

Nutrient management in California rice systems

Bruce Linquist

January 19 and 20, 2016

University of California Rice On-line

University of California
Agronomy Research & Information Center

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In The News

- California Calrose Wins 2015 World's Best Rice Award | See Sacramento Bee article
- Armyworms invade rice: Armyworm feeding can cause the panicle to turn white and fall.
- Debido a la sequía declina la producción de arroz (Long-term drought causing rice production decline)
- Rice disease-resistance discovery closes the loop for scientific integrity
- Why a 'super El Niño' could still be a bust for California drought relief
- Rice production and water efficiency: Bruce Linquist reports

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NEW!
Degree Day Model
Estimate rice growth stages for water control risk

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2016 Annual Rice Grower Meetings
Added January 6, 2016
WHERE & WHEN Richvale: Tuesday, Jan. 19, 8:30 am, Evangelical Church, 5219 Church St., Richvale
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Outline

- Rice Yield Contest and winners
- Website
- Salinity
- Topdress N

Yield Contest



- 2015 Pilot study – Butte County
- 5 field entries
- Yields ranged from 108 to 127 cwt/ac
 - Minimum of 3 ac from a 10 ac plot
 - 14% moisture plus dockage
- 2-3 hours (without recheck)



2015 Rice Yield Contest winners



- Joe Richter (Richter Ag, Inc)
 - 126.9 cwt/ac
 - M205



- Rodney Jenkins
 - 113.0 cwt/ac
 - M206



2015 Rice Yield Contest: what did we learn?



- The varieties available have very good yield potential
- Yield and quality
 - Head/total
 - 1st 66/73 (M205)
 - 2nd 65/69 (M206)
- High yields were achieved with solid management practices
 - Total N applied across fields ranged from 162-180
- Learned enough to try again

Rice Yield Contest

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UCCE Rice Yield Contest

Purpose



The purpose of the California Rice Yield Contest is to provide an opportunity for rice producers and UC scientists to share information about intensive rice production in California and to recognize individuals who have achieved the highest yields in the state. Please read the rules carefully.

Organization

The California Rice Yield Contest is run and operated by the University of California Cooperative Extension. If you have any questions please call Bruce Linquist (530 752-3125), Randal Muttters (530 538-7 201) or Luis Espino (530 458-0578). Entry form, Rules and Harvest forms can all be viewed and downloaded here.

Rice Yield Contest 2015

- [Rice Yield Contest Rules 2015](#)
- [Yield Contest Entry form 2015](#)
- [Yield Contest Harvest form 2015](#)



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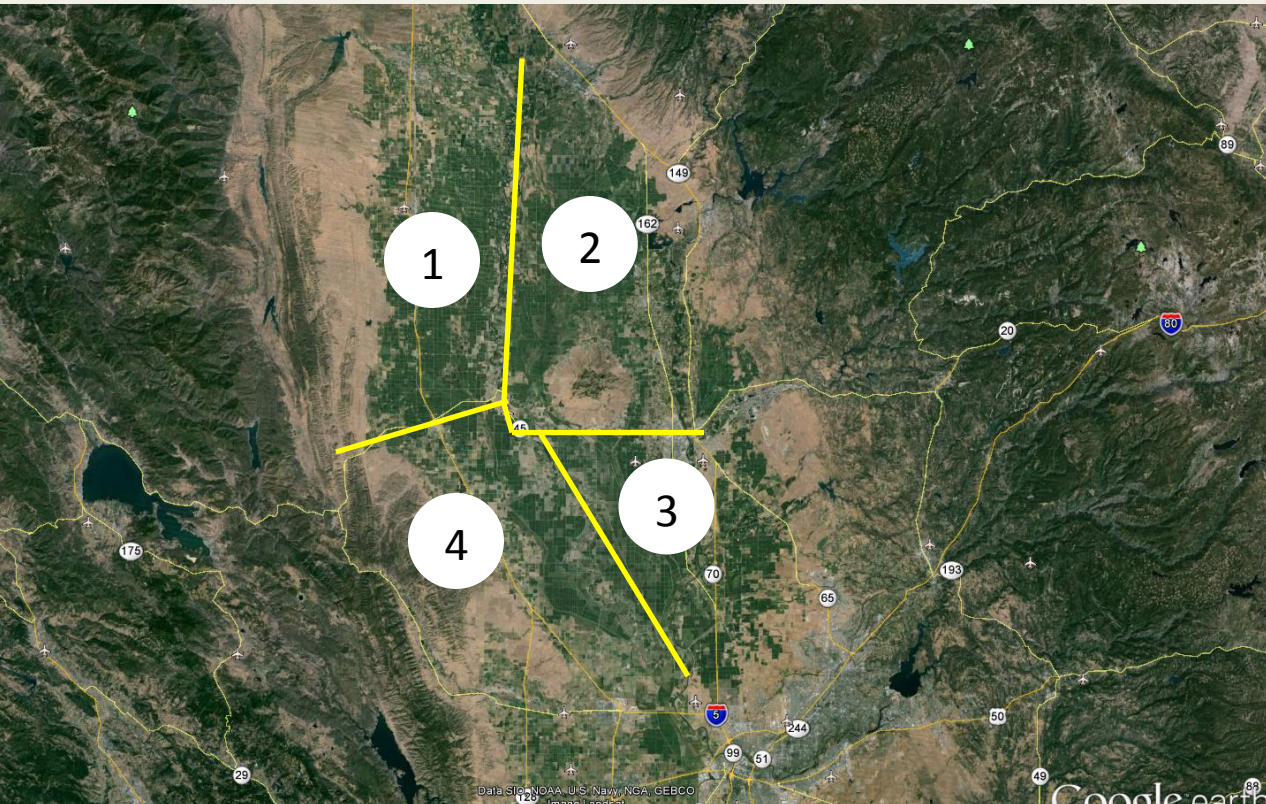
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2016 Rice Yield Contest

- Go to web site to find rules
 - Rules will be updated for 2016
- Entries will be due by Aug 1**
- Open to all participants this year
- Competition will be between growers in 4 regions
 - E/W of Sacramento River
 - N/S of Hwy 20



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Alfalfa Beans Bio-Fuels/Bio-Energy Corn Cotton Oil Seeds Rice Small Grains Sugar Beets Other Crop Resources

University of California Agronomy

Delivering scientific, research-based information, resources, education, and on-line tools in California agronomic crops to growers, researchers, industry professionals, governmental agencies, and the general public.

Agronomic Crops in California

Agronomic crops occupy over 5 million of the approximately 8 million irrigated acres in California, having large impacts on water use, nutrient management, farm profitability and human health. [more](#)



Agromony News & Updates

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New UC IPM photo repository shows plant damage from herbicides

Added December 23, 2015


Identifying nontarget crop and ornamental plant damage from herbicides has become much easier with the launch of a new...



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Irrigation, Water the Focus of 2015 Western Alfalfa & Forage Symposium in Reno

Added December 10, 2015


...est. Considering that the 2011-2015 "Exceptional Drought" has had HUGE (can you say HUGE like a certain presidential candidate?)... [more](#)



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History of Agronomy at the University of California

In 1904, a Division of Experimental Agronomy was established in the College of Agriculture of the University of California, Berkeley. By 1906, it was clear that a Berkeley location for experimental work could not meet requirements and the Division was shifted to the University Farm at Davis. [more](#)



What is Agronomy?


Agronomy is the application of science and technology from the fields of biology, chemistry, economics, ecology, soil science, water science, pest management and genetics to the improvement and management of the major food crops of the world. [more](#)



About the Agronomy Research & Information Center


Alfalfa

Alfalfa production occurs over about 1,000,000 acres throughout California, with the highest-producing regions in Imperial County and the San Joaquin Valley.




Beans

California farmers grow mainly four classes of dry beans — lima (70% of U.S. supply), common beans, garbanzo, and cowpeas — on about 50,000 total acres.




Bio-Fuels/Bio-Energy

Imported corn and sorghum are currently used to produce bio-fuel in California. However, canola, camelina, sugar beets, and sorghum offer promise as a base for in-state production.




Corn

Corn is grown on nearly 600,000 acres in California, primarily in the Central Valley. It is mainly used for silage and grain, with a small specialty crop market comprised of sweet corn, corn nuts and popcorn.




Cotton

Uses for cotton fibers range from heavy industrial to fine fabrics. California cotton grows mainly in the San Joaquin Valley on 200,000 to 300,000 acres.




Oil Seeds

Safflower is the primary oil seed grown for oil in California. Sunflower hybrid seeds are grown and exported for oil production. Canola and camelina are showing promise as new oil seed crops.




Rice

California rice is grown primarily in the Sacramento Valley on approximately 550,000 total acres. Mostly high quality medium grain rice is produced as well as some other specialty rice varieties.




Small Grains

Small grains are an important rotation crop in California and include wheat, barley, oats and triticale planted on over 800,000 acres. Wheat is the predominant California small grain crop.




Sorghum

Sorghum is being rediscovered as a valuable rotational crop and forage that can help California meet future water needs, specialty food markets, and potentially as a renewable fuel crop.



Sugar Beets

California sugar beet production began in 1870 and beets have been produced in nearly all agricultural areas. Beets are now grown only on about 25,000 acres in the Imperial Valley.



