EFFECT OF RATE, METHOD OF APPLICATION, AND SOURCE OF PHOSPHATE FERTILIZERS ON YIELD OF WHEAT AND DURUM

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Three phosphate fertilizers were compared, on the basis of their effect on the yield of spring wheat sown on fallow, in field trials by the Soils Department of the North Dakota Agricultural Experiment Station. The trials took place in 1949, and were located at the substation at Edgeley, N. D., the Bob Peters farm at Jamestown, N. D., and the Peder M. Johnson farm at Park River, N. D.

Results of the trials at Edgeley and Park River are presented in Table I and Table II respectively.

Table 1. EFFECT OF RATE, METHOD OF APPLICATION AND SOURCE OF PHOSPHATE FERTILIZER ON THE YIELD IN 1949 OF DURUM WHEAT ON EDGELEY LOAM, EDGELEY SUBSTATION.

Rate of application (as lbs. of 0-47-0)*	How Applied	Yields in bushels per acre			
		No Fertilizer	0-47-0[1]	0-63-0[2]	Colloidal Phosphate[3]
25	Drill	9.1	13.4	13.9	9.3
50	Drill	9.6	14.1	14.3	10.3
100	Drill	9.6	13.8	13.6	9.8
100	Broadcast	9.1	12.2	12.0	10.0

*Rates are expressed as pounds of 0-47-0 per acre. Colloidal phosphate and calcium metaphosphate were applied in amounts containing amounts of phosphorus equivalent to that in the 0-47-0.
[1]High-Analysis Superphosphate—47% available P_2O_5.
[2]Calcium Metaphosphate—63% available P_2O_5.
[3]Colloidal Phosphate—20% total P_2O_5.

Table 2. EFFECT OF RATE, METHOD OF APPLICATION AND SOURCE OF PHOSPHATE FERTILIZER ON YIELD IN 1949 OF WHEAT ON GARDAR LOAM[1] AT PARK RIVER.

Rate of application (as lbs. of 0-47-0)	How Applied	Yields in bushels per acre			
		No Fertilizer	0-47-0[2]	0-63-0[3]	Colloidal[4] Phosphate
25	Drill	16.6	23.6	20.1	16.8
50	Drill	17.1	28.1	23.1	16.7
100	Drill	16.3	29.1	25.8	17.1
100	Broadcast	17.3	27.5	24.1	17.5

[1]Tentative soil series name, subject to revision.
[2]High-Analysis Superphosphate, 47% available P_2O_5.
[3]Calcium Metaphosphate, 63% available P_2O_5.
[4]Colloidal Phosphate, 20% total P_2O_5.

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The phosphate fertilizers compared in these trials were high analysis superphosphate (0-47-0), calcium metaphosphate (an experimental material not available commercially), and colloidal phosphate. High-analysis superphosphate was applied at rates of 25, 50, and 100 pounds per acre with a drill attachment at seeding time. The 100-pound rate was also tested as a broadcast application, to compare the value of broadcast and drill methods of application. The calcium metaphosphate and colloidal phosphate were applied in a similar manner, in amounts supplying phosphorus equal to that supplied by the high analysis superphosphate.

No increase in yield was obtained from the use of colloidal phosphate in any of these trials, which included rates as high as 250 pounds per acre. Substantial increases in yield were obtained from high analysis superphosphate and calcium metaphosphate fertilizers tested, but the high analysis superphosphate was superior to the calcium metaphosphate, both in effect on early crop growth as well as in final yield increase.

Drill Application Is Better

Striking differences in early growth were obtained for the various rates of superphosphate. Furthermore, drill application of the soluble phosphates were distinctly superior to the broadcast treatments. Plots receiving 100 pounds of 0-47-0 broadcast did not at any time look as good as plots receiving 50 pounds of 0-47-0 drilled, nor were final yields of grain as high. In addition, where fertilizer was drilled, plants made more rapid early growth, enabling the crop to compete more effectively with weeds.

Dry soil conditions during the last half of the growing season at Jamestown and Edgeley prevented full expression in yield of the benefits of fertilizer use. In spite of this, all plots receiving superphosphate and calcium metaphosphate gave substantial increases in yield, though final yield differences between various treatment rates were lower than early growth indicated.

