WINTER WHEAT RESPONSE TO NITROGEN, PHOSPHORUS, POTASSIUM AND LIMESTONE ON A BURLESON CLAY LOAM

A. T. Leonard, V. A. Haby, and J. V. Davis

SUMMARY

A soil test without calibration to crop response from applied nutrients is difficult to interpret. This research was done as part of a state-wide cooperative effort to reevaluate soil test recommendations for nitrogen (N) and phosphorus (P) fertilization of winter wheat. In Experiment I, nitrogen rates to 120 lb/ac and P rates to 90 lb/ac were applied to a slightly acid Burleson clay loam soil in Red River County. Approximately 1 ton of limestone/ac was applied to neutralize soil acidity. Nitrogen and P soil test data indicated these nutrients were in the very low category. Wheat yield was increased by N in each test. Grain yield was increased 30 and 44 bu/ac by 120 lb N/ac in 1987 and 1988, respectively. A 30 bu/ac yield increase was attained by the same treatment on an adjacent site in 1988. Application of limestone minimized wheat response to P in this experiment. In Experiment II which varied limestone and potassium (K) rates, a 100 lb P/ac application increased yield 19 bu/ac. At a soil pH of 5.3, the optimum limestone rate was 1 ton/ac which increased grain yield by 10.5 bu/ac. Broadcast, incorporated P at the rate of 75 to 100 lb P_2O_5/ac was optimum for this soil which tested very low in P. Potassium applications to 160 lbs K_2O/ac did not increase wheat yield.

INTRODUCTION

A properly calibrated soil test is required in order to make accurate fertilizer recommendations for optimum crop yield and minimal environmental pollution. Scientists have recognized that unused nutrients from fertilizer application in previous years remained in the soil and were available to subsequent crops. The buildup of residual soil nitrate nitrogen (NO_3-N) has the potential to pollute ground water. Residual P is not readily leached through the soil, but it can become a problem in surface runoff from heavily fertilized fields. This study was part of a three year, state-wide soil test correlation effort initiated in 1985 to improve soil test recommendations for N and P to more accurately reflect the need of winter wheat for N and P in Texas soils.

PROCEDURES

The soil at this research site was a Burleson clay loam (Fine, montmorillonitic, thermic Udic Pellustert) having a pH of 5.3, a very low P level in the surface 6-inch depth, and a low soil NO_3-N level in the surface 4-foot depth. A single test was conducted in 1986-1987. In 1987-1988 the test was repeated on the site from the previous year (Site A) and also on an adjacent site (Site B). Fertilizer N rates of 0, 30, 60, 90, and 120 lb/ac and P_2O_5 rates of 0, 30, 60, and 90 lb/ac were evaluated in all combinations and four replications. Each test site was limed with 1 ton limestone per acre equivalent and received 200 lb/ac potassium magnesium sulfate (18.3-11.2-22.7), 30 lb/ac N, and all P fertilizer rates. Treatments were broadcast and incorporated before planting each year. Pioneer 2157® winter wheat was drilled at the rate of 120 lb/ac on a 7-inch row spacing. Chlorsulfuron (Glean®) was broadcast at the rate of 0.25 ounces active ingredient per acre for weed control. The remainder of the N fertilizer treatments were broadcast applied prior to growth initiation in February.

Experiment II was conducted on an adjacent site on the same soil in 1987-1988 to evaluate winter wheat response to P, K, and limestone. Applied amendments ranged from 0 to 120, 160, and 4000 lb/ac P_2O_5, K_2O, and limestone, respectively, to fit the requirements of a central composite rotatable design. All treatments were broadcast and incorporated immediately prior to drill-seeding Pioneer 2157 winter wheat.

Grain was harvested from a 3.5 x 16 foot area in each plot with a small plot combine and placed into individual paper bags. Grain was allowed to air-dry in the bags prior to weighing and determining test weight.

