NUMBER 157 CURRENT INFORMATION SERIES MAY 1971

# NITROGEN FERTILIZER REQUIREMENTS OF IRRIGATED WHEAT IN IDAHO

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Wheat yields have dramatically increased in recent years in the irrigated areas of southern Idaho with the introduction of new varieties. How high can yields go? The principal factors limiting yields are variety, soil fertility level, stand, disease, weather conditions, date of seeding and irrigation. The preceding crop history and nature of the soil are important in predicting the necessity of adding fertilizer in the production of irrigated wheat. Of all the nutrients required by grain, nitrogen is usually the most limiting.

To fully utilize the yield potential of new varieties such as Gaines and Nugaines, fertilizer recommendations for irrigated wheat must be adjusted. The shift from a soft white spring wheat to a hard red spring wheat due to the stripe rust epidemic in the sixties also required adjustments in fertilizer recommendations.

## METHODS

The Idaho Agricultural Experiment Station and Idaho Extension Service conducted a series of off-station fertilizer trials in Fremont, Madison and Twin Falls counties and on the Twin Falls Branch Experiment Station. Fields were selected that gave different crop sequences. The fertilizer plots were put on wheat following crops of potatoes, grain, beans, sugar beets and peas.

Nitrogen, in the form of ammonium nitrate at rates from 0 to 200 lbs. of nitrogen per acre, was spring applied on spring grain crops and both fall and spring applied on the winter wheat crops.

Lemhi type wheat was the principal spring wheat variety grown in the irrigated areas of southern Idaho for many years. However, the stripe rust epidemic in the early sixties made it necessary to switch to hard red spring resistant varieties. Then, with the release of stripe rust resistant Lemhi 66, many farmers returned to the use of this variety. Because red spring wheat varieties such as Thatcher produce a bread type of flour and a high protein content is desired, more nitrogen can be utilized to increase yield and protein than when a soft white wheat is grown.

Eight trials were run on Thatcher in the Madison, Fremont and Twin Falls County areas. Ten trials were run on Lemhi 53, 62 and 66 in Madison and Fremont Counties.

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## RESULTS

### Soft White Spring Wheat

Following potatoes both the 30 and 60 lb. rate gave a significant increase in yield of Lemhi type wheat over the check with the 30 lb. rate giving the highest yield (Table 1). The protein level was satisfactory for the 30 lb. nitrogen rate but 60 lbs. nitrogen gave protein levels too high for good pastry flour. (Protein levels of soft white wheat should not exceed 10 percent for good quality pastry flour.) The 90 lb. rate caused excessive growth that lodged and delayed maturity.

Following a grain crop the response to nitrogen was not as great as expected. The 60 lb. rate gave the highest yield; additional nitrogen did not increase the yield. The percent protein was satisfactory for all rates of nitrogen.

In the Twin Falls area where Idaed spring wheat followed sugar beets, nitrogen rate affected both the yield and percent protein of wheat (Table 2). Maximum yield is shown at the 120 lb. rate, but there were no significant differences between the 80, 120 and 160 lb. rates. Percent protein was increased with each increase in nitrogen rate with all levels being too high for good pastry flour.

Table 1. Effect of nitrogen rates on yield and quality of soft, white spring wheat following potatoes and grain.

| | Following Potatoes | | Following Grain | |
|---|---|---|---|---|
| lb N/acre | bu/acre | % protein | bu/acre | % protein |
| 0 | 79.7 | 10.1 | 77.9 | 8.8 |
| 30 | 100.5 | 9.8 | 79.0 | 9.6 |
| 60 | 93.5 | 12.0 | 85.2 | 9.7 |
| 90 | 87.6 | 11.5 | 83.0 | 10.7 |

Table 2. Effect of nitrogen rates on yield and quality of Idaed soft, white spring wheat following sugar beets.

| lb N/acre | bu/a | % protein |
|---|---|---|
| 0 | 57.3 | 11.1 |
| 40 | 68.0 | 12.4 |
| 80 | 72.1 | 13.3 |
| 120 | 75.2 | 13.6 |
| 160 | 75.5 | 13.9 |

### Hard Red Spring Wheat

All rates of nitrogen gave a significant increase in yield over the check for both the potato and beet ground in the Madison-Fremont area (Table 3). The 90 lb. rate gave the highest yields, but it also delayed maturity and increased lodging. The percent protein increased with each increase in nitrogen rate. In other trials following beets on heavily fertilized medium textured soil, the addition of nitrogen fertilizer caused a decrease in yield.

