Reducing Fertilizer Needs of Potato with New Varieties and Clonal Strains of Existing Varieties

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Introduction

Potatoes are one of the important vegetable crops grown in California. Potato is also one of the heaviest fertilized crops in California. An average of approximately 300 lbs. of N per acre is applied, with rates varying from 100 to over 400 lbs/Ac. The rates of nitrogen application on potatoes are high for several reasons: (1) Potatoes are a high value crop (approx. $4,000/Ac gross farm gate), thus the goal is maximum yield; (2) Potatoes are relatively shallow rooted and have low root density, thus are inefficient in nitrogen uptake; (3) Much of the production is on sandy soils under solid-set sprinkler irrigation, thus with high leaching potential; and, (4) A relatively new reason: the most widely grown variety (Russet Norkotah) has a weak vine and is susceptible to early dying diseases. To compensate for this last deficiency, growers have increased the amount and duration of nitrogen fertilization in an effort to keep the vines healthier and alive longer. This situation is not unique to California. Russet Norkotah is widely grown, particularly in western U.S. Thus, even a 10% reduction in fertilizer nitrogen requirement for optimum yield and quality could result in tens of thousands of tons of nitrogen that 1) growers do not have to purchase, and 2) that are not subject to leaching below the root zone.

Several new clonal selections have been made of Russet Norkotah that have stronger vines and later maturity. Research in other states and grower observations indicate that at least some of these clonal selections, or strains, have lower nitrogen fertilizer needs than the standard Russet Norkotah. New varieties are also being grown and/or recently released in the long white, round red, as well as russet market classes. These varieties (e.g. CalWhite, CalRed, Silverton Russet, and Klamath Russet) may also have lower nitrogen requirements. Numerous advanced selections and clones are evaluated annually. For economic and environmental reasons, these clones should produce well under conditions of relatively low input.

Objectives

1. Determine the responses of standard and new potato varieties to nitrogen fertilization rates.
2. Determine if the new Russet Norkotah strains are more efficient in nitrogen utilization and thus require lower fertilization rates.
3. Determine if other new or potential potato varieties are more efficient in nitrogen use than existing standard varieties.
4. Demonstrate to potato industry the feasibility, profitability and sustainability of utilizing varieties/strains with lower fertilization requirements.
5. Demonstrate to potato industry the feasibility, profitability and sustainability of lower fertilization rates on standard and new varieties.

Project Description

In 2000, nitrogen rate experiments were conducted with 10 new varieties, including three new Russet Norkotah strain selections, at three locations – Kern Co., Davis, and Tulelake. Three years of experiments are necessary for conclusive results and recommendations to the industry. The 2001 and 2002 experiments, the second and third years of the study, were supported by the CDFA-FREP program, in cooperation with the California Potato Research Advisory Board and the USDA Potato Variety Development Progam.

The three components of the FREP project are, as follows:

1. *Nitrogen x Variety Trials:* Nine trials have been conducted in the three years of the study, three in each year. A trial has been conducted in Kern County and in the Tulelake Basin each of the three years. Trials have been conducted in the Stocton Delta in 2001 and 2002, and one trial was conducted at UC Davis in 2000. The number of varieties in each trial has varied from six to nine entries. In Kern County and at Davis, red, long white and russet varieties were studied. At Tulelake (UC-IREC) the emphasis has been on russets. In the Stockton Delta, the emphasis has been on red skinned varieties. A total of 8 russet, 1 long white, and 8 red varieties were studied. Five nitrogen rates were utilized in each trial. An effort to have a zero (0) rate was made, but some trials were grown in grower's fields with unavoidable sprinkler applied and/or pre-plant applied nitrogen. The maximum rate varied based on the experience in the respective locations, from 300 to 400 pounds N per acre. Applications were split into two equal components at most locations, with half at planting and half as a side-dress 45-60 days after planting.

Petiole samples were accomplished at most locations at 15-day intervals. Soil samples were collected at the beginning and end of growing seasons. Whole plant samples, followed by partitioning into vines, roots and tubers, were collected at two sites at the same time as petiole samples were collected. Total nitrogen and nitrate-nitrogen, as well as P and K on some samples, were determined on all samples. Total root mass samples were also collected at maturity from two sites. All of these petiole and nutrient analyses, as well as fresh and dry weights, are still being conducted and/or analyzed.

2. *Field Days, Grower Meetings, & Other Dissemination of Information:* Field days were conducted at harvest in Kern County and UC-IREC locations in 2000 and 2001, at midseason at UC-IREC in 2002, and at harvest at Kern County in 2002. The annual results are published in the California Potato Research Advisory Board annual report and orally presented to the Board at their annual meeting. The FREP annual report and annual conference will be used to disseminate information. Upon completion, results will be published in California Agriculture, California trade magazines and journals, and professional society journal.

3. *Grower Surveys:* To determine and evaluate current fertilizer practices, attitudes toward changing those practices, and to determine the need for phosphorus and potassium trials, a grower survey has been developed. In combination of soil and plant analyses, this survey will be used to determine the need for P and K trials. The survey will also provide a basis for evaluating the success and impact of this FREP project.

Results and Conclusions

Although all nine trials of this project have been harvested, yield data are available from seven. Petiole and whole plant analyses are not yet complete. The survey has been partially completed. Thus, conclusions are pre-mature, and all results must be considered preliminary. Numerous interesting findings have been recorded, however.