RESULTS

Data from Experiment I indicated a 30 bu/ac yield increase due to application of 120 lb N/ac in 1987 and on Site B in 1988, both years that the study was initiated on a new site in a field which had previously been cropped to soybeans (Table 1). Sufficient residual N was available in this soil to produce 24 bu of wheat grain/ac in 1987 and 19 bu/ac in 1988 without N application. Phosphorus had no effect on yield with N applications to 120 lb/ac, but a trend toward increased yield due to P was beginning to emerge at the 90 lb N/ac rate and above in 1987. The 30 lb P_2O_5/ac rate increased grain yield on Site B 1988. A nonsignificant 10 bu/ac grain yield increase occurred due to increased P rates at the 120 lb N/ac rate. A significant grain yield response to P application occurred at the high N rate on Site B in 1988.

In Experiment II, limestone treatment of 2000 lb/ac increased grain yield in excess of 10 bu/ac on the central composite rotatable design test plot in 1988 (Fig. 1). A significant interaction between limestone and applied P increased yield (Fig. 2). Phosphorus increased wheat grain yield by 18 bu/ac at the 100 lb/ac P_2O_5 rate. Regression analysis provided the following response equation which explained 72% of the yield variation:

$$Y = 25.09 + 0.010475(L) + 0.391348(P) - 0.000002764(L^2) - 0.002137(P^2) - 0.0000056(PxL)$$

Potassium applications to 160 lb K_2O/ac did not effect a grain yield increase at this site. Although soil extractable K was not analyzed, the Burleson soil usually tests high.

Test results indicate this soil is responsive to nitrogen fertilization for winter wheat production and, when limed, may contain sufficient P for one cropping season. The second season, P fertilizer should be applied in order to obtain optimum yields. Lack of limestone application to decrease the acidity level did not prevent a grain yield increase due to P application, but application of limestone significantly increased the wheat yield response to applied P.

TABLE 1. MEAN WHEAT GRAIN YIELD RESPONSE TO N AND P APPLICATIONS BY YEAR IN RED RIVER COUNTY (EXPERIMENT I)

Applied P_2O_5 (lb/ac)	Applied N (lb/ac) 0	30	60	90	120	Avg.
1987	bu/ac					
0	27.1	32.0	48.6	44.7	48.8	40.2
30	22.2	33.1	38.3	52.3	54.1	40.0
60	22.8	34.2	45.5	49.2	53.9	41.1
90	23.6	31.5	39.7	46.9	58.1	39.9
Avg.	23.9	32.7	43.0	48.3	53.7	
LSD (0.05) = 6.4		C.V. = 13.4%				
1988 (Site A)						
0	5.2	7.3	30.7	29.7	40.4	22.7
30	4.9	9.5	30.0	36.6	54.4	27.1
60	6.0	12.6	26.9	38.5	49.8	26.7
90	4.8	13.2	18.5	37.2	51.5	25.0
Avg.	5.2	10.6	26.5	35.5	49.0	
LSD (0.05) = 5.12		C.V. = 20.2%				
1988 (Site B)						
0	19.6	24.1	27.4	34.3	39.4	29.0
30	20.8	23.3	36.4	45.2	51.8	35.5
60	18.1	22.7	32.6	41.6	50.5	33.1
90	16.5	22.2	34.4	48.3	52.6	34.8
Avg.	18.7	23.1	32.7	42.4	48.6	
LSD (0.05) = NS		C.V. = 17%				