General question for the Agronomy RIC?
Email us at agronomy@ucdavis.edu

Page Last Updated: January 12, 2016

http://rice.ucanr.edu/

- Website overview
 - Meetings, news, newsletters, blogs, presentations, reports, contacts, yield contest
 - Place for comments
 - Guidelines,

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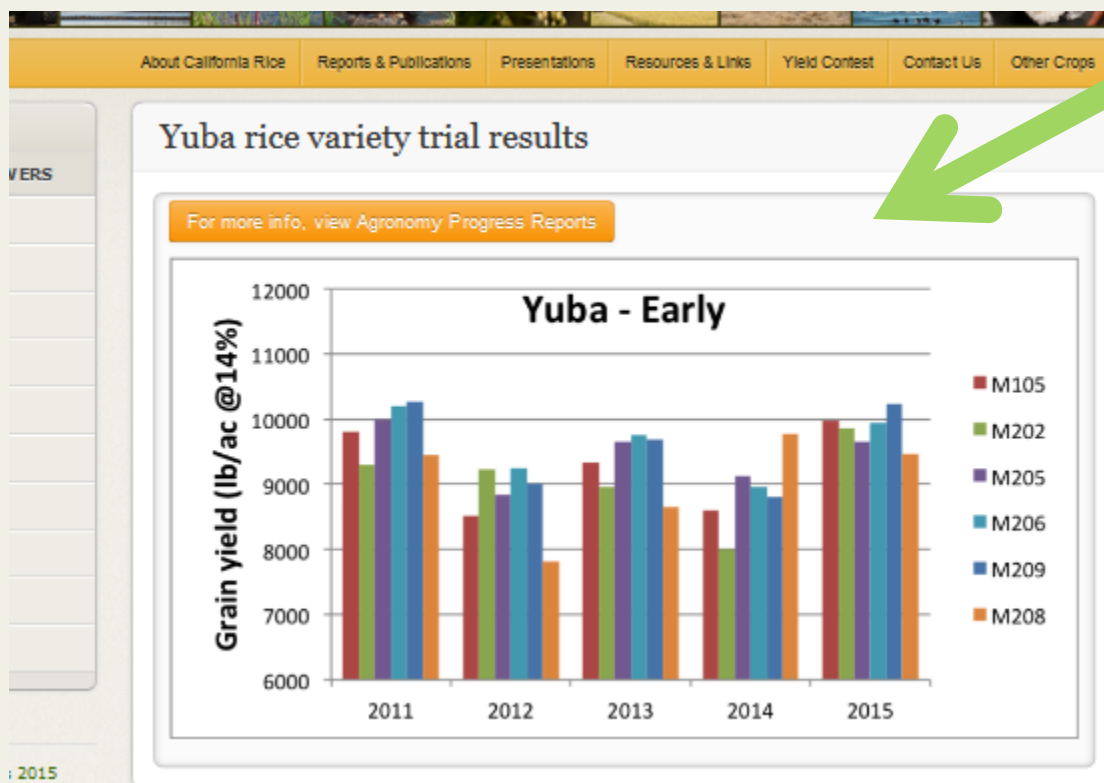
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Variety yield comparison

- Click on a dot to get yields of main varieties over past 5 years
 - Data from UCCE variety trials funded by RRB



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Degree day calculator

- Estimates date of
 - PI
 - Heading
 - R7 (roughly 3 weeks after heading and when draining the field should be considered).
- Estimates these times using a DD model
 - Planting to current date based on current year data
 - Forward projection based on average weather data from current date onwards
- Info required
 - A weather station
 - Variety
 - Planting date

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Degree Day model to predict key growth stages

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Degree Day Model (Available for Testing)

Estimating rice growth stages for water-seeded rice

To find your growth stages, select the CIMIS weather station closest to your field or with the most similar climatic conditions by either clicking on the interactive map or using the pull-down menu below. Then select your variety/cultivar and planting date, enter optional field and acres, and press 'update.' Growth stages for your field will be displayed on a new page.

Important Notice: UC Rice On-line has made every effort to ensure the accuracy and reliability of rice growth stages estimation information presented and produced by this online tool. However, we cannot guarantee 100% accuracy for every and all situations. Thus, the information and results presented here should be viewed and used only as a guideline.

Active station: 12 - Durham

Variety/Cultivar: M206

Planting date: May Not set

Field: (optional)

Acres: (optional)

Update

CIMIS Weather Stations



Questions about using this web tool or interpreting the prediction results? Contact us at: ucrice@ucdavis.edu

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Degree Day Model (Available for Testing)

Print

Estimated Growth Stages

CIMIS Station: Durham (12)

Planting date: 05-04-2015

Variety/Cultivar: M206

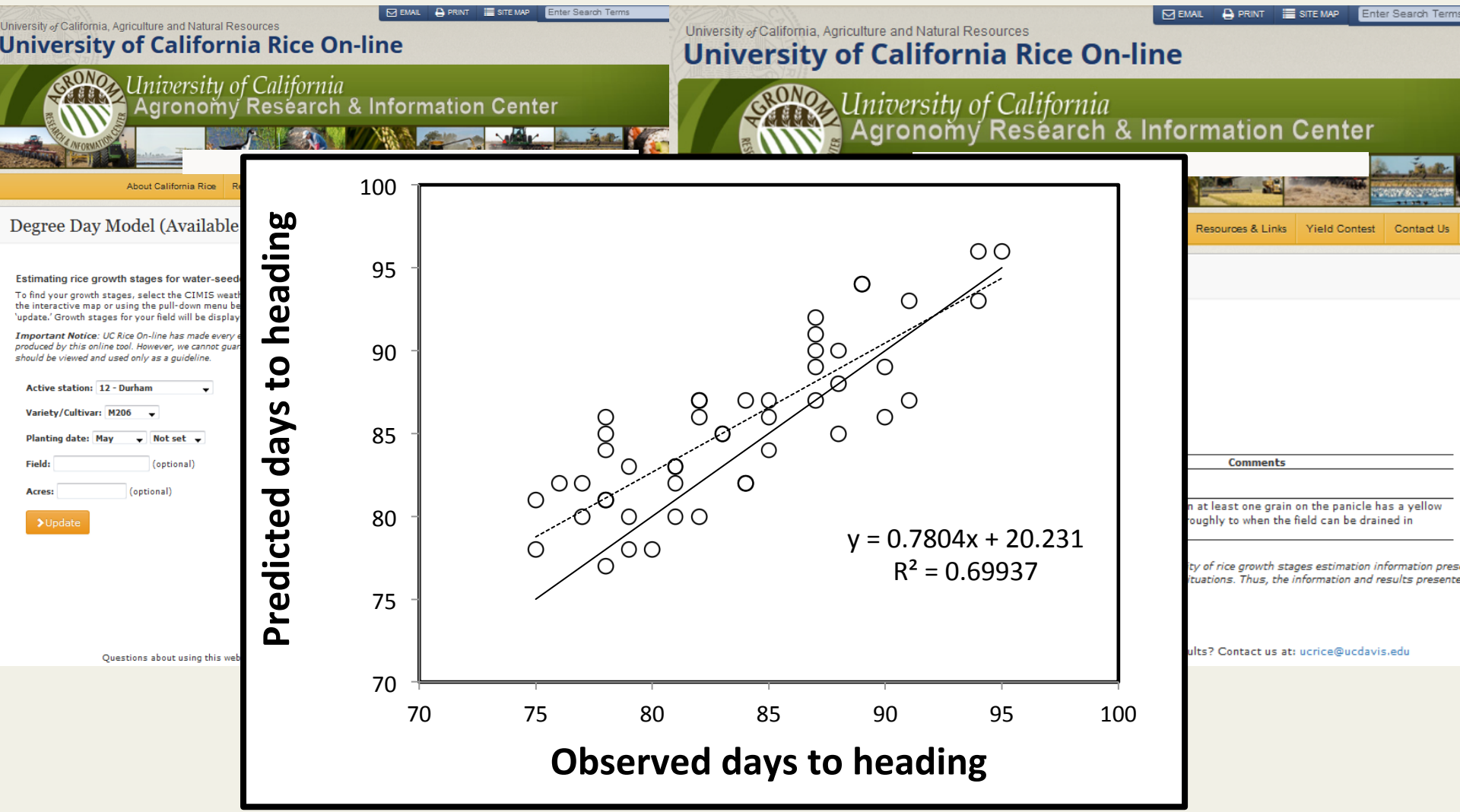
Growth Stage	Predicted Date	Average Date	Comments
panicle initiation	06-27-2015	06-26-2015	
50% heading	07-30-2015	07-27-2015	
maturity	08-18-2015	08-14-2015	This is R7 which is when at least one grain on the panicle has a yellow hull. This corresponds roughly to when the field can be drained in preparation for harvest.

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Refresh

Questions about using this web tool or interpreting the prediction results? Contact us at: ucrice@ucdavis.edu

Degree Day model to predict key growth stages



Phosphorus management

- Deciding the correct rate
- How to apply

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Fertilizer

Rice Production Manual
(Fertility & Crop Nutrition section)

Fertilizer Research & Education Program
General Water-Seeded Rice Fertilizer Guidelines

Phosphorus Fertilizer Budget & Application calculator
New!

Phosphorus management: rate

- Should you apply?
- Frequency of P deficiencies
 - Less than 10% of CA rice soils respond significantly to added P fertilizer.
- Determining the P status of your soil.
 - Soil test
 - Plant tissue test
 - Input-output P budget
- How much do should you apply?