Nitrogen rate and spacing experiments were conducted with sixteen varieties (7 reds, 1 long white and 6 russets) in Kern County – CalRed, Cherry Red, Red LaSoda, Mazama, Winema, Durango, Cherry Red, CalWhite, Russet Burbank Russet Norkotah, CORN #3, TXNS 112, TXNS 223, and Silverton Russet. The nine varieties (8 russets and 1 red) included in Tulelake trials were Gem Russet, Klamath Russet, Russet Burbank, Russet Norkotah, CORN #3, TXNS 112, TXNS 223, Silverton Russet and CalRed. At UC, in the spacing and growth rate study, the nine varieties (3 reds, 1 long white and 5 russets) included were CalRed, Cherry Red, Red LaSoda, CalWhite, Russet Norkotah, CORN #3, TXNS 112, TXNS 223, and Russet Burbank. In the Stockton Delta, the eight varieties (6 reds and two whites) were Cheiftain, CalRed, Modoc, NDO4323-2R, Red Ruby, Mazama, CalWhite and A91556-2W. Thus, a total of 19 varieties (8 russets, 9 reds and 2 long whites) were included in one or more locations.

Figures 1 – 6 illustrate the average response of all varieties included at each location-year. The response to nitrogen varied widely among the different locations. The classic parabolic response was observed at some locations, i.e. increasing yield up to the 4th rate and then a decrease in yield at excessive nitrogen rates. In some locations yields were increasing still at the highest rate, while in other locations no response or negative response to increasing nitrogen rates was measured. Thus, a preliminary conclusion is that optimum nitrogen fertilization rate varies from location to location. The organic soils in the Delta, and the high clay and organic soils of Tulelake were less responsive to nitrogen than the very sandy soils of Kern County. However, even among the sandy sites in Kern County, the response varied significantly. Thus, other factors must be considered. Soil type, past cropping history, residual nitrogen and the nitrogen content in the irrigation water are all important components in determining nitrogen fertilizer rates.

Figures 7 through 12 illustrate the variability among varieties in their responses to nitrogen fertilization. In some locations, the new Russet Norkotah strains did respond to lower nitrogen rates than the standard Russet Norkotah. In other locations, however, no differences among responses were measured. Some varieties, such as CalWhite, respond to high rates of nitrogen, while others, such as CalRed, do not respond to high rates. The level of responsiveness, understandably, correlates well with the total yield potential. In some locations all or nearly all varieties responded similarly (e.g. Davis 2000), while in other locations varieties responded quite differently (e.g. Kern County 2000).

Since the petiole and soil analyses have not been completed, correlations among plant analyses, soil nitrogen residual, fertilizer rate and yield response have not been determined. Similarly, the growth rate measurements have not been completed, thus the correlations with that parameter have not been determined.

It will be difficult, if not impossible, to make generalized nitrogen fertilizer recommendations based on potato variety or soil type in California. Several other factors must be included in determining the fertilizer needs. It does appear that potato varieties do respond differently to nitrogen. Thus, growers should consider the variety in making fertilizer applications. Furthermore, breeders should consider the fertility level of the soil when making selections; more efficient varieties can be selected if lower nitrogen rates are used.

