual observations suggest again that the late September planting date was poorer yielding than the October. Again, it appears that planting in late September is too early and leads to greater frost injury to the plant over winter. Plants look excellent heading into winter but they are more sensitive to freezing temperatures at that growth stage. In contrast to last year, the February planting looks extremely poor this year. The plants are short and the yield looks very low. The trial was planted later in February this year and temperatures following planting were abnormally mild and it appeared the plots may not vernalize and send up a seed head. Eventually, they did but overall growth was poor and the plants were affected by a bacterial leaf disease that caused significant damage to the leaves, worse than the other planting dates.

Recommendations to Date

- Late September planting is not advised. It would be difficult to plant at that time following most crops and would likely require extra fall irrigation. In addition, yield was actually less at this planting time, likely due to winter injury.
- October and November planting times appear to be best provided there is irrigation or rainfall after planting. After harvest this year, we will better be able to compare October and November planting dates. The yield decline with a November planting in 2014 may have been a result of the poorer stand from the lack of rainfall after planting.
- February plantings can perform well in years like 2014, but are riskier. It is difficult to predict what the weather will be like after planting and whether there will be adequate cold temperatures for vernalization. Or, if it is a warm spring like this year, yield potential can be dramatically reduced by the high temperatures and the plants may be more susceptible to the bacterial leaf disease affecting wheat in the Klamath Basin.

Alfalfa's Nitrogen Benefit to Wheat following Alfalfa¹

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INTRODUCTION

Row crops, such as small grains, corn, cotton, and tomatoes, can often benefit from the nitrogen fixed by a previous alfalfa crop. Like other legumes, alfalfa supports bacteria that convert, or fix, N₂ from the atmosphere into a form plants can use. These bacteria can fix between 350 and 800 lb N/ac per year. While a lot of this N is removed with each alfalfa harvest, much of this N is also stored in the roots and crowns. For crops grown after alfalfa, this N can reduce the subsequent crop's N fertilizer need; in some cases, crops following alfalfa do not need N fertilizer at all. This research has the objective of quantifying the N contributions of alfalfa to subsequent crops, using wheat as the test crop.

FIELD STUDY

Field trials were established at three locations: Davis (Solano County), Kearney/Parlier (Fresno County), and Tulelake (Siskiyou County), and conducted over two rotation periods (2 years). Soils in Davis and Tulelake are clay loams, and in Parlier, a sandy loam. Data from the second year of this study (2014-2015) are in process. Data presented here are primarily from the first year (2013-2014).



Figure 1: Rotation treatments of 2014-2015 alfalfa N credit trial at Tulelake, prior to establishment of wheat test crop in Fall, 2014.

At each location, we grew plots of irrigated wheat to quantify plant-available nitrogen within larger replicated strips that previously had either: (1) alfalfa for 2.5+ years or (2) sudangrass-wheat rotation for 1.5+ years (Figure 1). Neither the alfalfa nor the sudangrass-wheat received N fertilizer, but were otherwise managed using standard farming practices. Strips were plowed under in the fall of each year and were planted to wheat shortly after. Within each strip, the plots of irrigated wheat were fertilized with N rates ranging from 0 to 250 lb N/ac. Besides N fertilization, the wheat was grown using standard farming practices for the region. Once the wheat reached the soft dough stage, plots were harvested to determine aboveground biomass. Sub-samples were taken to determine moisture content and N content.

HOW MUCH N DID THE ALFALFA CONTRIBUTE?

Depending on the location, the alfalfa contributed between 75 and 120 lb N/ac (Figure 2). Pronounced differences in growth, likely as a result of this N contribution from alfalfa, were observed both years (Figures 3 and 4). This N contribution also slowed crop maturity and thus affected moisture content at harvest, but not any more than N fertilization typically would.

1 Supported by the Fertilizer Research and Education Program (California Department of Food and Agriculture) and the California Wheat Commission.

At Tulelake, wheat biomass following the alfalfa-grain rotation responded to N fertilization up to 200 lb N/ac (Figure 3, right), as did nitrogen uptake (Figure 2, right). Extrapolating between the N treatments for wheat following grains, the alfalfa may have contributed around 119 lb N/ac at Tulelake (Figure 2, right). At Davis and Kearney, the alfalfa may have contributed 114 lb N/ac and 82 lb N/ac, respectively (Figure 2, left and center).