Determining the P status of your soil

- Soil test
 - Olsen P test (sodium-bicarbonate)
 - above 6-9 ppm
 - Bray test not good for CA rice soils
- Plant tissue test
 - Y-leaf tissue test.
 - 35 DAS
 - 0.2% P
- Input-output P budget

Input-output P budget:

Think of soil as a phosphorus bank

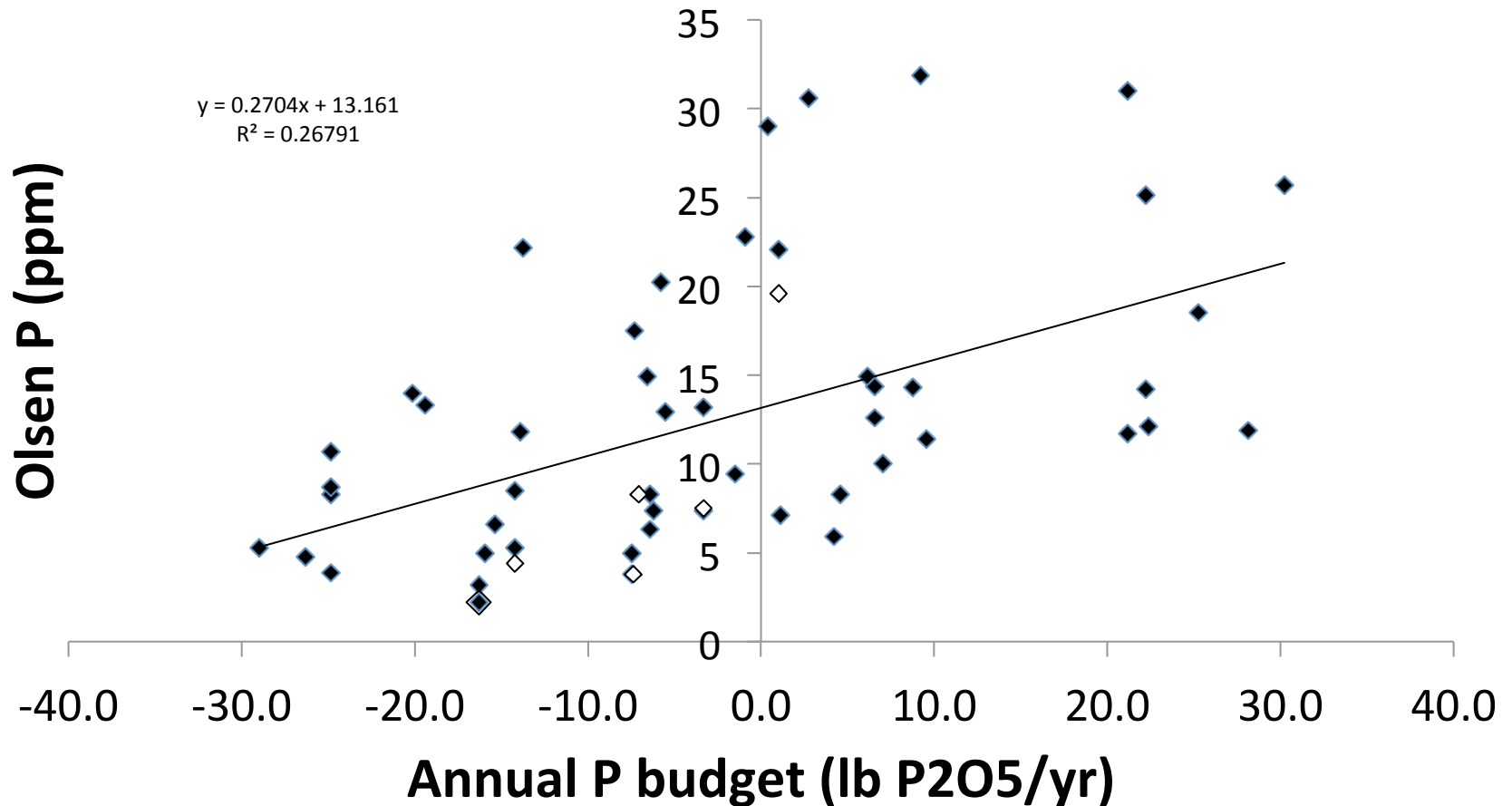
- When managed correctly, P is relatively immobile in soils.
 - No gas losses
 - Little is lost through water
 - Little lost by leaching
- Inputs
 - Fertilizer
- Outputs
 - Grain removal (0.23% P / 0.52% P_2O_5)
 - Straw removal (0.08% P / 0.18% P_2O_5)



Input-output P budget

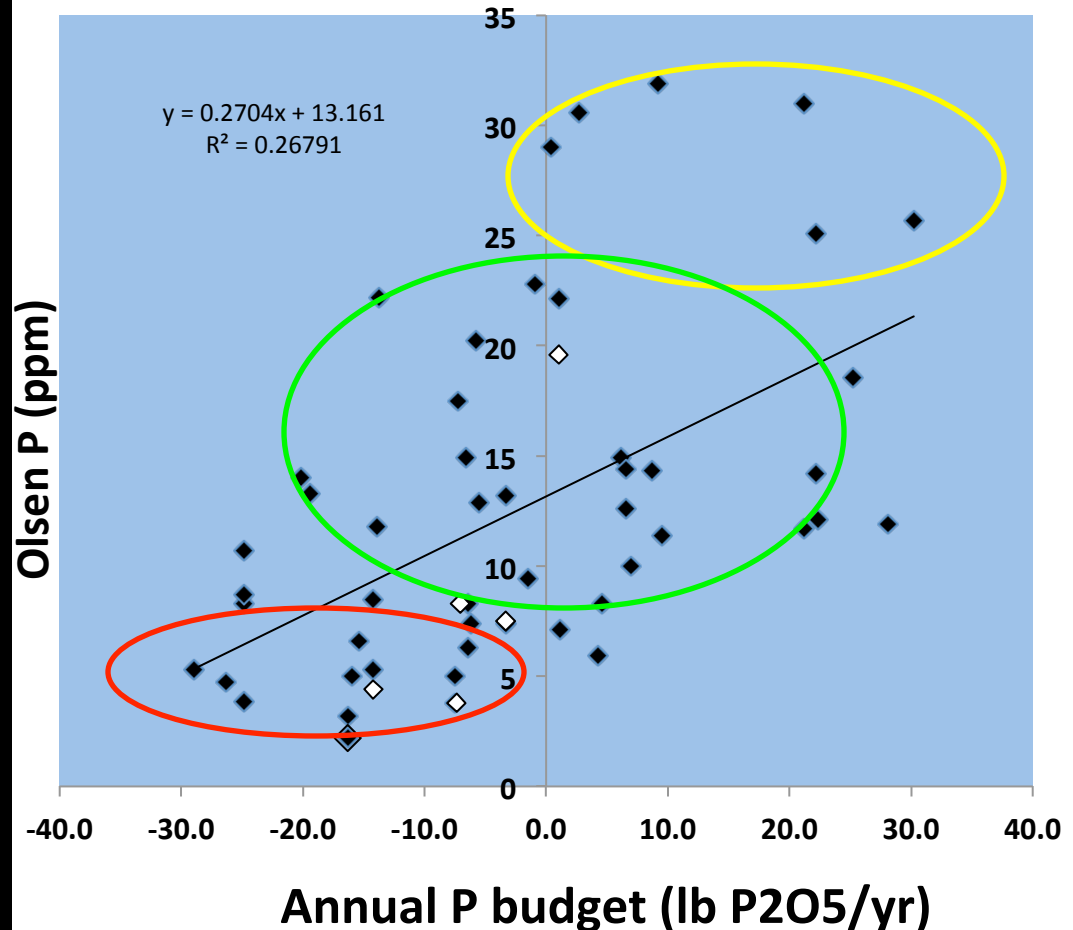
- Develop a budget
 - **Inputs** (lb/ac of P₂O₅ as fertilizer) – **Outputs** (lb/ac removed in grain and straw)
 - Develop such a budget over at least a 5 yr period
 - take average

P budget effects on soil P and yield response



Should you apply?

- Soils have very high P levels based on soil test (i.e. above 20 ppm) and positive P budget
 - Apply no P
- Soils have very low P (less than 6) and a negative P budget
 - Build up soil P
- In most cases where P is not limiting use a maintenance strategy
 - Apply what is removed by the crop
 - How much is removed?