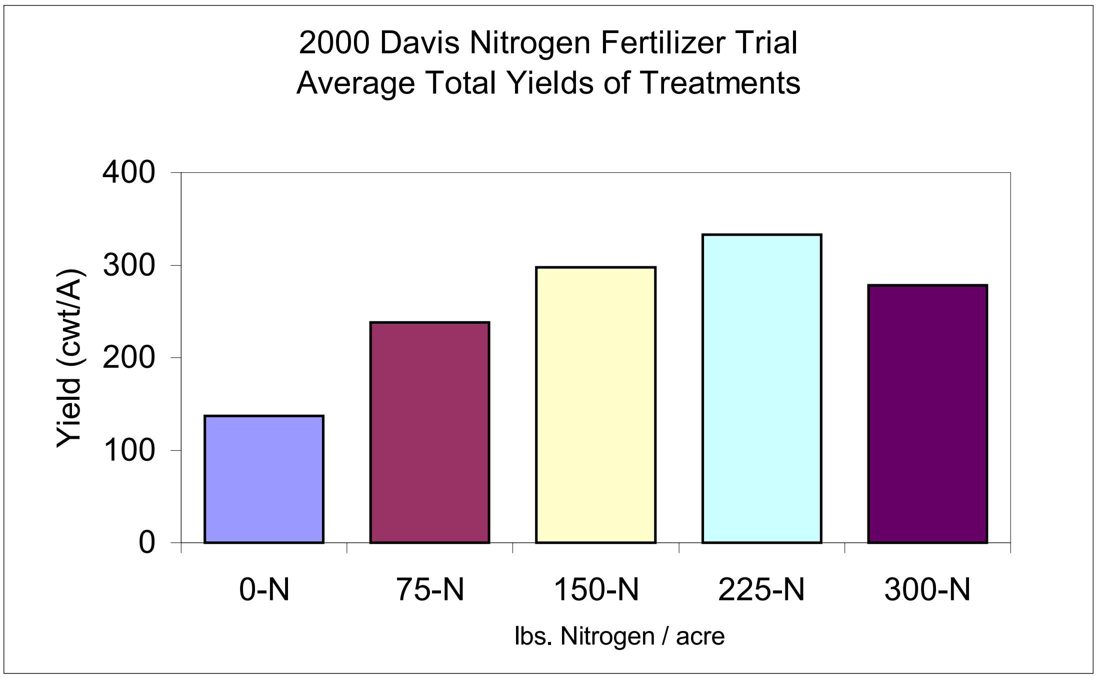
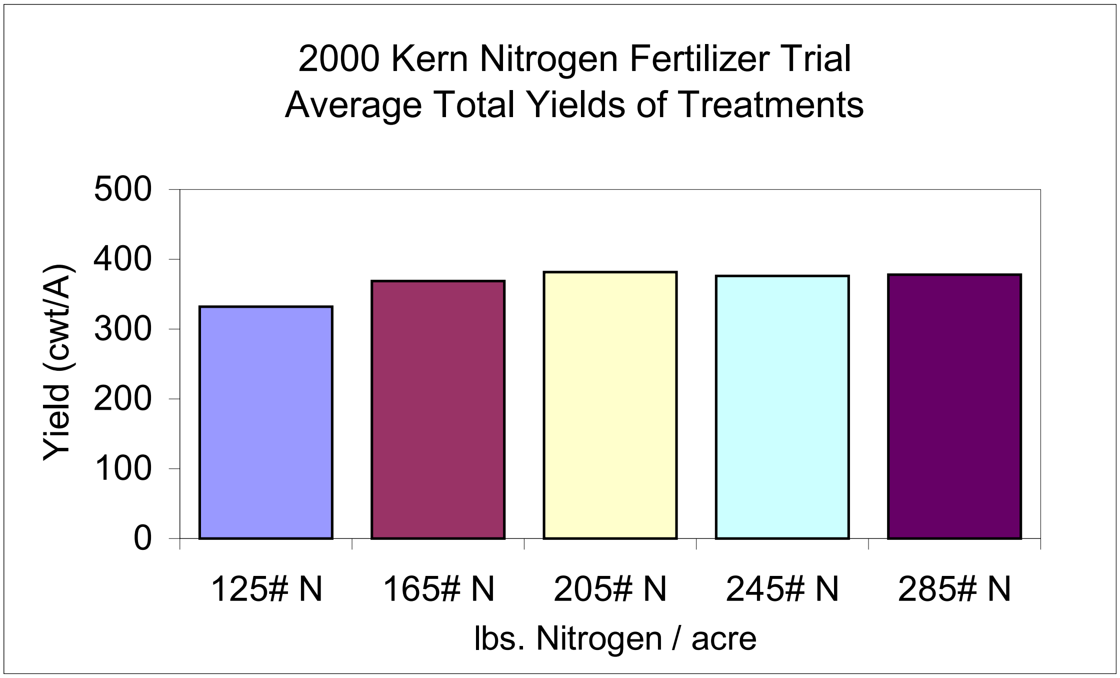


Figure 1.



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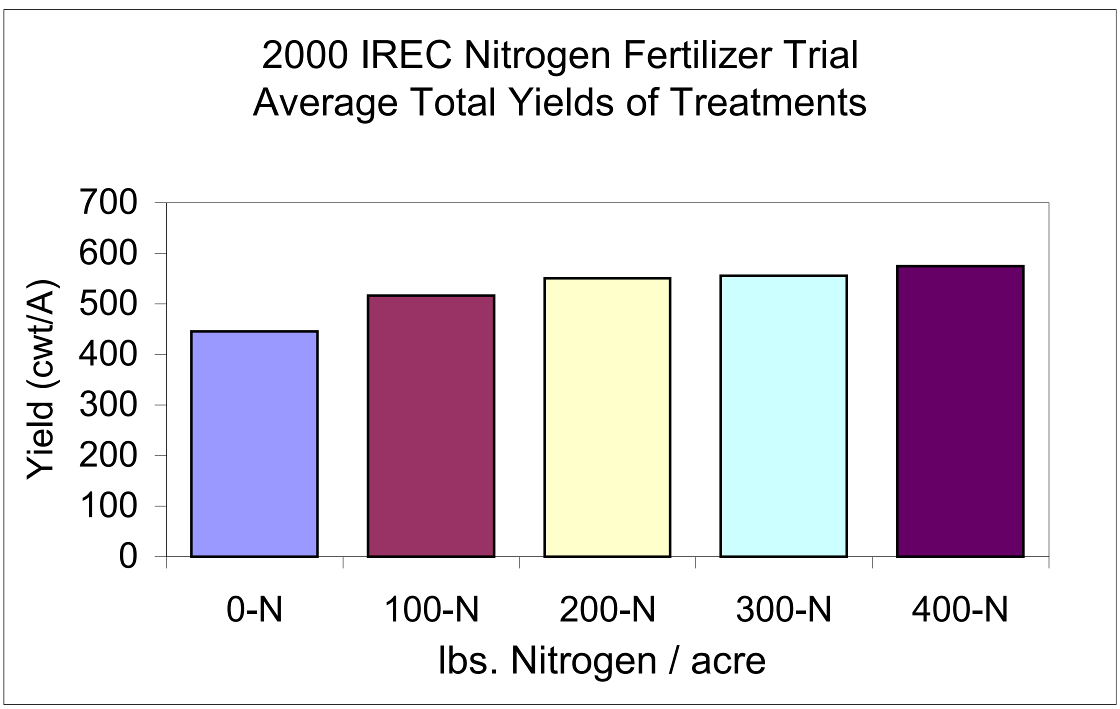