Using aboveground biomass (Figure 3) instead of nitrogen uptake to calculate alfalfa's N contribution yields slightly different values, but estimates using different metrics seem to mostly lie within the range of 75 to 120 lb N/ac. Aboveground biomass data from the second year (Figure 4) also seem to confer estimates in the same range.

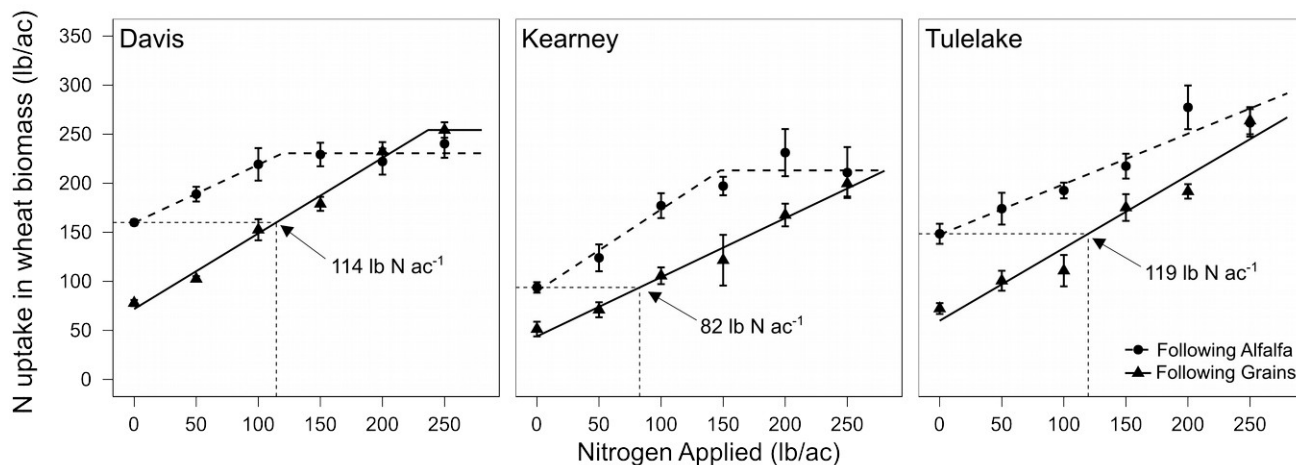


Figure 2: Data from first year (2013-2014). Nitrogen uptake in biomass of wheat grown after alfalfa and after grains at Davis (left), Kearney (center), and Tulelake (right). By comparing the N uptake of unfertilized wheat (receiving 0 N) following alfalfa against the N response of wheat following grains, the alfalfa contributed 114 lb N ac⁻¹ at Davis, 82 lb N ac⁻¹ at Kearney, and 119 lb N ac⁻¹ at Tulelake.