Amount of P removed: Only grain removed

Grain yield (cwt@14%)	P fertilizer added (lb P ₂ O ₅ /ac)															
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	
	P balance (lb P ₂ O ₅ /ac)															
50	-26	-21	-16	-11	-6	-1	4	9	14	19	24	29	34	39	44	
55	-29	-24	-19	-14	-9	-4	1	6	11	Maintenance line						
60	-31	-26	-21	-16	-11	-6	-1	4	9	14	19	24	29	34	39	
65	-34	-29	-24	-19	-14	-9	-4	1	6	11	16	21	26	31	36	
70	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	18	23	28	33	
75	-39	-34	-29	-24	-19	-14	-9	-4	1	6	11	16	21	26	31	
80	-42	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	18	23	28	
85	-44	-39	-34	-29	-24	-19	-14	-9	-4	1	6	11	16	21	26	
90	-47	-42	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	18	23	
95	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	
100	-52	-47	-42	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	18	
105	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	
110	-57	-52	-47	-42	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	

Maintenance line

How much to apply:

Remove grain and ½ of straw

Grain yield (cwt@14%)	P fertilizer added (lb P ₂ O ₅ /ac)															
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	
	P balance (lb P ₂ O ₅ /ac)															
50	-31	-26	-21	-16	-11	-6	-1	4	9	14	19	24	29	34	39	
55	-34	-29	-24	-19	-14	-9	-4	1	6	11	16	21	26	31	36	
60	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	18	23	28	33	
65	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	
70	-43	-38	-33	-28	-23	-18	-13	-8	-3	2	7	12	17	22	27	
75	-46	-41	-36	-31	-26	-21	-16	-11	-6	-1	4	9	14	19	24	
80	-49	-44	-39	-34	-29	-24	-19	-14	-9	-4	1	6	11	16	21	
85	-52	-47	-42	-37	-32	-27	-22	-17	-12	-7	-2	3	8	13	18	
90	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	
95	-58	-53	-48	-43	-38	-33	-28	-23	-18	-13	-8	-3	2	7	12	
100	-61	-56	-51	-46	-41	-36	-31	-26	-21	-16	-11	-6	-1	4	9	
105	-64	-59	-54	-49	-44	-39	-34	-29	-24	-19	-14	-9	-4	1	6	
110	-67	-62	-57	-52	-47	-42	-37	-32	-27	-22	-17	-12	-7	-2	3	

Maintenance line





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Harvest & Grain Quality

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Insects & Other Pests

Diseases

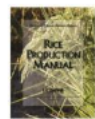
Weeds

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Rice Production Manual
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Phosphorus Fertilizer Budget & Application calculator

Application calculator
New!



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In The News

- California Calrose Wins 2015 World's Best Rice Award | See Sacramento Bee article
- Armyworms invade rice: Armyworm feeding can cause the panicle to turn white and fall...
- Debido a la sequía decline la producción de arroz (Long-term drought causing rice production decline)
- Rice disease-resistance discovery closes the loop for scientific integrity
- Why a 'super El Niño' could still be a bust for California drought relief
- Rice production and water efficiency: Bruce Linquist reports

Phosphorus Fertilizer Budget and Application online calculator

Introduction

Should I apply P?

The P balance is calculated as the difference between what you apply and what is removed by the crop. Most P is removed in the grain, but if you remove straw then you are also removing some P. Below we ask you to estimate straw removal, grain yields and fertilizer P additions. We suggest taking the average of the past 5 years for all of these estimated values.

*entry required

Over the past five years, how many years did you bail straw?*

Grain yield (cwt/acre; 5 year average)*

Fertilizer added per year (lb P₂O₅/acre/year; 5 year average) *

Calc P Balance

Continue

How much P should I apply?



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Phosphorus Fertilizer Budget and Application online calculator

Introduction

To determine if a P application is necessary we estimate a field P balance and use a soil P test (Olsen P) if available.

P balance: The P balance is calculated as the difference between what you apply and what is removed by the crop. Most P is removed in the grain but if you remove straw then you are also removing some P. Below we ask you to estimate straw removal, grain yields and fertilizer P additions. We suggest taking the average of the past 5 years.

Using this P balance we assume that the only P added to the field comes from fertilizer and that the only P removed is that which is removed when harvesting the crop (i.e. the P in the grain and the straw-if straw is removed). Burning straw does not remove significant amounts of P from the field. Also little P is added or removed in irrigation water. Finally P is not readily leached in these high clay soils.

Soil test: For the soil P test it is important that you have the Olsen P test. Sometimes this is called the bicarbonate P test.

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Continue

Should I apply P?

How much P should I apply?

When should I apply P?

View/Print Results

Calculations and Further Reading

Phosphorus Fertilizer Budget and Application online calculator

Introduction

Should I apply P?

The P balance is calculated as the difference between what you apply and what is removed by the crop. Most P is removed in the grain, but if you remove straw then you are also removing some P. Below we ask you to estimate straw removal, grain yields and fertilizer P additions. We suggest taking the average of the past 5 years for all of these estimated values.

*entry required

Over the past five years, how many years did you bail straw?*

0

Grain yield (cwt/acre; 5 year average)*

93

Fertilizer added per year (lb P₂O₅/acre/year; 5 year average) *

40

Calc P Balance

Yield: 93 (cwt@14%)

Years straw was bailed: 0

P Fertilizer added: 40 (lb P₂O₅/ac/year)

P balance: -8 (lb P₂O₅/ac/year)

Because P balance is negative, P should be applied.

- If your P balance is positive and your Olsen P soil test is above 15 you probably do not need to apply P.
- You should consider adding P if your P balance is negative and/or your Olsen P is below 15 ppm.
- We recommend getting a soil test done. If you do not have a soil P test result, we recommend applying P at least at maintenance levels (see next section)

Continue

Phosphorus Fertilizer Budget and Application online calculator

Introduction

Should I apply P?

How much P should I apply?

Please complete the fields below to estimate a maintenance phosphorus fertilizer application.

*entry required

Over a five year period, how many years did you bail straw?*

0

Grain yield (cwt/acre/year; 5 year average)*

93

How Much P fertilizer for maintenance application?

Yield: 93 (cwt@14%)

Years straw was bailed: 0

P Fertilizer to add: 48 (lb P₂O₅/ac/year)

This is the amount of P to add to maintain soil P levels at their current levels. If Olsen soil P levels are below 6 ppm, then consider adding more to build up soil P.

If you do not have a soil P test result and your soil P balance is positive or slightly negative (i.e. -5 lb P₂O₅/yr), then we recommend applying the maintenance P level. If the soil P balance was less than that (ie. A more negative value), then we suggest a buildup P application.

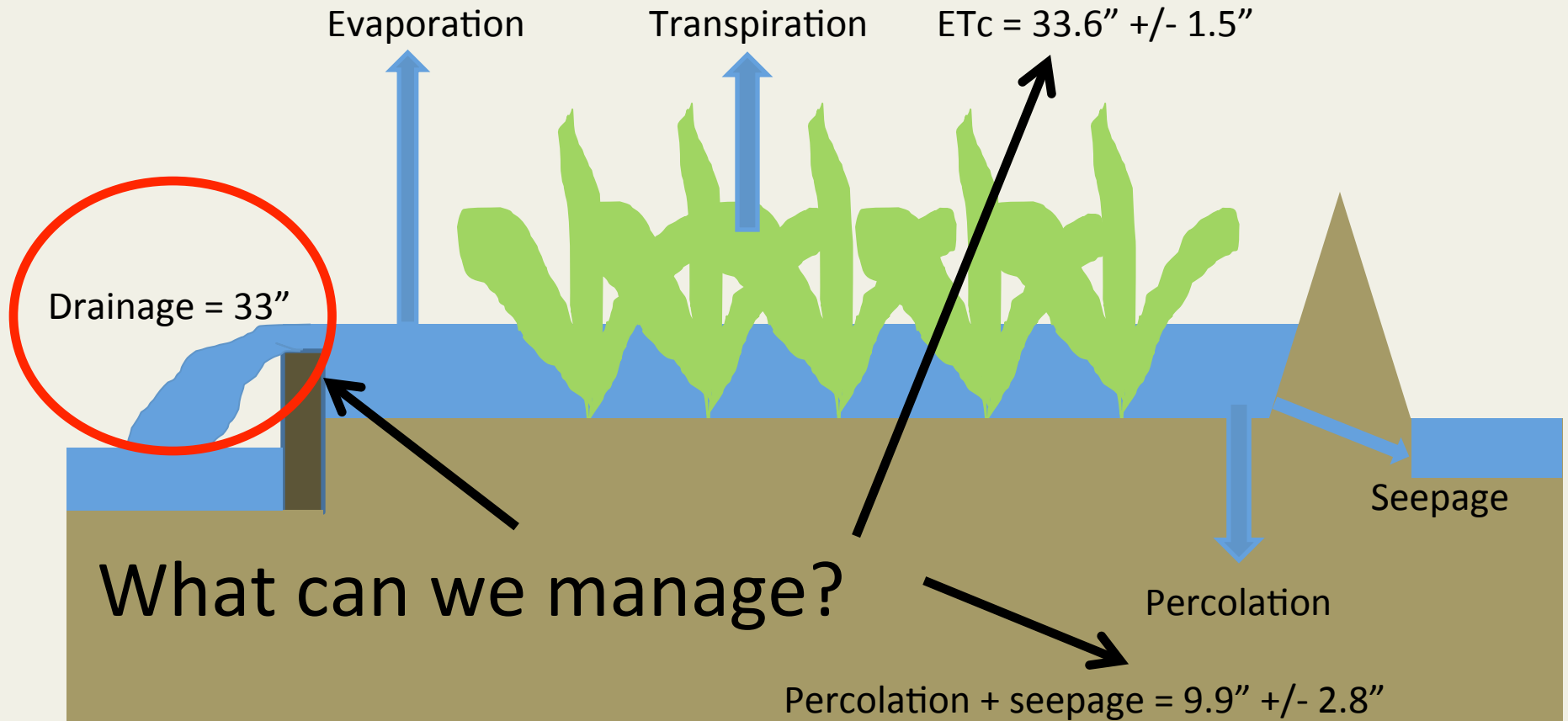
Continue

When should I apply P?