Nitrogen rates affected both the yield and percent protein of Thatcher spring wheat in the Twin Falls area on a silt loam soil (Table 4). All rates of nitrogen resulted in a significant increase in yield over the check; however, there were no significant differences among the rates above the 40 lb. rate. Protein increased with each increase in nitrogen rate. Nitrogen rates of 40 to 80 pounds per acre appear to be sufficient for producing yield and protein following beans in the Twin Falls area.

Table 3. Effect of nitrogen rates on yield and quality of Thatcher hard, red spring wheat following potatoes and beets in Fremont and Madison Counties.

| | Following Potatoes | | Following Beets | |
|---|---|---|---|---|
| lb N/acre | bu/a | % protein | bu/a | % protein |
| 0 | 62.2 | 13.1 | 55.9 | 11.9 |
| 30 | 76.0 | 13.7 | 79.5 | 12.0 |
| 60 | 81.2 | 14.0 | 86.7 | 12.1 |
| 90 | 83.5 | 14.7 | 93.9 | 12.7 |

Table 4. Effect of nitrogen rates on yield and quality of hard, red spring wheat.

| Nitrogen lb/a | Yield bu/a | Protein % |
|---|---|---|
| 0 | 46.1 | 11.4 |
| 40 | 61.4 | 12.2 |
| 80 | 68.0 | 13.5 |
| 120 | 69.0 | 14.1 |
| 160 | 72.8 | 14.6 |

## Soft White Winter Wheat — Gaines

With the introduction of Gaines, a soft white winter wheat, into the irrigated areas of southern Idaho, yields were dramatically increased with 151 bushel yields reported. In the Madison and Fremont county areas the fall season is short and definitely limits the time of planting. The most common practice is to follow another grain crop or a potato crop.

Where Gaines followed another grain crop the yields from all nitrogen rates were significantly higher than the check except for the spring applied 50 lb. rate (Table 5). The 150 lb. rate applied in the spring gave the highest yield, whereas there was a significant reduction in yield from the 200 lb. spring application as compared to the 150 lb. application. Except for the 50 lb. rate, spring application gave higher yields than either fall or split applications. The percent protein was in a satisfactory range for pastry flour for all rates of fertilizer.

Where Gaines followed potatoes, all fertilizer rates gave a significant increase in yield over the check with the 150 lb. rate, spring applied, giving the highest yield. Following potatoes, fall application is not as good as split application or spring application of fertilizer. The percent protein was satisfactory for all rates of fertilizer.

The yield potential of Gaines is high as shown by a set of plots in the Ashton area (Table 6). Gaines seeded in September following the harvest of seed peas produced an excellent stand. Fifty pounds of nitrogen were applied in the fall and several rates of nitrogen were applied in the spring (Table 6).

There was a significant increase in yield as the fertilizer rate increased with the highest yield of 151.3 bu/acre produced with the 125 lb. rate. It is evident from the percent protein that most of the nitrogen was being utilized in yield and not for the production of protein.

At the Twin Falls Branch Experiment Station where Gaines followed beans, nitrogen rates affected both yield and quality (Table 7). Nitrogen rates of 40 to 160 pounds per acre significantly increased yield over the check plot; however, no significant increase between the 40 lb. and higher rates was observed. Percent protein was increased by nitrogen rate increases.

It would appear that 40 to 80 lbs. nitrogen per acre following beans produced optimum yields with desirable protein levels.