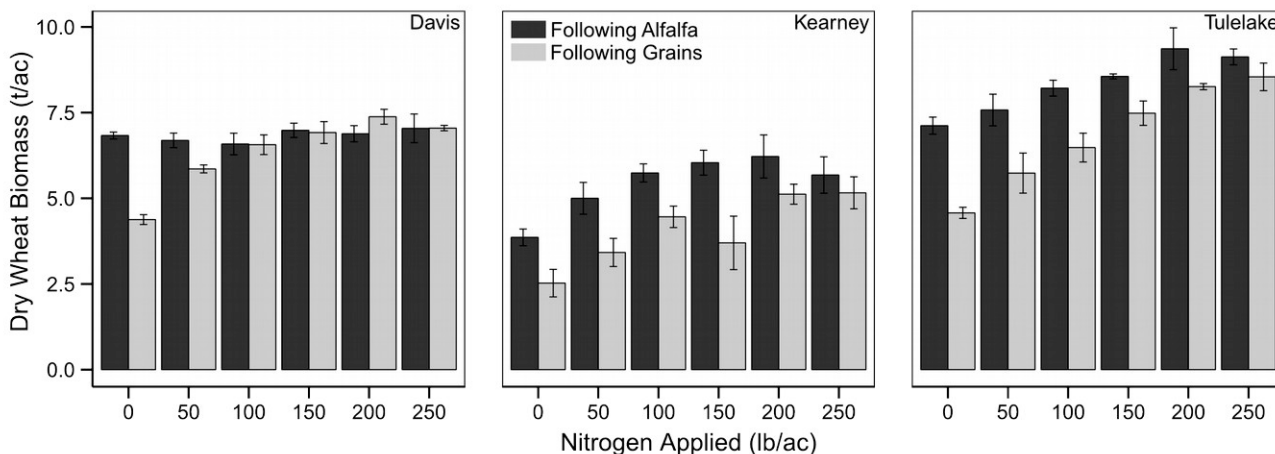


Figure 3: Data from first year (2013-2014). Wheat biomass at soft dough at N rates ranging from 0 to 250 lb N/ac, following alfalfa and following grains at Davis (left), Kearney (center), and Tulelake (right).

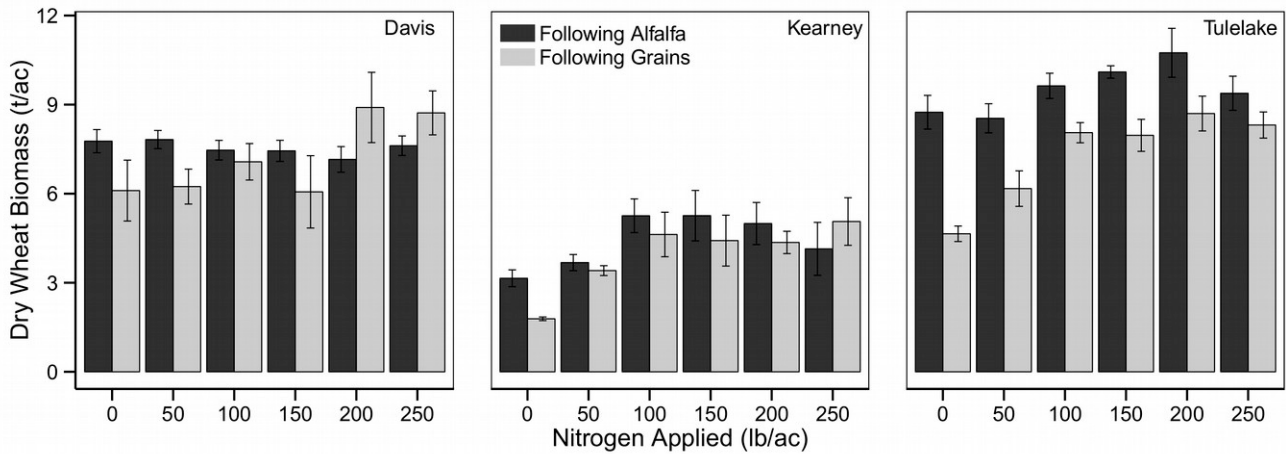


Figure 4: Data from second year (2014-2015). Wheat biomass at soft dough at N rates ranging from 0 to 250 lb N/ac, following alfalfa and following grains at: Davis (left), Kearney (center), Tulelake (middle).

HOW DO SOILS AND SOIL TEXTURES PLAY INTO ALL OF THIS?

Based on past research from other regions, soil texture has been found to affect alfalfa's N benefit. Alfalfa provides the least benefit when grown in coarse soils, provides more of a benefit in fine-textured soils, and provides the most benefit in medium-textured soils. Since the Tulelake and Davis sites had finer soils than the site in Parlier (Kearney), our results were as expected.