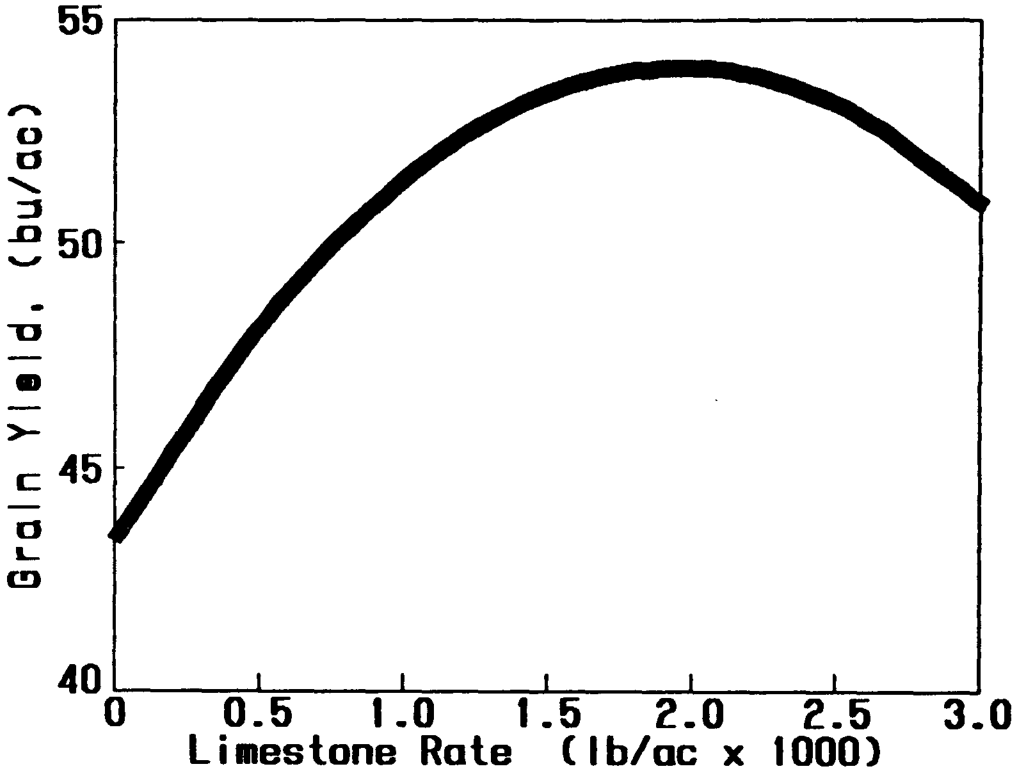

Fig. 1. Limestone rate effect on HRW wheat yield on a moderately acid Burleson clay loam

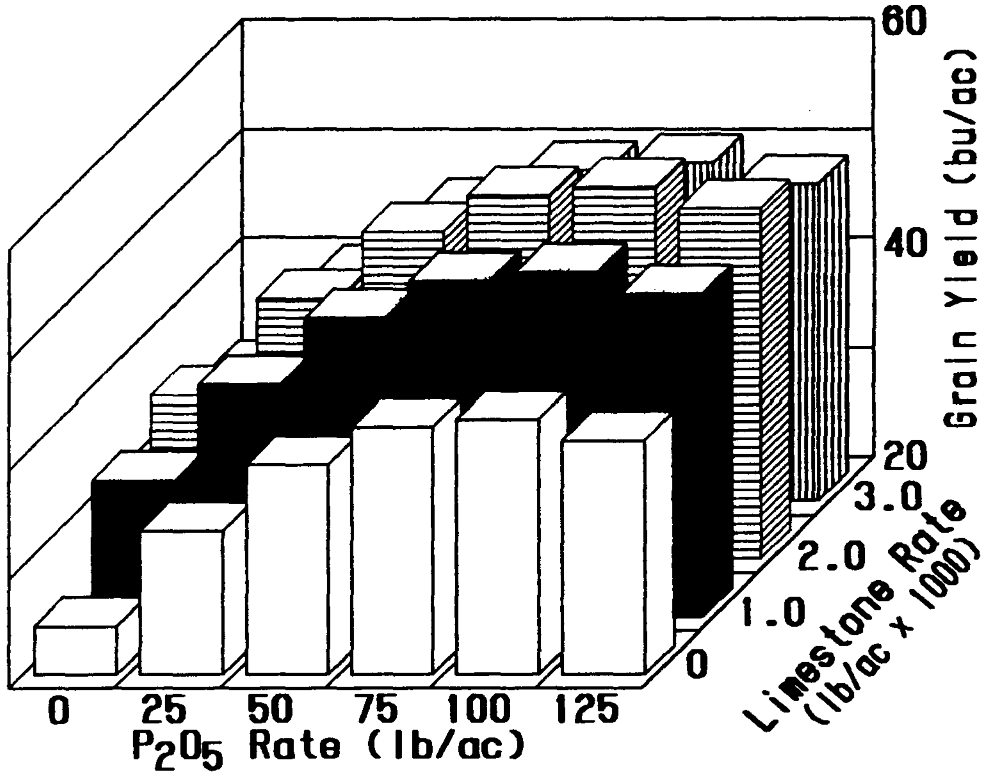

Fig. 2. Interactive effect of limestone and phosphorus on HRW wheat grain yield.