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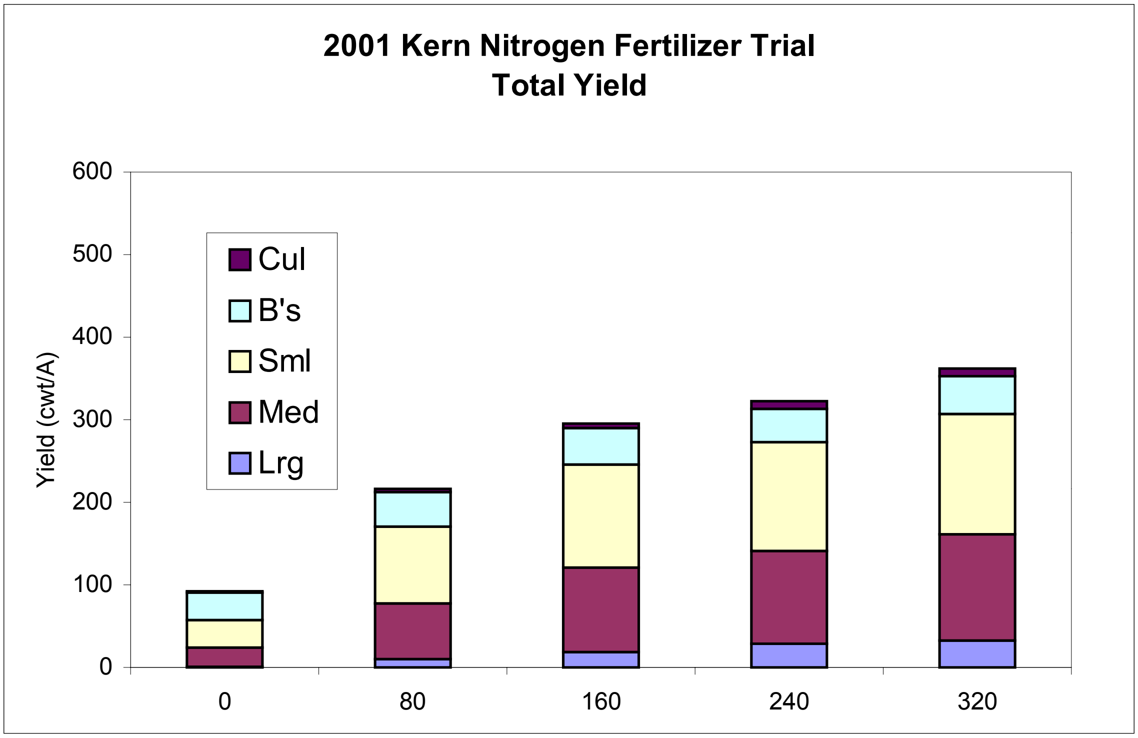

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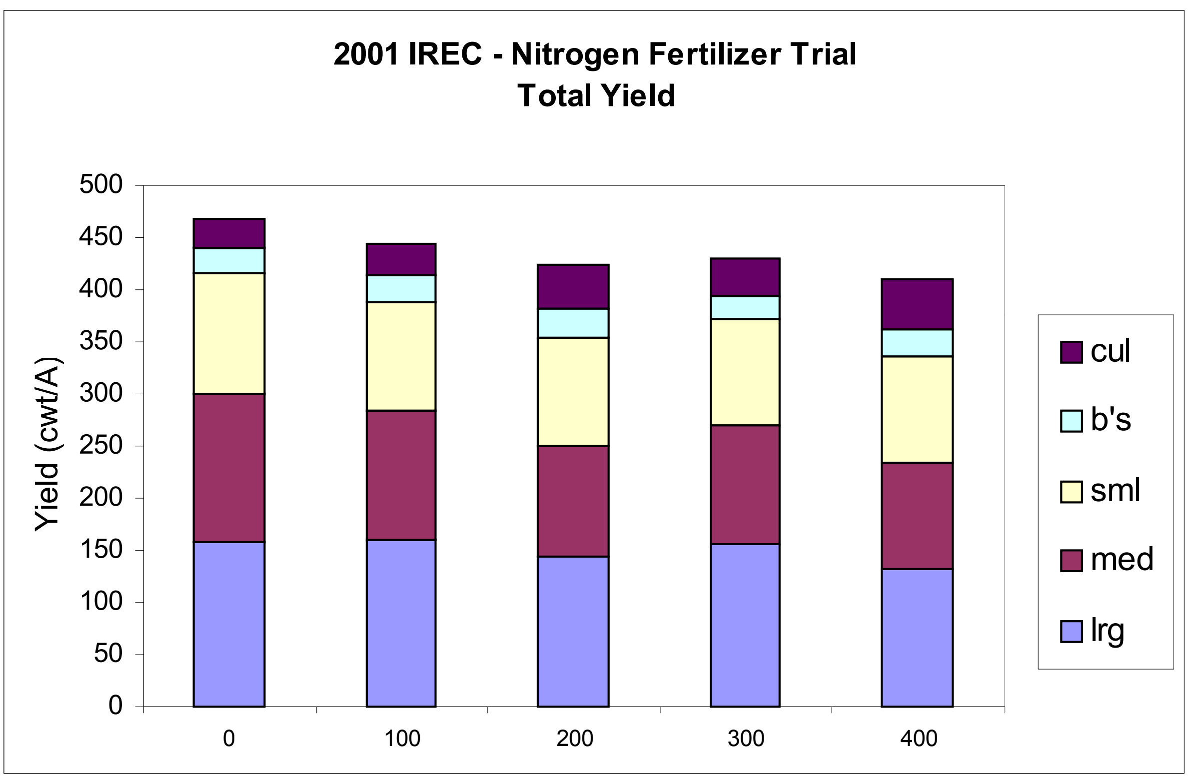