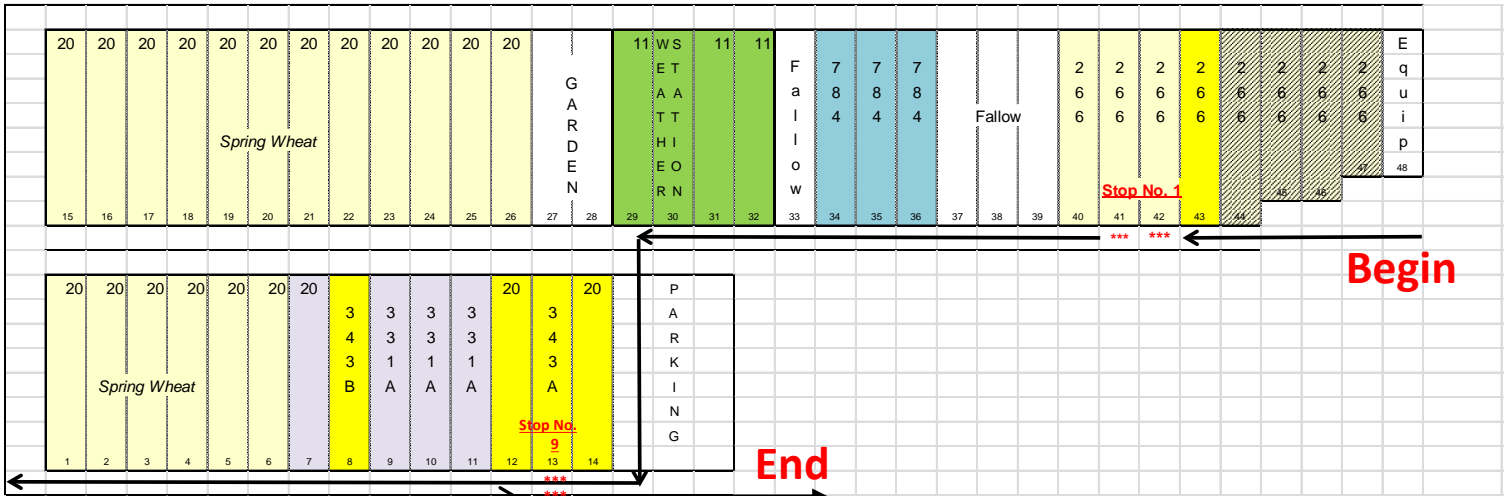
2015 IREC Field Day Sponsors

We would like to take this opportunity to sincerely thank the following sponsors. The support they provide allows us to offer the morning refreshments, the informational publication, and the excellent catered lunch and dessert.

