

Yield Response of Small Grains to Nitrogen Fertilization¹

RUSSELL K. STIVERS, Purdue University²

Nitrogen top-dressing rates studies on soft red winter wheat in Indiana have been reported by Stivers, et al. (4) and by Hodges and Stivers (2). These experiments used only one variety of wheat. Reports of fertilizer demonstrations conducted by the Purdue Extension Service (5, 3) indicate that only one variety was used in each trial.

The purposes of this study were first, to study yield responses of wheat and oats to rates of nitrogen fertilizer, and second, to study yield interactions between two different varieties of each crop and rates of nitrogen fertilizer.

METHODS AND PROCEDURES

Experiment 1

This experiment was conducted at two locations in 1964, and at two different locations in 1965. Locations used are numbers 1, 2, 3, and 4 described in Table 1. The previous corn crop at these locations had been fertilized with at least 100 pounds per acre of nitrogen. Some received more.

A split plot design with five main plots and two subplots was used at each location. Main plots were five rates of spring top-dressed nitrogen, and subplots were the two wheat varieties, Reed and Redcoat. Four replications were used.

Certified Reed and Redcoat wheat were seeded at the rate of approximately 7.5 pecks per acre at about the Hessian fly free date. This date was in late September in the northern part and in early October in the southern part of Indiana. The fertilization and planting were done with a 9-hole farm type grain drill. Approximately 15 pounds per acre of nitrogen along with phosphorus and potassium fertilizer were applied at planting. The amount of phosphorus and potassium fertilizer applied was as high or higher than recommendations based upon Purdue soil tests. Ammonium nitrate fertilizer was top-dressed by hand in late February or March.

Lodging was estimated just prior to harvest. Yields were determined by harvesting with a commercial farm combine. Harvested areas were approximately 120 feet by 5 feet. Yield data were adjusted to 14% moisture in the grain.

Experiment 2

This experiment was conducted at two locations in 1964 and at one location in 1965. Locations used were 2, 5, and 6 given in Table 1. The

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TABLE 1
Description of Soils

Location	Year	Farm and Address	Previous crop	Soil type	Soil pH	Purdue Soil Tests		
						P Lbs. per A.	K Lbs. per A.	
1	1964	R. W. Carnahan Edwardsport, Ind.	Corn	Iva silt loam	7.1	25 (Low)	61 (Very Low)	
2	1964	H. Davis Forestry Farmland, Ind.	Corn	Morley silt loam	6.7	302 (Very High)	386 (Very High)	
3	1965	R. D. Holstine Plainville, Ind.	Corn	Iona silt loam	6.2	74 (Medium)	118 (Low)	
4	1965	H. Davis Forestry Farmland, Ind.	Corn	Blount silt loam	5.2	87 (High)	224 (High)	
5	1964	Pinney Purdue Wanatah, Ind.	Corn	Runnymede loam	6.2	154 (Very High)	212 (High)	
6	1965	Pinney Purdue Wanatah, Ind.	Corn	Runnymede loam	6.8	113 (High)	210 (Medium)	

crop used was spring oats. As in Experiment 1, the previous corn crop at these locations had been fertilized with at least 100 pounds per acre of nitrogen.

Experimental design and general procedure were approximately the same as for Experiment 1. The Runnymede locations were seeded on April 15, 1964, and on April 19, 1965. The Morley location was seeded May 8, 1965, after a long wet period. The rate of seeding used was approximately 9 pecks per acre. The five nitrogen rates were top-dressed immediately following planting. Subplots were the two spring oat varieties, Newton and Goodfield, in 1964, and they were Newton and Tippecanoe in 1965.

RESULTS AND DISCUSSION

Experiment 1

In two of the four wheat experiments, increasing rates of top-dressed nitrogen resulted in yield decreases (Table 2). One hundred twenty pounds per acre of nitrogen was associated with significantly depressed

TABLE 2
Relation of Rates of Top-Dressed Nitrogen to Yields of Wheat.

Year	Soil	Lbs. per A. of Top-Dressed Nitrogen					Lsd 5% Level
		0	15	30	60	120	
1964	Iva silt loam	53.1	57.1	56.2	55.5	53.8	Not Sig.
1964	Morley silt loam	56.1	55.0	56.6	56.3	52.7	2.4 bu.
1965	Iona silt loam	57.7	58.4	58.7	56.1	48.6	1.5 bu.
1965	Blount silt loam	44.1	45.8	44.2	46.5	47.7	Not Sig.

wheat yields over those obtained with 60 pounds on the Morley and Iona soil areas. Differences in lodging were too small to account for this difference. The bold face figures in Table 2 indicate the most profitable level of returns from nitrogen when nitrogen was valued at \$.15 per pound and wheat was worth \$1.30 per bushel.

It is perplexing that there were no significant increases in yields in relation to increasing rates of top-dressed nitrogen. Demonstrations of the Purdue University Extension Service (5) indicate that about five bushels per acre increases in wheat yields can be expected for the first 25 pounds nitrogen top-dressed. All of the experiments listed in Table 2 followed high yielding corn heavily fertilized with nitrogen. There must have been a considerable amount of nitrogen carryover from the corn. Barber's work in Indiana (1) indicates that a residual value of 40 pounds per acre of nitrogen can be expected where 120 pounds was applied for corn.