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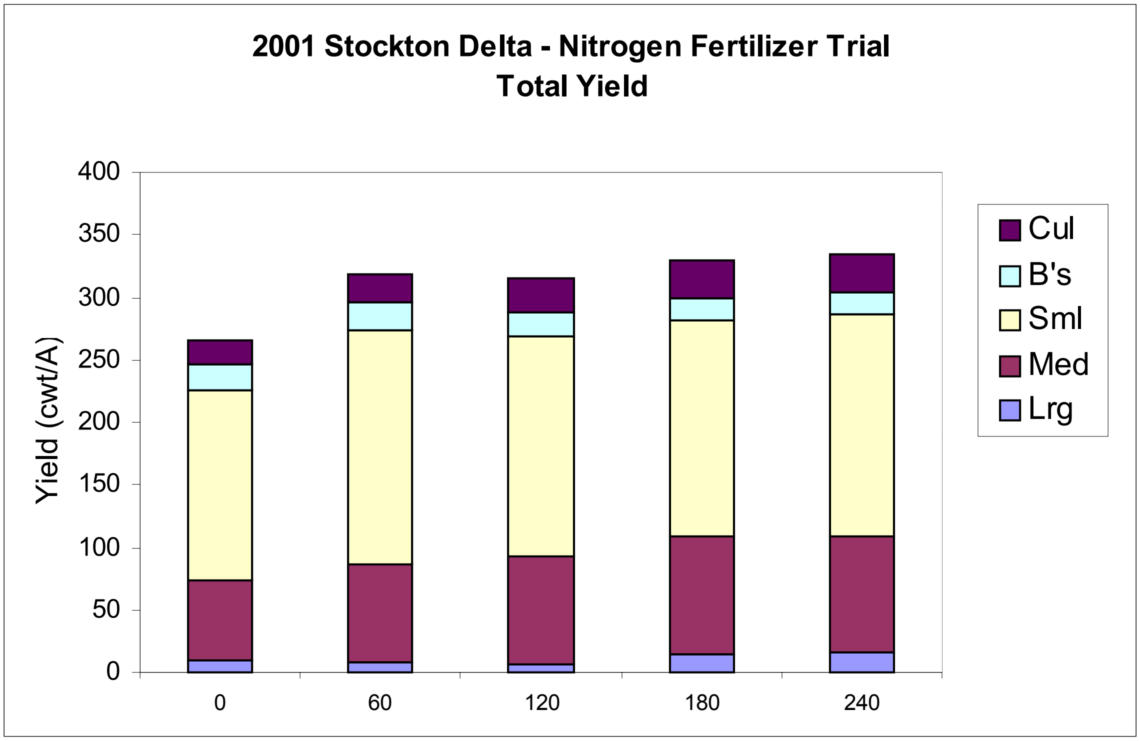

