PHOSPHORUS ECONOMICS ON DRYLAND WINTER WHEAT

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ABSTRACT

Phosphorus fertilizer trials on dryland wheat were initiated in 1984 on 13 cooperating farms from northern Oklahoma through western Kansas to eastern Colorado. Soil test P ranged from very low to high with most soils in the low to very low range. Treatments consisted of six P rates from 0 to 75 lb P205/A as 10-34-0, preplant dual applied with anhydrous ammonia, under a sweep plow. Treatments were replicated three or four times at each location. Significant positive yield responses were detected at four of the nine locations harvested. On low testing soils,66% of the sites responded to P. Yields leveled out in the 45 to 60 lb P205/A range.

Regression analysis of the yield data from the P responsive sites generated the following yield prediction equation:

Grain Yield = 38.8bu/A + 0.332 (P205 rate) - 0.0026 (P205 rate)**2

The maximum yield potential P fertilization rate determined from this equation was 63.8 lb P205/A. Based on $3.00 wheat and $0.27/lb P205 fertilizer, the maximum profit would have been generated at 46.5 lb P205.

OBJECTIVE

Substantial university man-hours have been expended in the High Plains since 1965 evaluating wheat response to phosphorus fertilization and efficient methods of applying P. Thompson (1979) summarized data showing significant wheat yield responses on 40% of 99 western Kansas dryland sites over a 15 year period. Sixty-two percent of sites testing low to very low in soil P responded to P with an average 16% increase in yield over N only fertilization. Data from these studies indicated that 46lb P205/A may be required on soils testing low to avoid limiting yields. There would appear to be substantial acreage of potentially P responsive dryland wheat. Yet, Kansas stastics show that only 40% of the harvested wheat acreage over the entire state in 1983 received any phosphorus fertilizer. (66th Report Kansas Agriculture, 1983). Fertilizer use stastics for Colorado in 1984 indicated 2 lb P205/A applied to wheat (Hargett and Berry, 1985).

A series of sites in western Kansas and eastern Colorado were established to demonstrate the potential economic return from phosphorus fertilization and enhance farmer interest in P use on dryland wheat.

METHODS AND MATERIALS

A total of 13 farmer-cooperator field locations were selected with the assistance of Servi-Tech, Inc., fieldmen in the summer of 1984. Site information as complete as could be verified is provided in Table 1.

TABLE 1 FIELD SITE LOCATIONS, SELECTED SOIL, AND VARIETY INFORMATION

Location	P Soil Test ppm P *	Soil Type	Variety
Woods Co.,Ok	63.0	Reinach vfsal	Wings
Trego Co.,Ks-I	9.0	Hastings sl	Bounty 205
Trego Co.,Ks-II	8.5	Hastings sl	Bounty 205
Sherman Co.,Ks	18.5	Ulysses sl	Larned
Ford Co.,Ks	9.9	Harney sl	Unknown
Greeley Co.,Ks	10.8	Ulysses sl	Rocky
Wallace Co.,Ks	11.3	Keith sl	Uknown
Gray Co., Ks	21.0	Richfield sl	TAM 105
Kit Carson Co.,Co	7.0	Unknown	Unknown

Sites deleted because of nonexistent or poor stands;
Grant Co.,Ks Ford Co.,Ks-II Kiowa Co.,Co Cheyenne Co.,Co
* Mehlich II P soil test procedure.

Treatments as indicated in Table 2 were arranged in a randomized complete block design with four replications at all locations, except Trego II, which had only three replications.

TABLE 2 TREATMENTS EMPLOYED AT ALL LOCATIONS

Treatments	
Lb N/A	Lb P205/A
0	0
80	0
80	15
80	30
80	45
80	60
80	75

Phosphorus, as 10-34-0, was dual-applied with anhydrous ammonia, preplant, on 12" centers under a sweep plow. The sweep was also operated through the no-fertilizer control plots. The sites were planted by the respective cooperating farmers. Four locations were abandoned because of dry fall soil conditions that resulted in poor stands and/or severe weed competition in the spring. The remaining nine locations were harvested with a small plot combine.