Salinity and water management



Seasonal rice field water losses



Total water input = 77"

No-spill water management

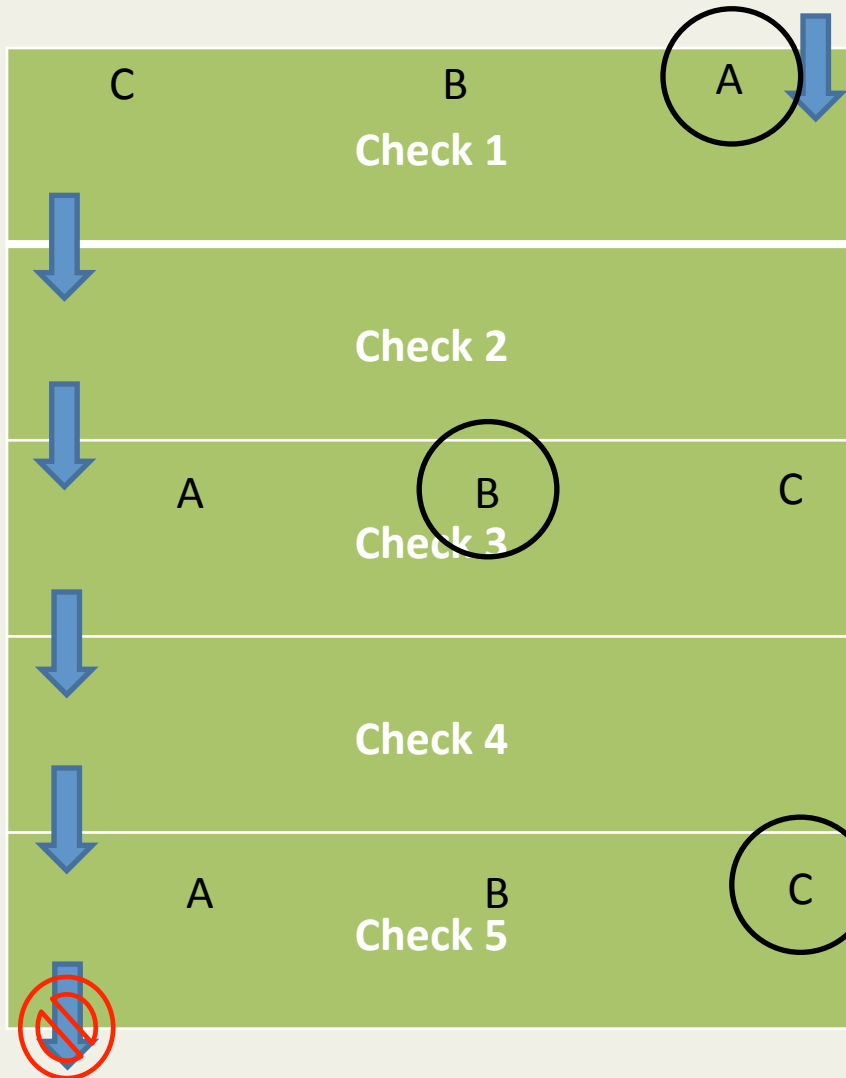
- Maintenance flow management
 - **Minimize salinity**
 - Maintain water levels
- No-spill
 - Does salinity increase due to evapo-concentration?
 - If so, enough to reduce crop yield?



2014/15 salinity studies

- Evaluate flood water and soil salinity across fields and season.
 - Quantify changes in time and location in field
- Quantify the effect of soil salinity on rice yields

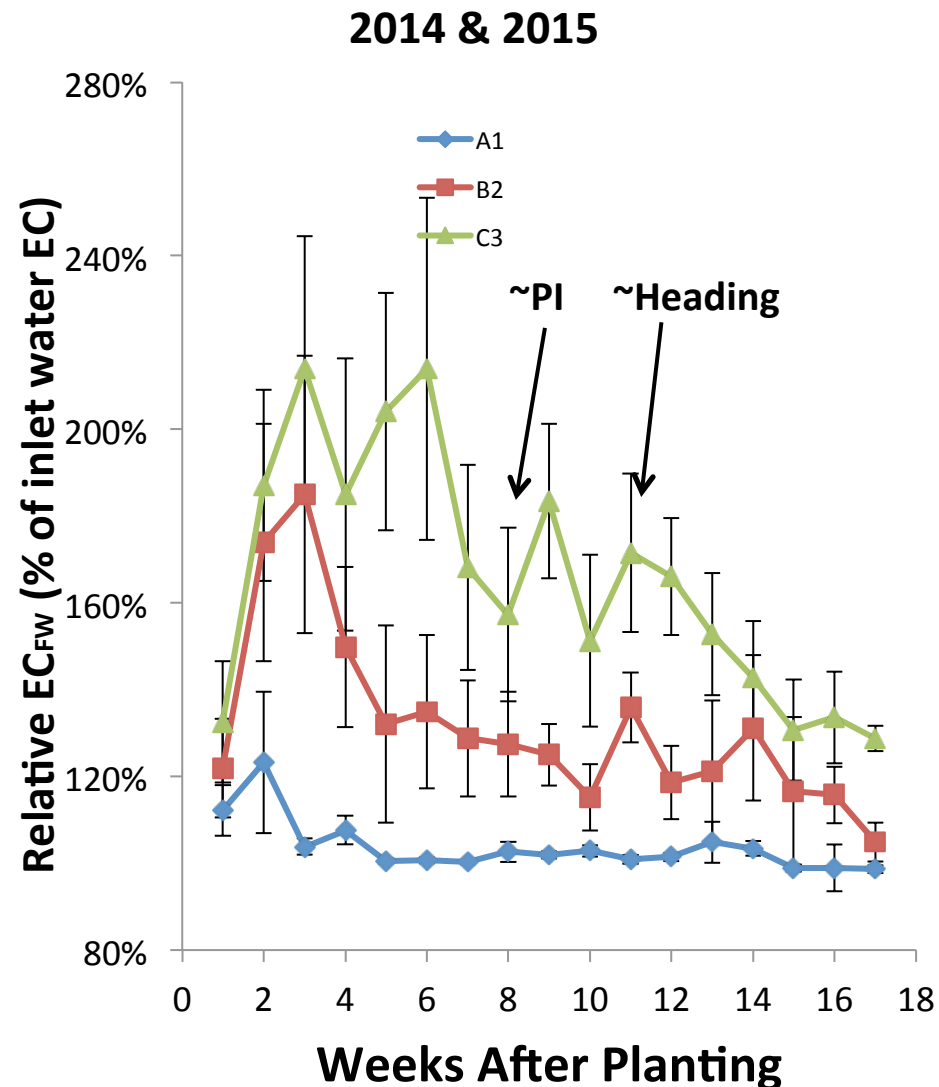
Methods: quantifying in-field salinity dynamics



- Fields
 - 6 fields in 2014
 - 5 fields in 2015
- 9 plots in each field. 3 in top, middle and bottom checks.
- 9 Fields were no-spill, 2 fields had flow.
- Weekly water salinity measurements were made in all plots in all fields.
- Soil solution was extracted from 3 points in each field: A1, B2, C3.

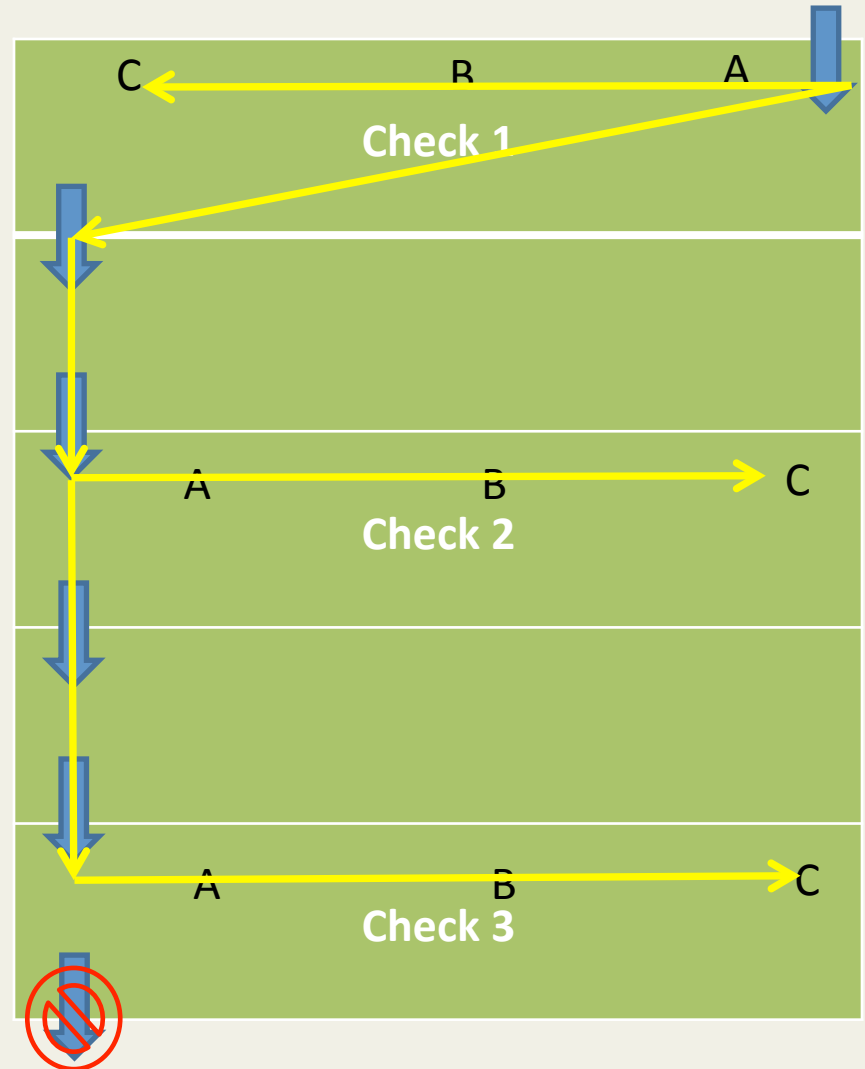
Flood water salinity through the growing season: averaged across fields and years