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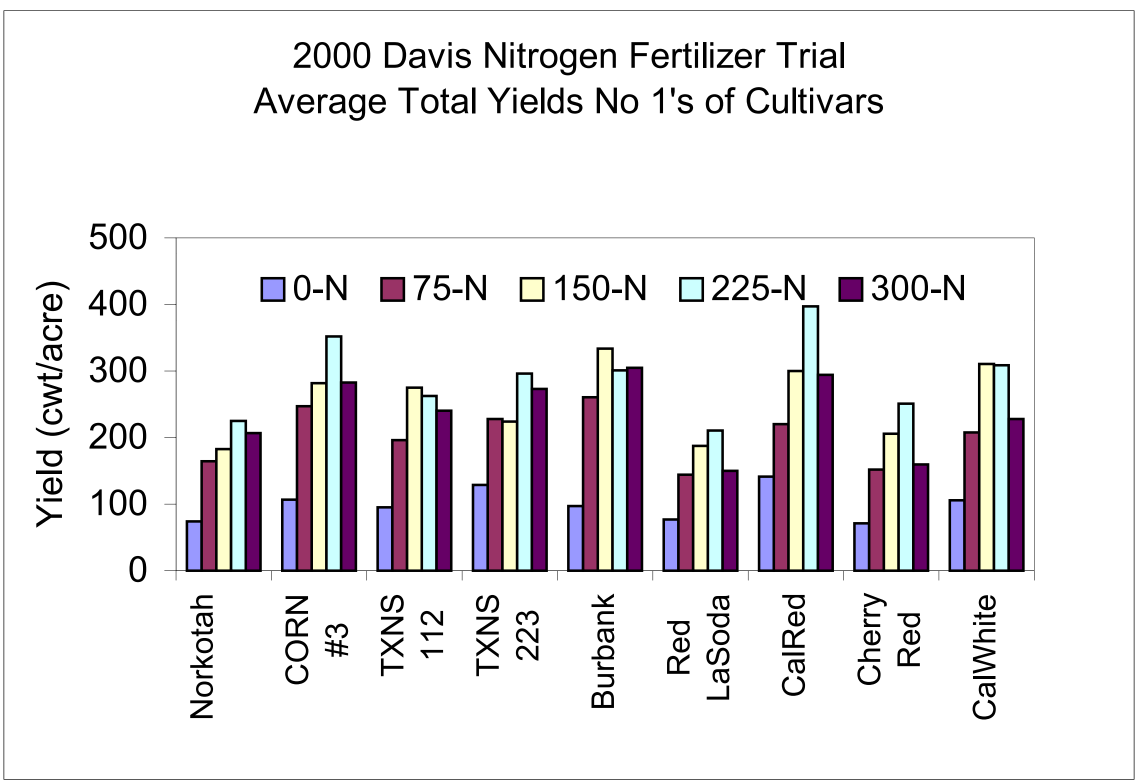
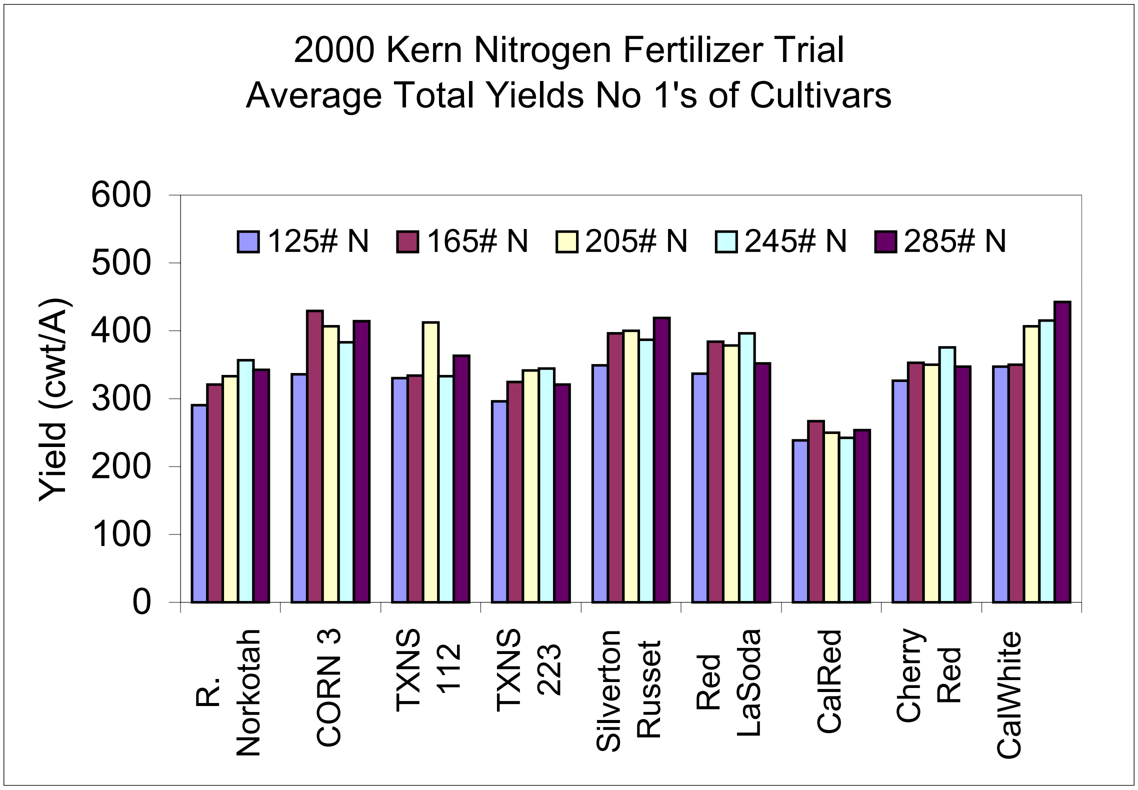


Figure 7.