RESULTS AND DISCUSSION

TABLE 3 GRAIN YIELD RESULTS AT NINE HARVESTED LOCATIONS IN 1985.

Treatment		Woods Co., OK	Kit Carson Co., CO	Trego-I Co., KS	Trego-II Co., KS	Sherman Co., KS	Ford Co., KS	Greeley Co., KS	Wallace Co., KS	Gray Co., KS
lb N/A	lb P205/A									
						Yield (Bu/A)				
0	0	36.6	22.4	32.2	41.4	74.4	27.3	57.7	49.4	25.0
80	0	39.5	25.4	59.5	48.1	82.2	29.6	52.0	47.3	20.2
80	15	38.5	33.6	56.0	49.6	76.7	30.7	56.2	58.4	21.1
80	30	37.6	33.6	57.0	52.7	75.9	35.4	57.3	61.4	22.5
80	45	41.3	38.1	54.0	52.8	81.7	39.1	53.1	59.8	24.6
80	60	40.6	37.0	53.0	53.6	64.3	38.2	57.1	62.4	22.4
80	75	42.5	37.6	54.5	55.0	65.9	41.1	57.6	63.4	22.9
LSD .05	TRT	ns	3.9	5.7	ns	11.6	3.7	3.3	4.5	ns
	FAC	ns	4.2	ns	ns	12.7	3.4	3.1	3.9	ns
Coef Var %		17.0	8.2	6.5	10.2	11.3	6.3	3.1	4.4	11.3

A significant positive yield response to the phosphorus fertilizer application was detected at four of the nine sites. Grain yield response appeared to plateau at somewhere between 45 and 60 lb P205/A on the responsive sites. Available soil P levels at these locations were all in the low range varying from 7 to 10.8 ppm P in the surface 6 inch.

Yield data from the four locations showing significant positive P responses was combined after a chi-square variance test indicated homogeneous variances over these locations. Regression analysis of the pooled yield data produced the response curve shown in Figure 1. The P fertilizer rate producing the point of maximim yield was calculated as follows:

P rate = (-0.332/ 2*(-0.0026)) = 63.8 lb P205/A

Using this same regression equation and assuming a $3.00/bu wheat price and $0.27/lb P205 P fertilizer, the P rate for maximum profit was determined by the following:

P rate = ($0.27/$3.00)-0.332 / 2*(-0.0026) = 46.5 lb P205/A

Using the same regression equation, the nomograph in Figure 2 is presented to aid in determining the maximum profitable P fertilization rate at various wheat and fertilizer prices. Note that Figure 2 is based on one year's data and applies to low or very low P testing soils only.

Phosphorus application method costs are compared in Table 4 in gallons of diesel fuel per acre. Dual N-P costs assume that the farmer will sweep three times for weeds and wheat with fertilizer applied with the last sweep operation. The Drill method includes three sweep operations with NH3 applied in the last pass and P banded at seeding. Broadcast P assumes phosphorus applied as a separate operation and NH3 applied with the last sweep operation.

TABLE 4 COSTS OF VARIOUS TILLAGE SYSTEMS 1/

Tillage System		Cost Gal. Diesel/A
Dual N-P Band		
	Harvest	1.38
	Sweep 2x	1.30
	Sweep + NH3 + APP	.65
	Disc	.70
	Drill	.35
	Insect - Herbicide	.20
	Total	4.58
Drill Band		
	Harvest	1.38
	Sweep 2x	1.30
	Sweep + N3	.65
	Disc	.70
	Drill	.35
	Insect - Herbicide	.20
	Total	4.58
Broadcast P		
	Harvest	1.38
	Sweep 2x	1.30
	Sweep + NH3	.65
	Broadcast P	.42
	Disc	.70
	Drill	.35
	Insect - Herbicide	.20
	Total	5.00

Sources
1/ Kuhlman (1977); Doane's Agri. Report (1985); Schrock (1985)

Costs are similar with both the Dual N-P and Drill methods, however, considerable time is saved at planting with the Dual N-P method as the fertilizers are applied with a tillage operation. Broadcast P may save farmer time if the P is custom applied, however, there is a large volume of data that shows there could be some agronomic advantages to N and P applied in a dual band compared to broadcast P alone on soils testing low or very low.