- Flood water salinity highest in bottom check
- Flood water salinity peaks between 2 and 6 weeks after planting
 - Water holds
 - High evaporation
- Flood water salinity declines after 6 weeks
 - Cool water/low evaporation



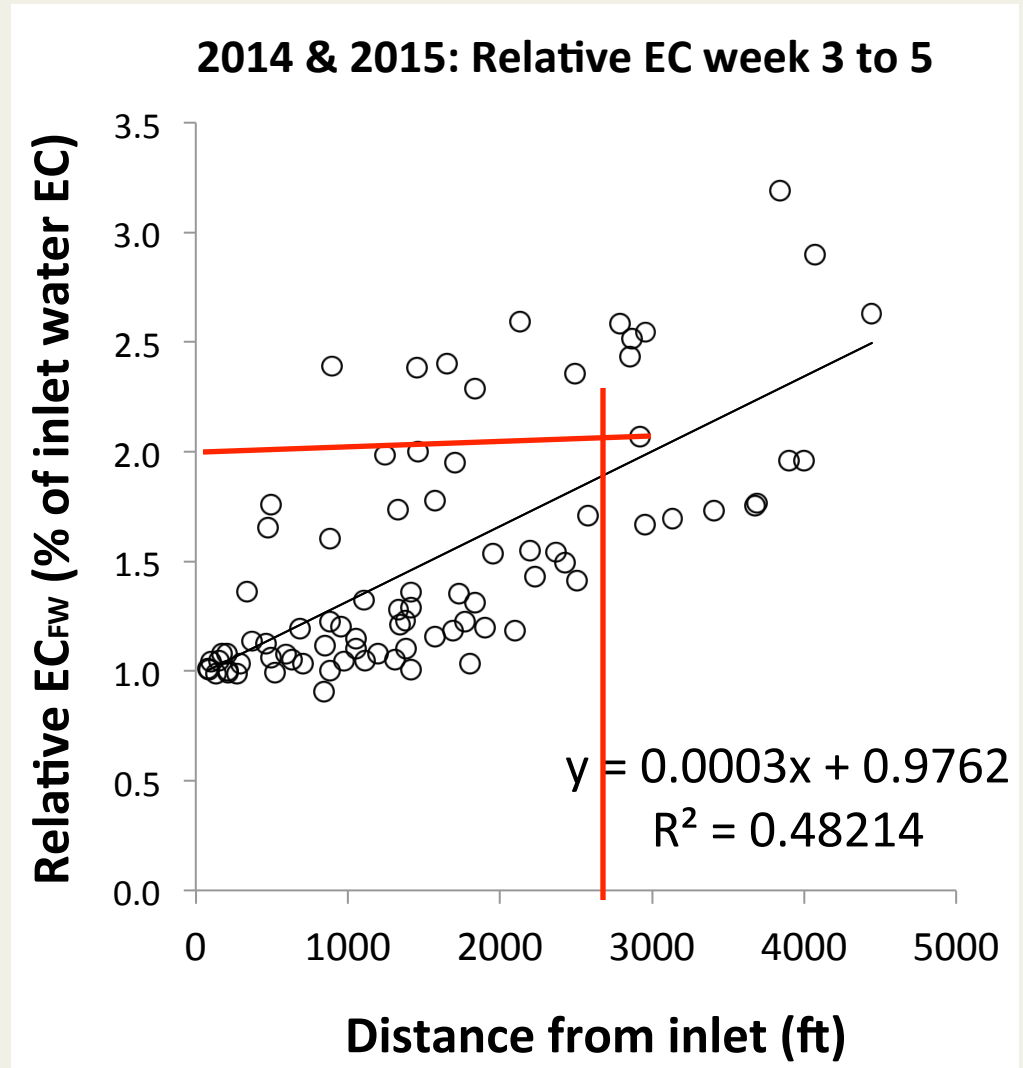
Quantifying salinity

Flood water salinity
versus the distance
from the inlet

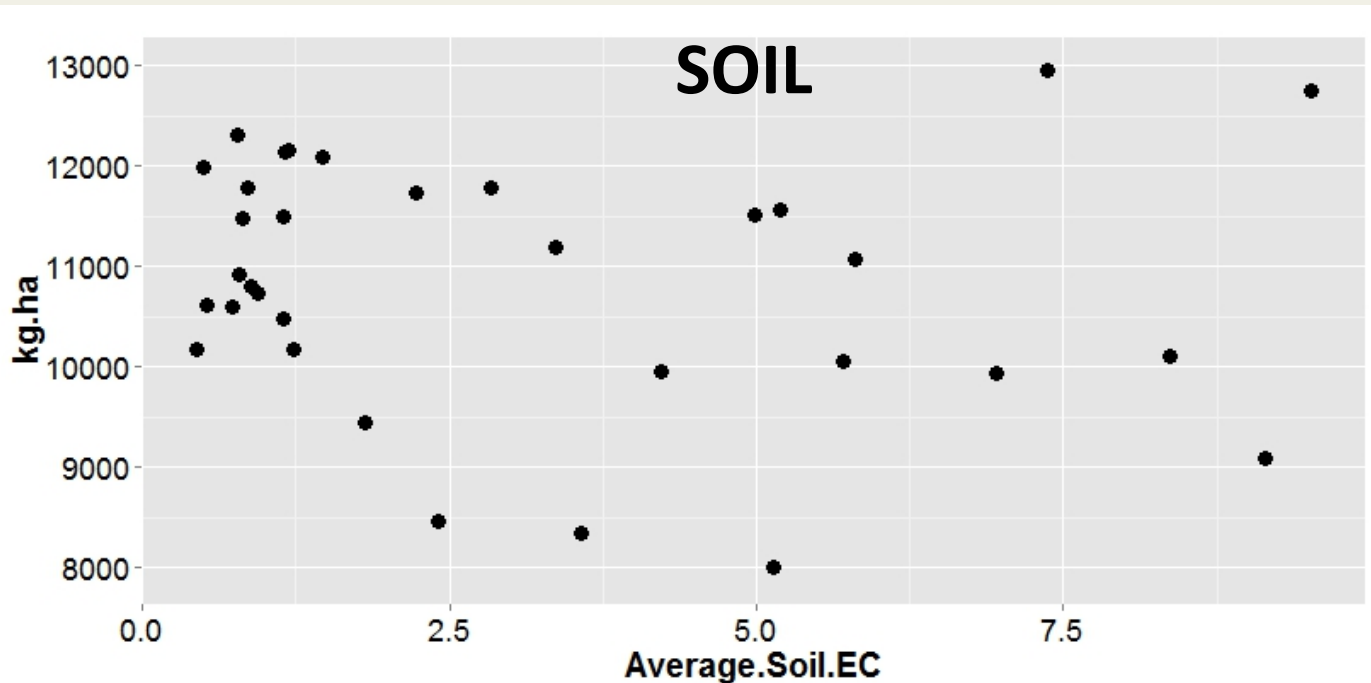
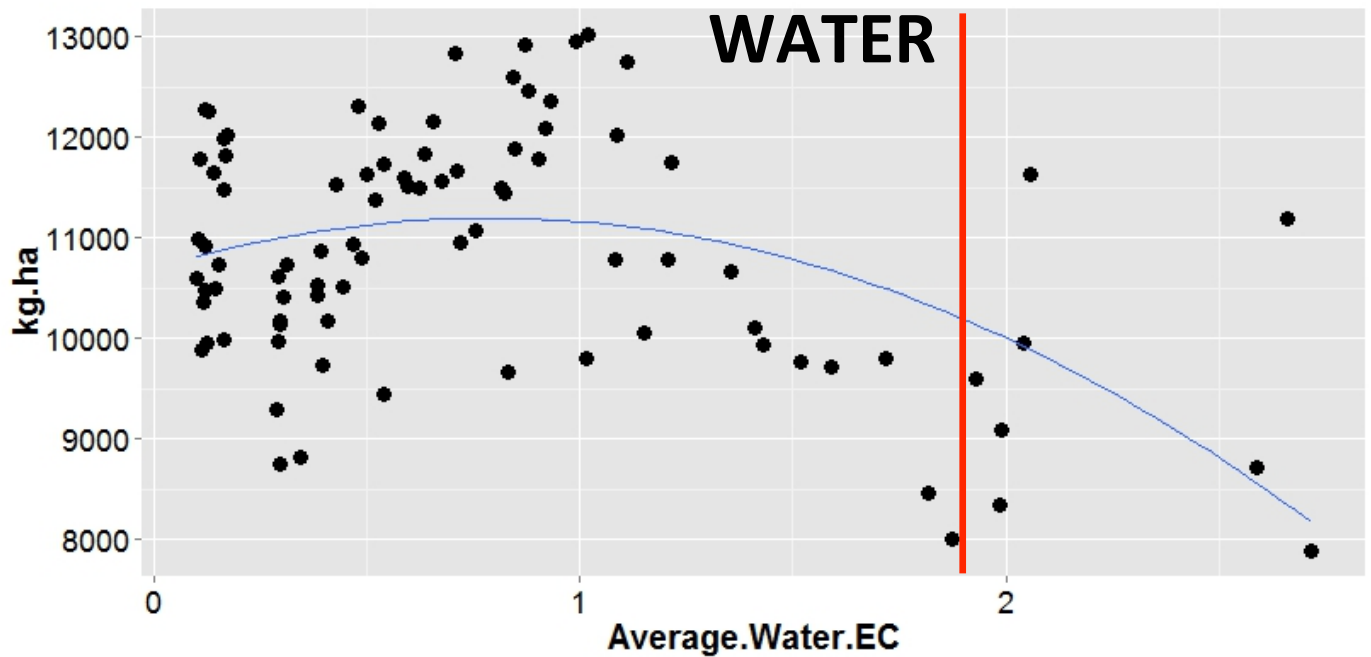