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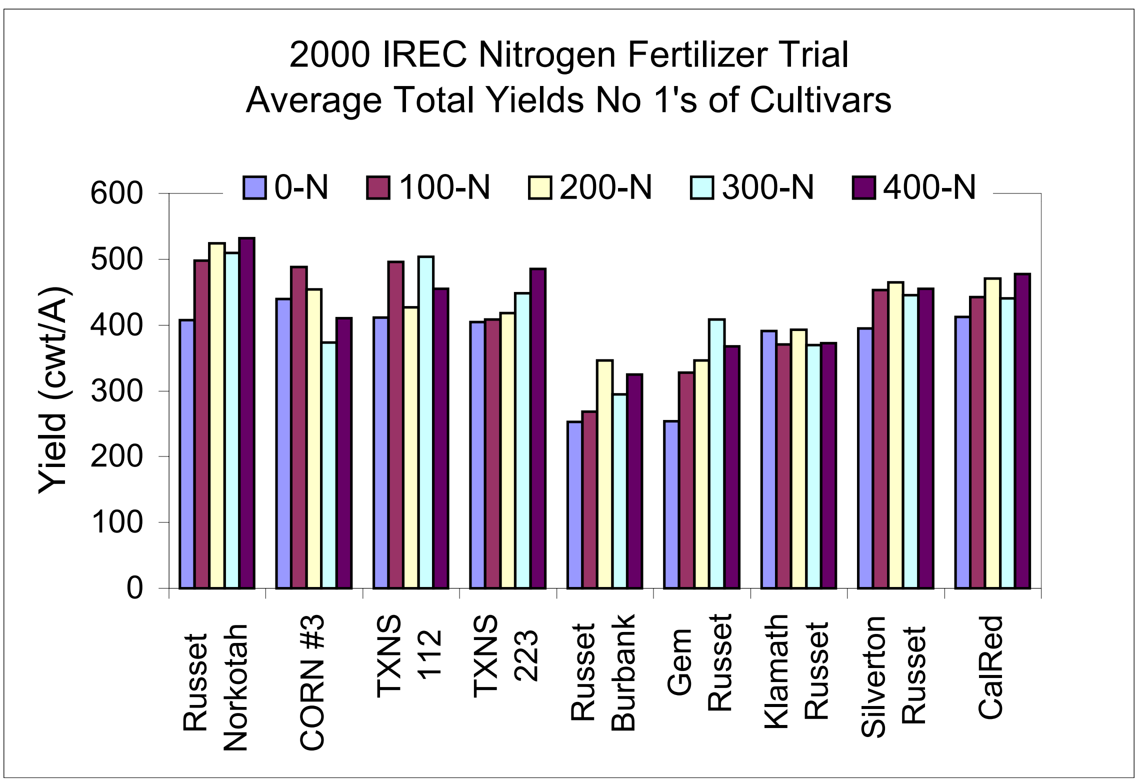

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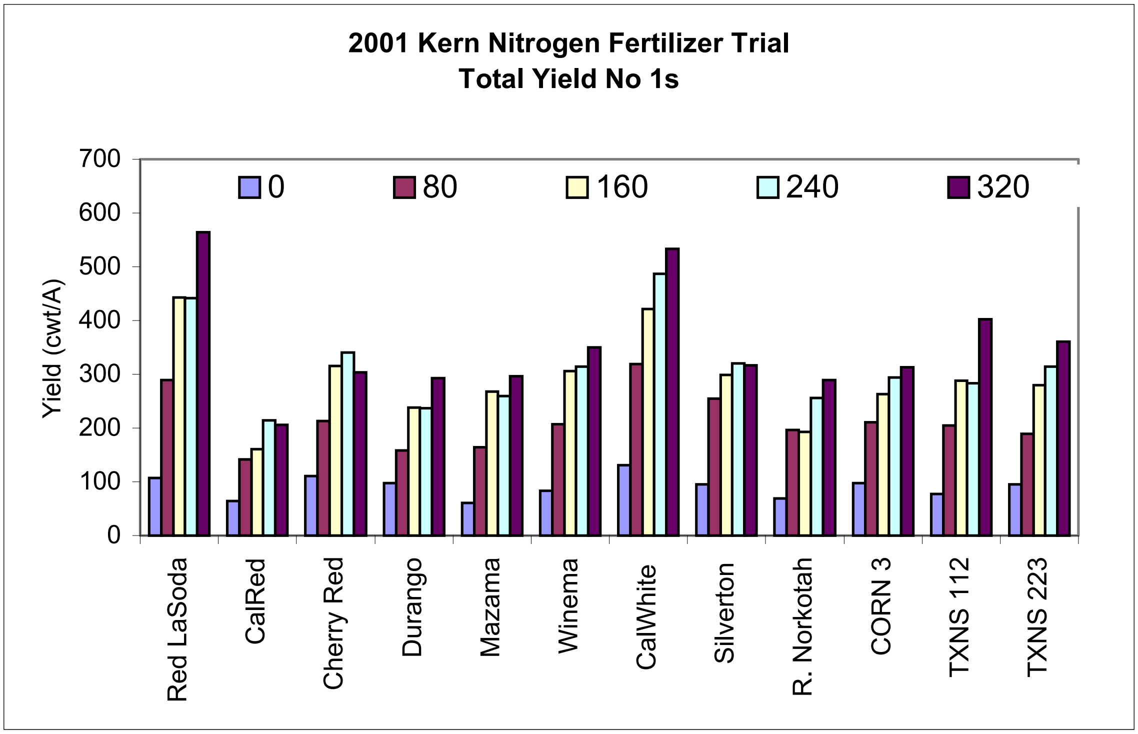