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Tour Route

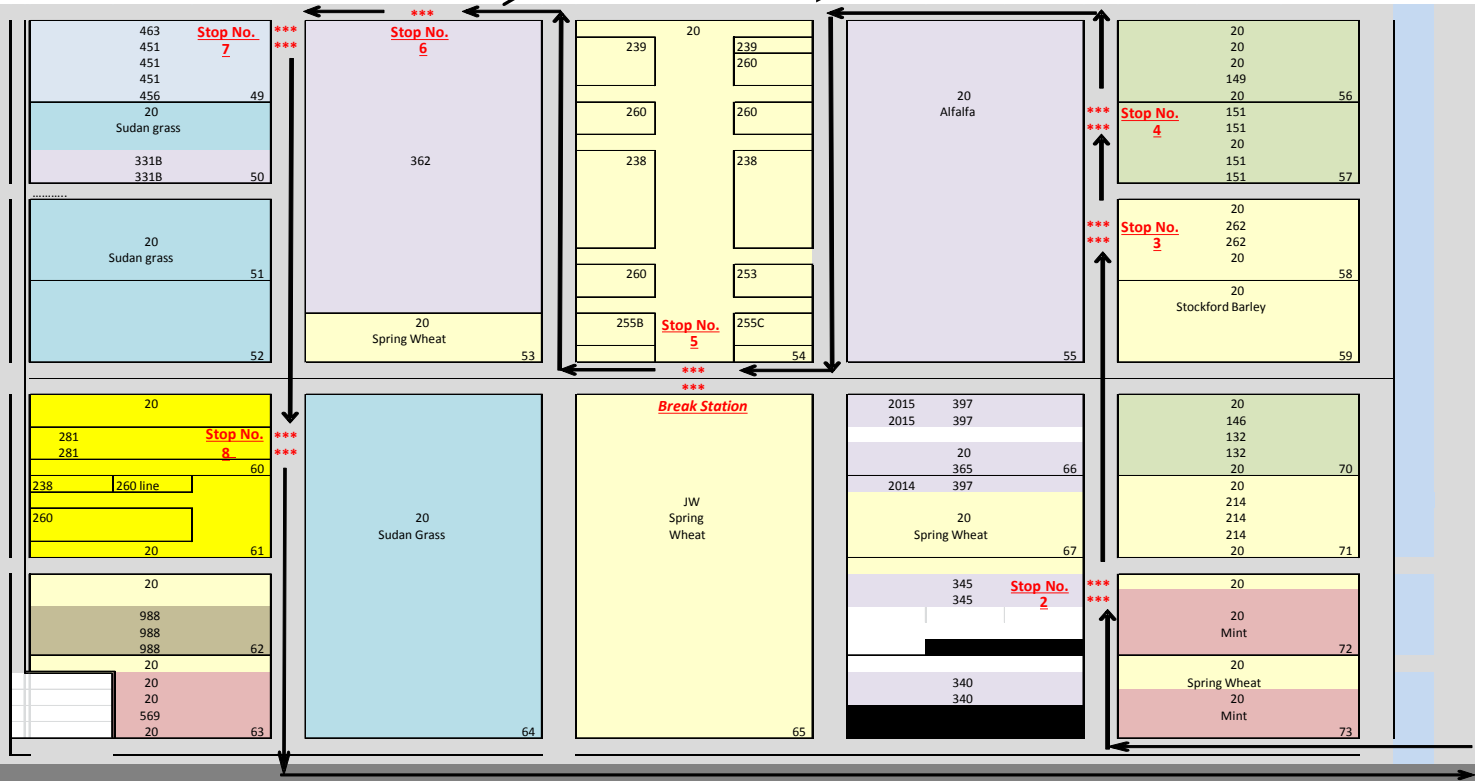
Station Map



To North Field

From North Field

North Field Map



2015 IREC Field Day
Wednesday, August 5, 2015
Tulelake, CA

- 8:00 am *Registration Opens*
- 8:20 am *Introduction and Opening Remarks*
Rob Wilson, IREC Center Director/Farm Advisor, Tulelake, CA
- 8:30 am *Tour Starts*
- 8:40 am **Stop 1** *Biocontrol of Cereal Leaf Beetle*
Charlie Pickett, Staff Environmental Research Scientist (Entomology),
California Department of Food and Agriculture, Sacramento, CA
- 9:00 am **Stop 2** *Cutting Schedule Effects on Reduced Lignin & Conventional Alfalfa*
Steve Orloff, UCCE-Siskiyou County Director and Farm Advisor, Yreka, CA
- 9:20 am **Stop 3** *Evaluation of Small Grain Species and Varieties Under Dryland Conditions*
Steve Orloff, UCCE-Siskiyou County Director and Farm Advisor, Yreka, CA
- 9:40 am **Stop 4** *Comparison of Nitrogen Fixing Cover Crops & Organic Amendments for
Nitrogen Fertilization in Organic Potatoes*
Rob Wilson, IREC Center Director/Farm Advisor, Tulelake, CA
Daniel Geisseler, UC ANR Nutrition Management Specialist, UC-Davis, CA
- 10:00 am *Break and Refreshments*
- 10:20 am **Stop 5** *Nitrogen Fertilization of Wheat*
Mark Lundy, UCCE-Colusa County Farm Advisor, Colusa, CA
- 10:40 am **Stop 6** *Assessment of Alfalfa Irrigation Needs in the Klamath Basin*
Steve Orloff, UCCE-Siskiyou County Director and Farm Advisor, Yreka, CA
- 11:00 am **Stop 7** *Evaluating Onion Irrigation Uniformity in Tulelake*
Rob Wilson, IREC Center Director/ Farm Advisor, Tulelake, CA
- 11:20 am **Stop 8** *Planting Date and Cultivar Effects on Winter Wheat Yield*
Steve Orloff, UCCE-Siskiyou County Director and Farm Advisor, Yreka, CA
- 11:40 am **Stop 9** *Alfalfa's Nitrogen Benefit to Wheat Following Alfalfa*
Dan Putnam, Specialist, Department of Plant Sciences, UC-Davis, CA
- 12:00 pm Lunch