Water EC is related to distance from the inlet

- Salinity increases with distance from inlet
- Water salinity doubles with a 3000 ft run



Yield vs.
water or
soil salinity
(dS/m²)



Sterility symptoms seen in high salinity treatments



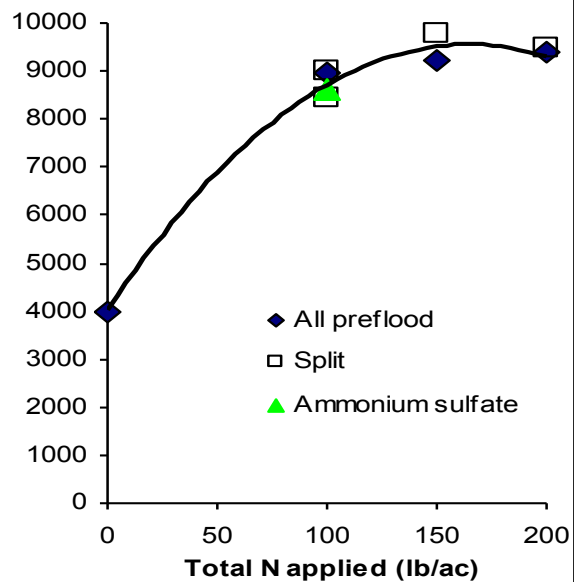
Summary

- In most fields, salinity is not a problem
 - Salinity builds up during the first month and then declines
 - Need to be mindful of the amount of salinity but also the duration of high salinity
 - Season long salinity is not a problem in most fields
 - Flood water salinity seems more important than soil salinity
 - At least once crop has established
 - Observation: If salinity is a problem, may not want to drain too early for harvest

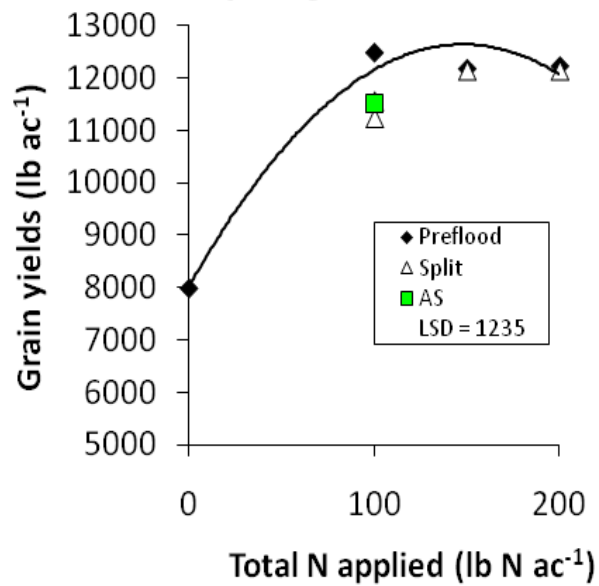
Top-dress N applications: guidelines

- Do not plan for a top-dress N application
- At equal amounts of N, there is no benefit of splitting the N between a preplant and top-dress.
- Apply enough preplant N (aqua and starter) for an average year
- A top-dress may be necessary
 - N losses (i.e. due to early season drain)
 - High yield potential year

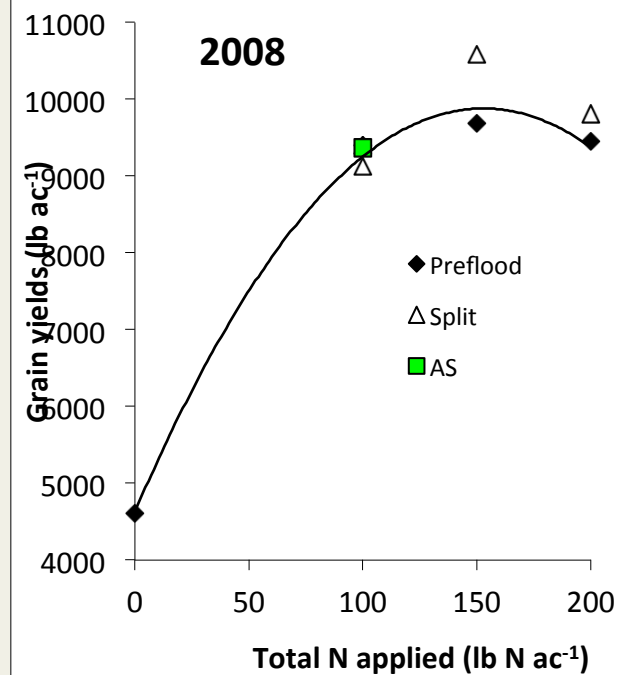
Wet seeded conventional grain yield (14% moisture)