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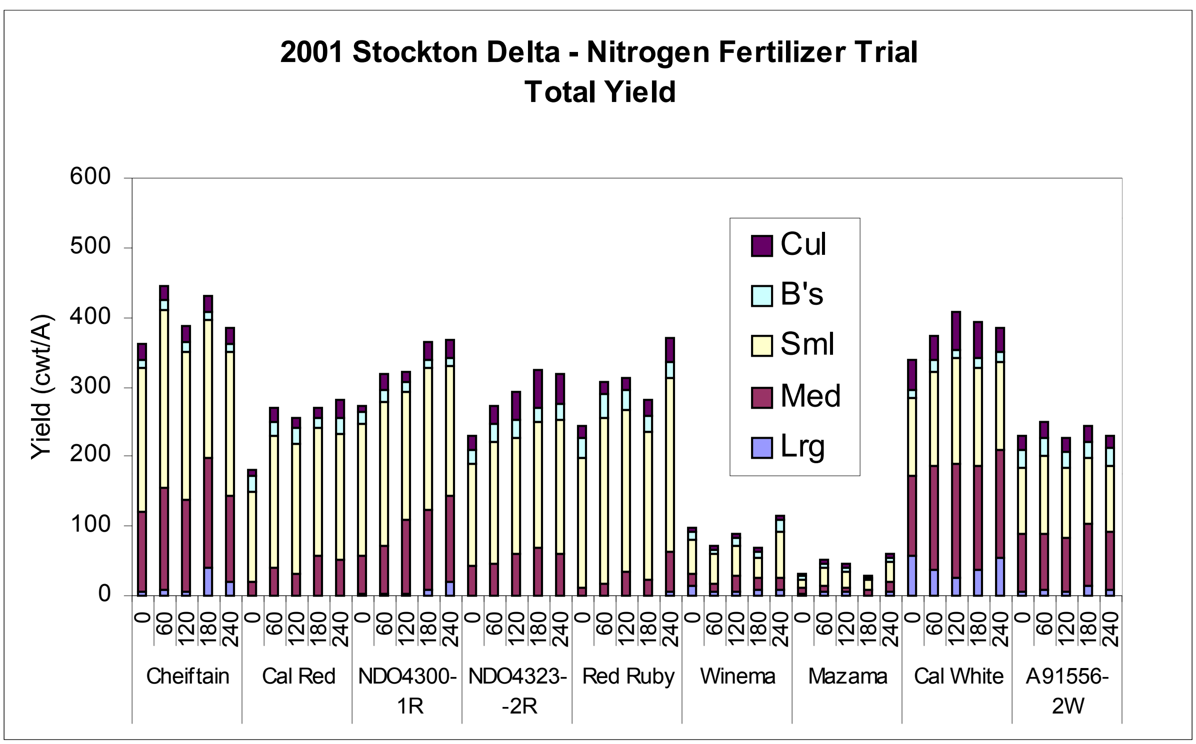

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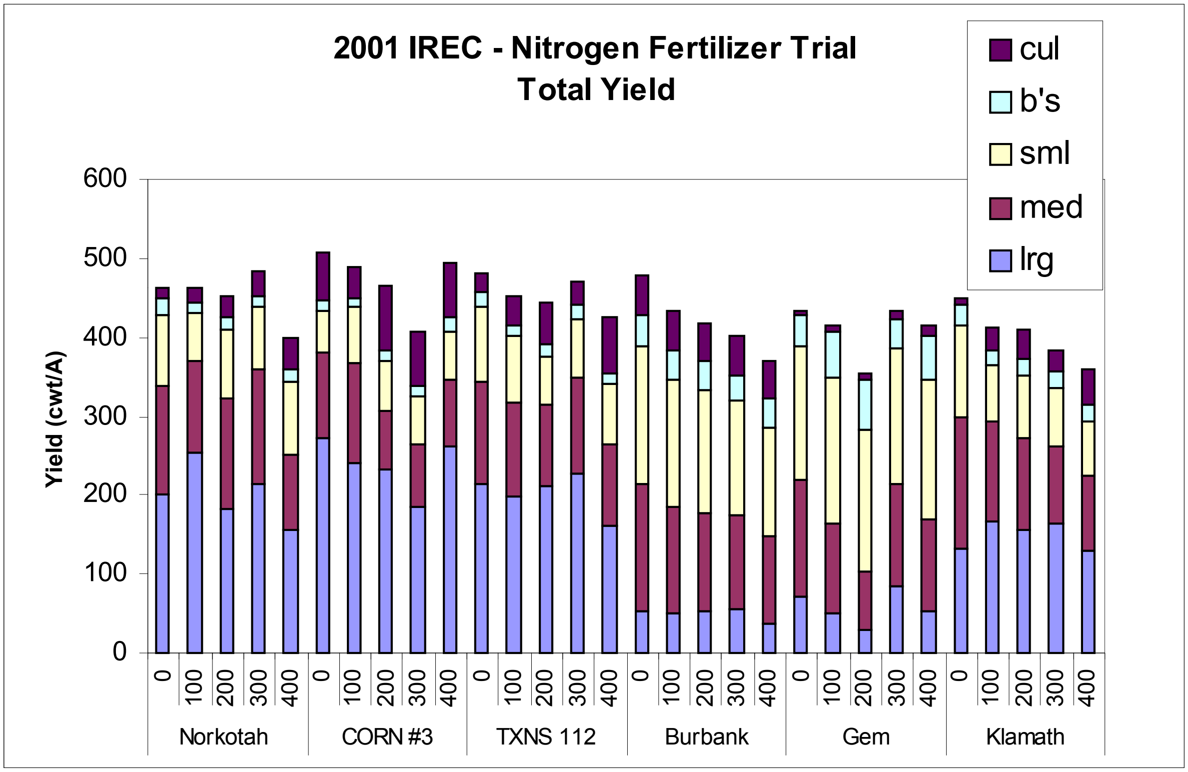

2001 IREC - Nitrogen Fertilizer Trial
Total Yield
cul
b's
sml
med
lrg
Yield (cwt/A)
0
100
200
300
400
500
600
Norkotah
CORN #3
TXNS 112
Burbank
Gem
Klamath

Figure 12.