At Edgeley, the increase in yield from 25, 50, and 100 pounds drill applications of triple superphosphate were practically the same, yields being increased from 9.4 bushels per acre on the check plots to 13.4 to 14.1, and 13.8 bushels per acre. The yield on plots receiving 100 pounds triple superphosphate broadcast was 12.2 bushels per acre. In this trial 25 pounds of fertilizer drilled was more effective than 100 pounds broadcast.

At Jamestown, drill applications of 25, 50, and 100 pounds of triple superphosphate increased the yield from 6.4 bushels per acre on the check plots to 10.5 bushels, 11.9, and 12.2 bushels per acre respectively.

In the Jamestown and Edgeley trials it is particularly noteworthy that substantial yield increases were obtained for rather light applications of fertilizer in spite of the moisture shortage at the time the grain was filling.

In the Park River trial, lack of moisture was not as great a limiting factor as in the other experiments. In this trial, check plots averaged 16.8 bushels per acre. The yields from drill applications of 25, 50, 100 pounds of high analysis superphosphate were 23.6 bushels, 28.1, and 29.1 bushels per acre, or increases of 6.8, 11.3, and 12.1 bushels per acre respectively. The yield increase for 100 pounds of high analysis superphosphate broadcast was slightly less than that from drill applications of 50 pounds of the same material.

Recommendations

On the basis of appearance of the crop during the growing season, it appears that for the eastern third of the state a drill application of 50 pounds of high analysis superphosphate or its equivalent in terms of available P_2O_5 from lower analysis superphosphates will furnish enough phosphorus to get nearly maximum response from wheat on fallow in most fields in most seasons. However, a greater response would be obtained in some fields from higher rates of application, especially in years of favorable rainfall.

In dry seasons, 25 pounds of triple superphosphate as a drill application may give as great increase in many fields as will be obtained from higher rates, but this rate is judged too low for most fields under average moisture conditions. In the western two-thirds of the state a rate equivalent in available P_2O_5 to 40 pounds of triple superphosphate is recommended as a drill application for wheat on fallow only.

The importance of adequate moisture, if one is to get maximum increases in yield from fertilizers, is emphasized by last year's results, but they also indicate that in many cases substantial increases in yield may be obtained even in very dry areas when used on crops on fallow. They also indicate that there is very little, if any, basis for the fear that an early season response to phosphate fertilization will be converted into a yield decrease if drought occurs.

Residual Effects

When fertilizers are applied at high rates, as is necessary when it is broadcast, some effect may be expected to carry over to succeeding crops, especially where moisture conditions are favorable. Carry-over effects from 1949 fertilization will be measured this year.

Where legumes are grown, there is an additional argument in favor of broadcasting phosphate fertilizers at rates furnishing 40 to 100 pounds available P_2O_5. Where phosphate fertilizer is applied principally for the purpose of increasing the yields of the crop grown the current season, or in areas where only the crop on fallow stands much chance of having enough moisture to benefit from the use of fertilizer, the drill method of application is clearly indicated.

Drill application places the fertilizer close to the seed where the growing plant can begin to draw on it as soon as it begins to grow. When fertilizer is broadcast, the plant cannot draw on the fertilizer phos-

phorus until the root system develops enough to reach the fertilizer distributed throughout the soil. Early stimulation of the crop is very important in getting the crop off to a good start. Furthermore, when fertilizer is broadcast, it is just as available to the weeds as to the crop. It was notable in last year's experiments that when fertilizer was drilled, weeds were suppressed much more effectively than when it was broadcast.

On the basis of these and other supporting data, the following conclusions are made:

Summary

1. Colloidal phosphate has very little value as a fertilizer on North Dakota soils.
2. High analysis superphosphate is superior to calcium metaphosphate as a source of phosphate for wheat, when compared on the basis of equal amounts of available phosphoric acid (P_2O^5).
3. If phosphate fertilizer is broadcast, instead of drilled in for wheat, at least twice as much, and often three or four times as much fertilizer is necessary to achieve equal effects on the current crop.
4. Wheat competes more effectively with weeds when fertilizer is applied in the row with the seed, as compared to broadcast application.
5. There appears to be little if any justification for the fear that phosphate fertilization will decrease the yield of grain in a dry season.

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