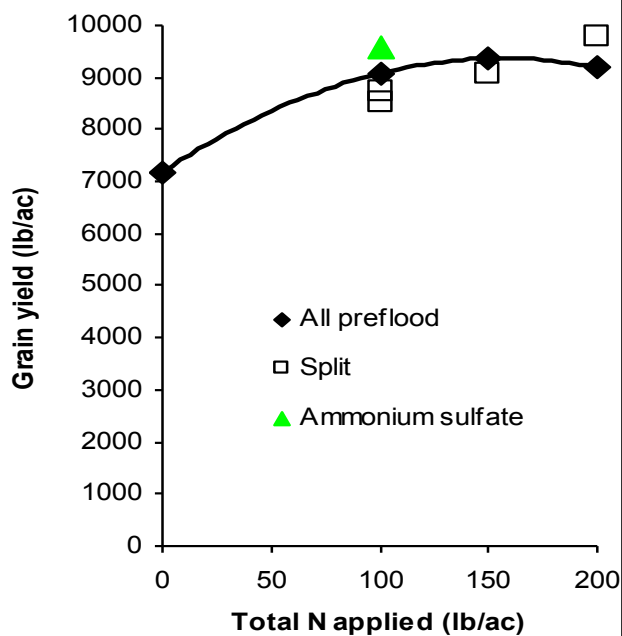
Maxwell



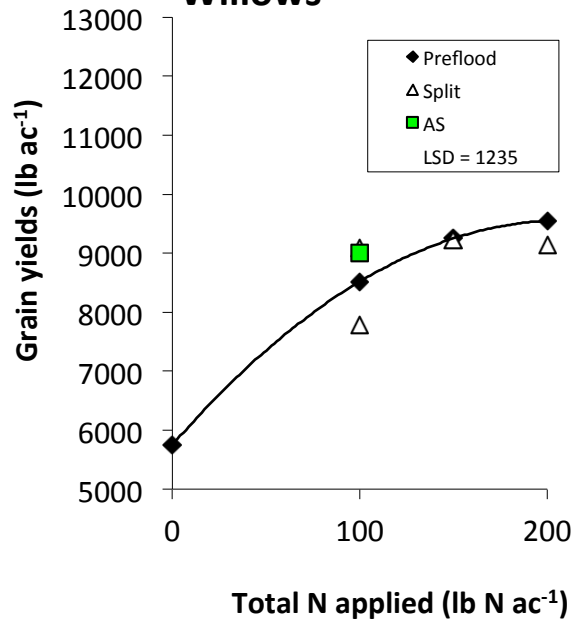
2008



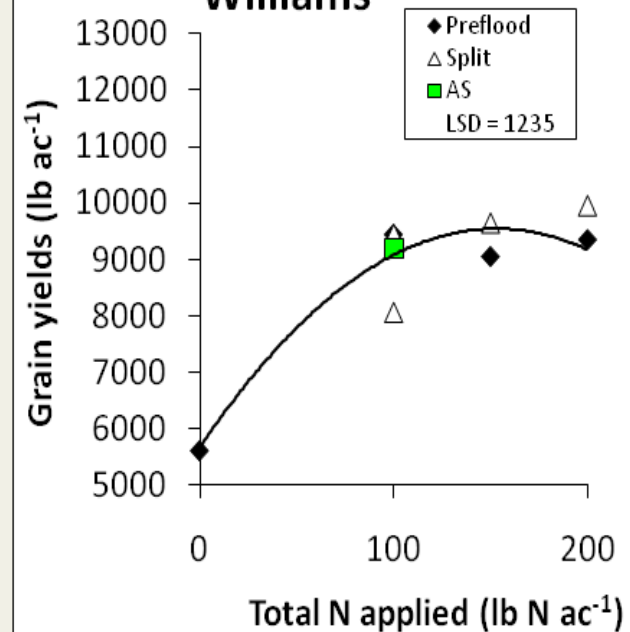
Grower wet seeded no-till



Willows

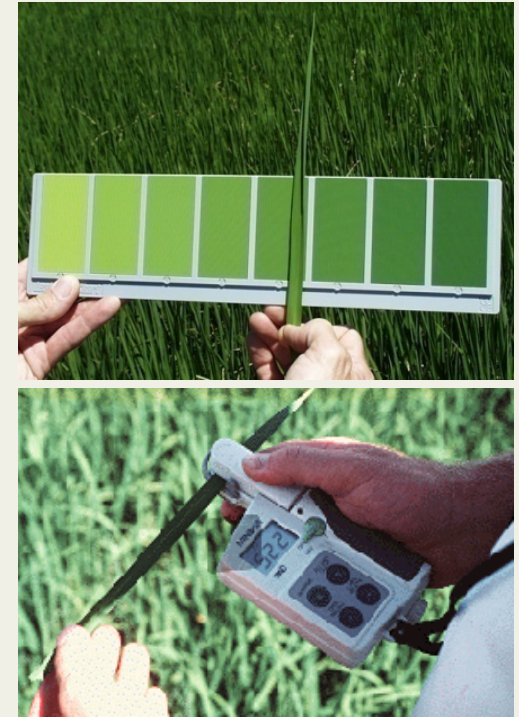


Williams



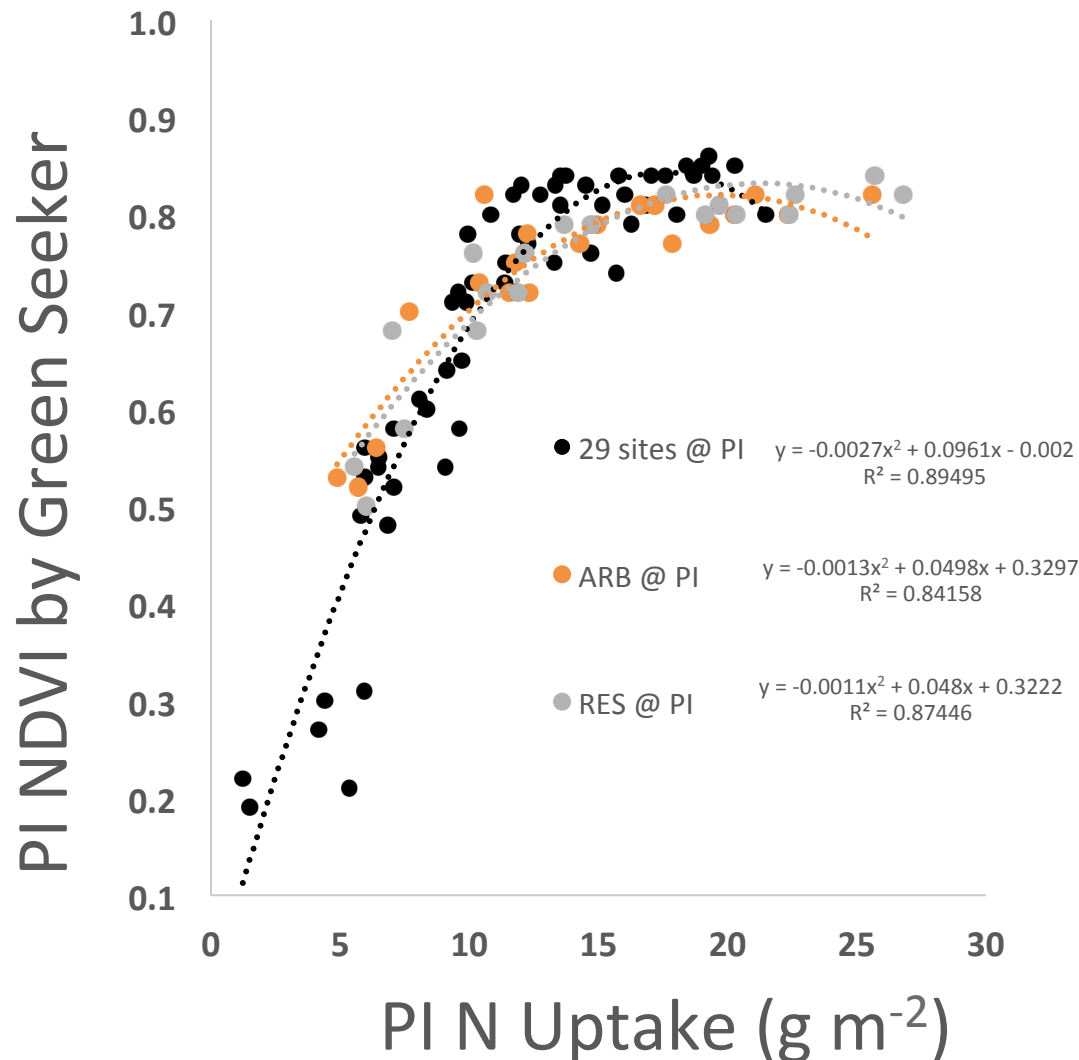
Top-dress N applications: Is it necessary?

- Leaf-color chart
- SPAD meter
- We are evaluating the potential for using aerial imagery
 - NDVI is not a great indicator of
 - N concentration
 - Biomass
 - NDVI may be promising for estimating total N (N conc X biomass)



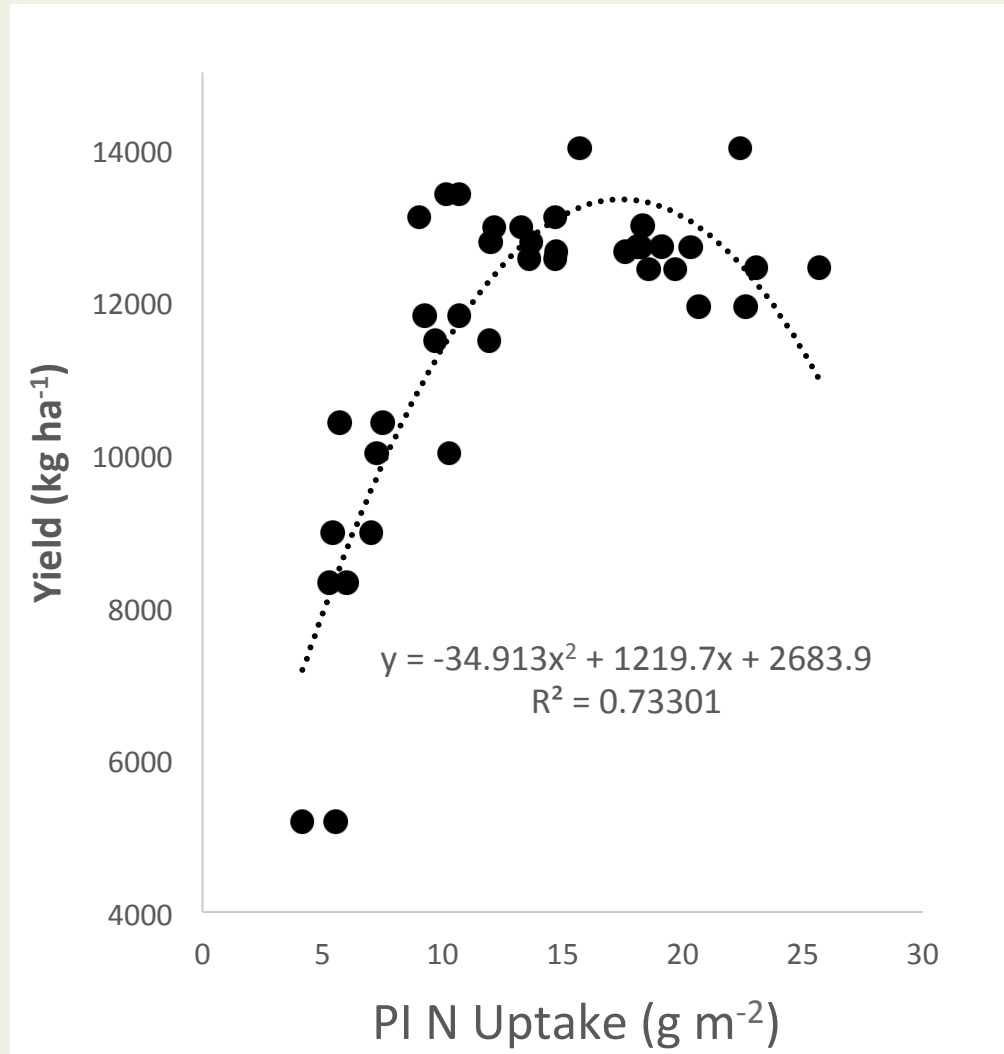
Preliminary results: NDVI at PI

- Not good at estimating biomass and N concentration
- Good correlation with N uptake



N uptake at PI versus yield

- SINCE
 - NDVI is a good predictor of PI N uptake AND
 - PI N uptake is good at predicting final yield
- THEN
 - We see potential in using the NDVI index to inform on midseason N management decisions.



Top-dress N applications: 2016 research

- Continue with 2015 research
 - Can we use aerial imagery to accurately assess crop N status?
 - Experimental plots
 - Effects across N rates and when is a top-dress necessary
 - Large field trials

Top-dress N applications: Field trials

- 3 treatments (one per check)

- standard preplant N rate with no top-dress

- standard preplant N rate with top-dress

- increased preplant N rate with no top-dress

Preplant (aqua +starter)	Top-dress
150	0
150	30
180	0

Top-dress N applications: Field trials

- 3 treatments (one per check)
 - standard preplant N rate with no top-dress
 - standard preplant N rate with top-dress
 - increased preplant N rate with no top-dress
- Run by growers
 - Application of rates
 - Yields from combines with yield monitors
- At time of top-dress
 - Measurements: biomass, NDVI from all treatment plots
- ***Sign up in back if you may be interested***

Thank you