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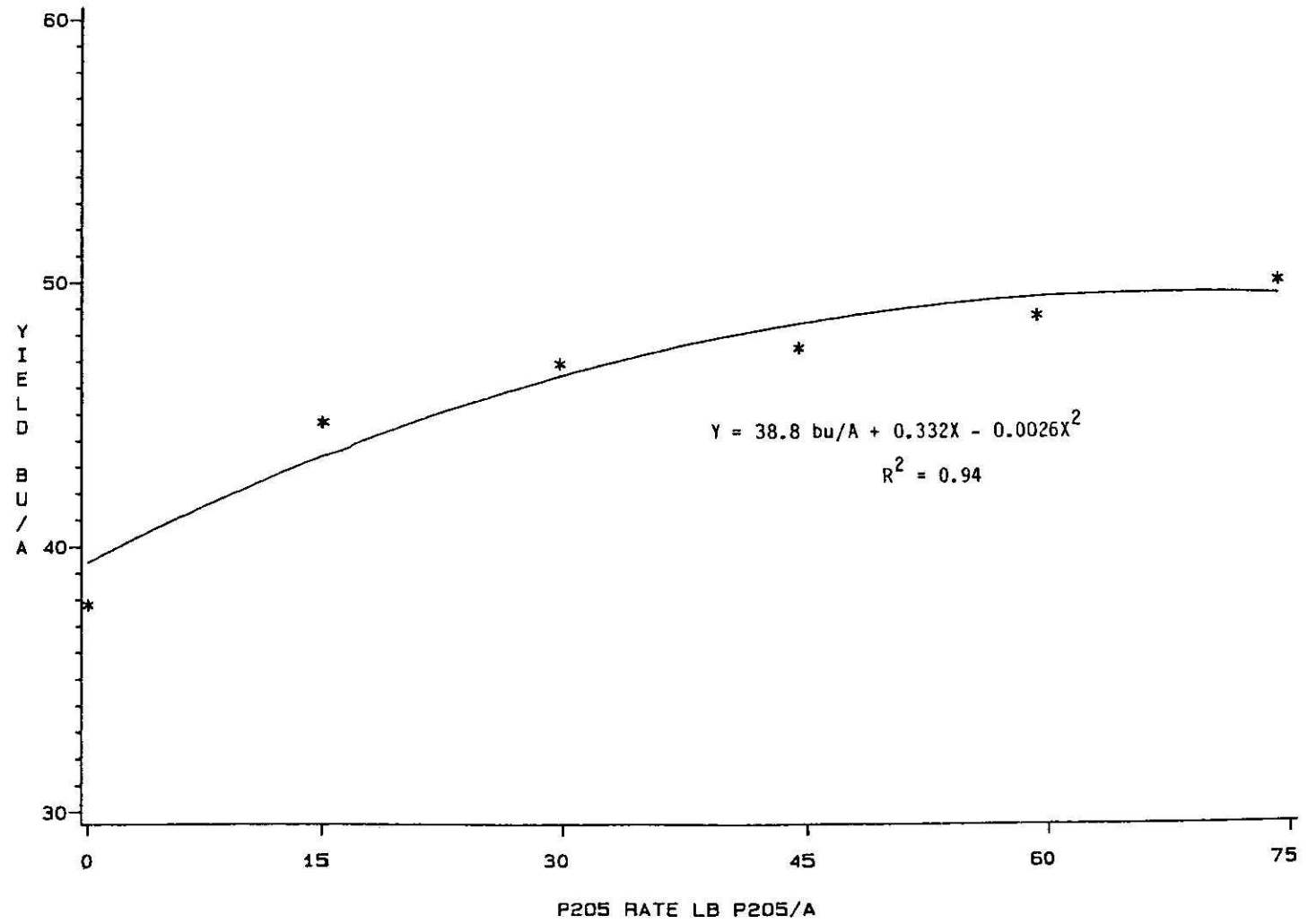

Figure 1. Regression of Pooled Yield Data From Sites at Kit Carson County, CO; Ford, Greeley, and Wallace County, KS, on P_2O_5 Rate Applied