Table 5. Effect of nitrogen rates on yield and quality of Gaines wheat following grain and potatoes.

| lb N/a | | Following Grain | | Following Potatoes | |
|---|---|---|---|---|---|
| Fall | Spring | bu/a | % protein | bu/a | % protein |
| 0 | | 69.2 | 8.1 | 74.3 | 7.2 |
| 50 lb. F | | 85.5 | 8.3 | 85.8 | 7.7 |
| 100 lb. F | | 102.2 | 8.4 | 116.9 | 8.5 |
| 150 lb. F | | 114.8 | 8.7 | 121.1 | 9.9 |
| 200 lb. F | | 111.6 | 9.1 | 117.3 | 9.7 |
| 25 lb. F | 25 lb. S | 90.5 | 8.4 | 115.0 | 8.8 |
| 50 lb. F | 50 lb. S | 102.1 | 8.4 | 119.0 | 8.6 |
| 75 lb. F | 75 lb. S | 106.0 | 8.4 | 128.3 | 8.8 |
| 100 lb. F | 75 lb. S | 111.7 | 9.3 | 129.7 | 8.6 |
| 50 lb. S | | 70.9 | 8.1 | 107.4 | 8.8 |
| 100 lb. S | | 111.8 | 8.6 | 120.5 | 10.0 |
| 150 lb. S | | 122.5 | 9.0 | 136.8 | 9.6 |
| 200 lb. S | | 87.2 | 9.5 | 131.0 | 10.3 |

F—Fall S—Spring

Table 6. Effect of nitrogen rates on yield and quality of Gaines wheat following peas.

| lb N/a | | Yield | Protein |
|---|---|---|---|
| Fall | Spring | bu/a | % |
| 50 | 0 | 120.8 | 7.1 |
| 50 | 25 | 136.1 | 7.1 |
| 50 | 50 | 144.8 | 7.8 |
| 50 | 75 | 151.3 | 7.4 |

Table 7. Effect of nitrogen rates on yield and quality of Gaines wheat following beans.

| lb N/a | Yield bu/a | Protein % |
|---|---|---|
| 0 | 73.8 | 8.0 |
| 40 | 88.6 | 9.0 |
| 80 | 94.3 | 9.7 |
| 120 | 96.6 | 10.7 |
| 160 | 94.5 | 11.1 |

## SUMMARY

The amount of nitrogen fertilizer to apply depends upon the type of wheat being grown, previous cropping history, soil type, area where grown and expected yield.

In the upper Snake River Valley, 30 lbs. of nitrogen resulted in satisfactory yields and protein when a soft white spring wheat (Lemhi type) was grown following potatoes. Following grain, 60 lbs. of nitrogen gave the highest yield. Additional increments of nitrogen decreased yield and, following potatoes, increased percent protein to an undesirable level. High nitrogen rates also delayed maturity and increased lodging.

For hard red spring wheat following potatoes and sugar beets, 90 lbs. of nitrogen gave maximum yield and protein. However, delayed maturity and lodging at the 90 lb. rate indicate that the 60 lb. rate would be a more practical rate to recommend following potatoes. Where Gaines followed grain and potatoes, 150 lbs. of spring applied nitrogen gave the highest yields. Fall or split application of nitrogen did not result in as great a yield increase as spring fertilization. Applications of 125 lbs. nitrogen to Gaines winter wheat following peas resulted in a yield of 151 bu/a.

In the Magic Valley area, where summer temperatures are considerably warmer than in the upper Snake River Valley and root rot diseases are a problem, wheat yields are not as high. Where Idaed followed beets, no significant increase in yield occurred above the 40 lb. nitrogen application rate and the percent protein was too high with all rates of nitrogen. Where Thatcher followed beets all rates of nitrogen showed a significant increase in yield over the check; however, there were no significant differences above the 80 lb. rate. Nitrogen rates up to 80 lbs. per acre appear to be sufficient for producing maximum yield and protein following beans. Where Gaines wheat followed beans, all rates of nitrogen gave a significant increase over the check but with no difference among the higher rates.

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PUBLISHED AND DISTRIBUTED IN FURTHERANCE OF THE ACTS OF MAY 8 AND JUNE 30, 1914, BY THE UNIVERSITY OF IDAHO COOPERATIVE EXTENSION SERVICE, JAMES E. KRAUS, DIRECTOR; AND THE U.S. DEPARTMENT OF AGRICULTURE, COOPERATING.

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