There were no significant differences in yields between Reed and Redcoat wheat in 1964. However, in 1965, Redcoat wheat yielded more than Reed at both the Iona and the Blount soil locations. At the Blount

location, winter killing of Reed was observed to be greater than that of Redcoat. At the Iona location Reed was observed to have more powdery mildew than Redcoat. This difference in disease resistance between the two varieties was, it is believed, partially responsible for their highly significant differing yield responses to increasing rates of top-dressed nitrogen (Table 3). With increasing rates of top-dressed nitrogen the

TABLE 3
Interaction between Rates of Top-Dressed Nitrogen and
Varieties of Wheat, Iona silt loam, 1965.

Variety	Yields in Bu. per A. with These Lbs. per A. of Top-Dressed Nitrogen					Av. Yield per A.
	0	15	30	60	120	
Reed	56.7	56.0	55.5	52.4	46.9	53.5
Redcoat	58.0	60.8	61.8	59.8	50.2	58.3

decline in yield of Reed was linear. Yields of Redcoat increased up to 30 pounds per acre of nitrogen, and then they declined. Higher rates of nitrogen probably resulted in powdery mildew being worse on Reed, the more mildew susceptible variety.

Experiment 2

Two of the three spring oat experiments had meaningful increases in yields as nitrogen fertilizer rates increased (Table 4). The extremely

TABLE 4
Yields of Spring Oats in Relation to Rates of Nitrogen Fertilizer

Year	Soil	Yields in Bu. per A. with These Lbs. per A. of Top-Dressed Nitrogen					Lsd 5 % Level
		0	15	30	60	120	
1964	Runnymede loam	67.8	70.0	76.6	81.4	85.8	14.9 bu.
1964	Morley silt loam	71.4	74.5	73.1	69.5	67.3	Not Sig.
1965	Runnymede loam	69.8	76.6	84.7	87.1	89.3	9.0 bu.

late date of seeding the third location, the Morley silt loam, could easily explain its lack of response. The bold face figures in Table 4 indicate the most profitable level of returns from nitrogen when nitrogen is valued at \$.15 per pound and oats are worth \$.65 per bushel. Where there was a response to nitrogen, 30 pounds per acre resulted in the

highest returns from nitrogen fertilization. Except for the Morley soil, these responses are about the same or a little greater than the 16-year averages obtained in Purdue University Extension demonstrations (3).

May, with temperatures 15 degrees above normal during the first 8 days and with an average rainfall 2.5 inches below normal limited oat yields at the Runnymede location in 1964 (Table 5) to an average of about 76 bushels per acre. It is believed that these conditions also limited the yield response of oats to nitrogen. The resulting efficiency of nitrogen usage was poor.

Oat yields revealed a highly significant interaction between varieties and rates of nitrogen on the Runnymede loam in 1964 (Table 5). Newton

TABLE 5
Yields of Spring Oats in Relation to Rates of Nitrogen Fertilization,
Runnymede loam, 1964

Variety	Yields in Bu. per A. with These Lbs. per A. of Top-Dressed Nitrogen					Av. Yield per A.
	0	15	30	60	120	
Newton	71.3	71.5	77.4	83.3	84.9	77.7
Goodfield	64.3	68.5	75.9	79.6	86.8	75.0

oats yielded more than Goodfield oats at all levels of nitrogen except the highest, 120 pounds per acre. This difference was not related to lodging since there was none at this location. It appeared that Goodfield was able to respond more to higher rates of nitrogen than was Newton oats in this environment.

Summary

One hundred twenty pounds per acre of nitrogen fertilizer significantly depressed wheat yields over those obtained with 60 pounds in two of four experiments. Redcoat wheat yielded more than Reed wheat in the two 1965 experiments. A difference in disease resistance was given as a probable reason for the differing yield responses of these two wheat varieties to increasing rates of nitrogen at the Iona soil location in 1965.

In two of the three spring oat experiments yields increased up to 120 pounds per acre of nitrogen. However, dollar returns from the increased yield over the cost of nitrogen were greater at lower rates. At the Runnymede soil location in 1965 Goodfield oats responded to 120 pounds per acre of nitrogen with a higher yield than did Newton oats. At lower rates of nitrogen Newton oats had the higher yield.

Literature Cited

1. American Potash Institute, 1963. Fertilizer and Lime Carryover. Potash News Letter M123 for September-October. 1-4.
2. HODGES, H. F., and R. K. STIVERS. 1964. Nitrogen Fertilizer Experiments with Wheat on Princeton Sandy Loam. Purdue Univ. Res. Progress Report **144**:1-3.
3. Oat Varieties for Indiana and Results of 1962 County Demonstrations. January 1963. Purdue Univ. Mimeo AY-3:1-2.
4. STIVERS, R. K., H. F. HODGES, R. F. DUDLEY and C. F. DOUGLAS. 1961. Response of Wheat to Nitrogen on Indiana Soils. Proc. Ind. Acad. Sci. **71**:361-366.
5. Wheat Varieties for Indiana and Results of 1963 County Demonstrations. March, 1964. Purdue Univ. Mimeo AY-4:1-4.