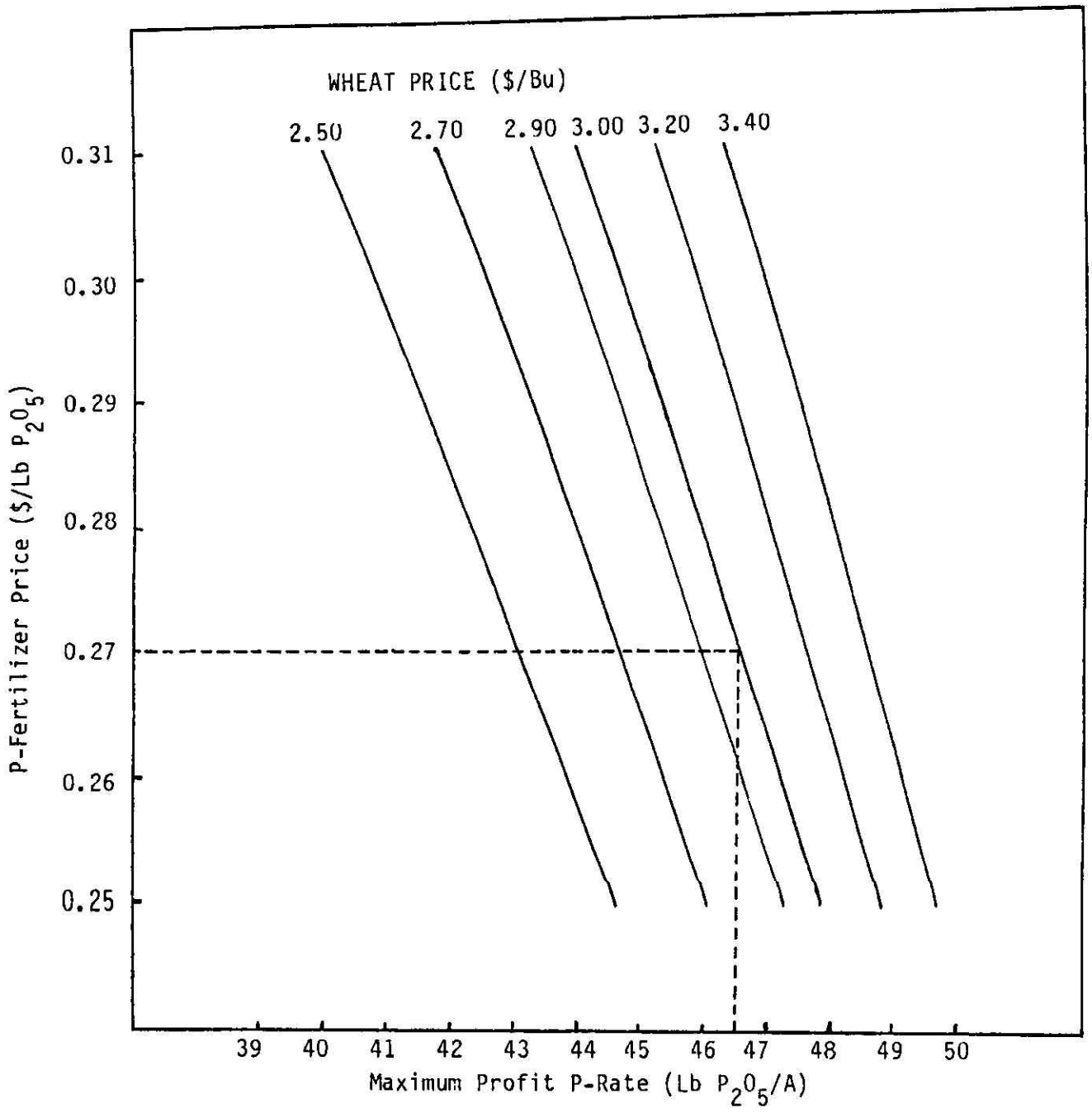

Figure 2. Nomograph of Maximum Profitable P-Fertilizer Rate at Various Wheat and Fertilizer Prices