Annual Report for Potash & Phosphate Institute (PPI)/Potash & Phosphate Institute of Canada (PPIC) and Foundation for Agronomic Research (FAR)

Title: Variable-rate Phosphorus Fertilizer Applications for Irrigated Cotton in the Southern High Plains

Location: Lamesa and Ropesville, TX

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Summary: Site-specific farming approaches, like variable-rate fertilization, can in theory mean greater use-efficiency of inputs on fields that are spatially non-uniform. However, little systematic testing of variable-rate technologies (VRT) have been done with cotton in the Texas High Plains. The objectives, therefore, of this study were to compare variable-rate P fertilization, with conventional, blanket-rate applications of P at two irrigated cotton sites in the Southern High Plains. Half-acre grid, GPS-referenced soil samples were taken in the spring of 2000 at 30-acre sites in Ropesville and Lamesa, TX. Three complete blocks contained plots which were 16, 40-in. rows wide and which varied in length from 1800 to 3200 feet. Hand-harvesting of 0.002 acre was done at each of the 60 grid-points at each site and at Lamesa a stripper harvester fitted with Micro-Trak® optical yield monitoring system was used. The rate VRT-P applied was slightly less and more than the P blanket-rate at Ropesville and Lamesa, respectively. At Ropesville, P response was observed with VRT-P only and on Amarillo soil at Ropesville but not on the calcareous Portales soil. Phosphorus response at Lamesa was only observed with Micro-Trak® yield-monitored data and not with hand-picking. Elevation/landscape position affected yields at Lamesa and was observed by hand-picking and by Micro-Trak®, and could delineate future management zones. Preliminary cost and returns analysis showed $ 11 to $ 24 returns/ac with VRT-P.

Methods:

Experimental Design:	Randomized complete block with 3 replications
Plot size:	53 ft wide (16 40-inch rows) and from 1800 to 3200 ft long.
Experimental area:	27 ac at Lamesa and 27 ac at Ropesville
Soil type:	Amarillo sandy loam to sandy clay loam
Variety:	Paymaster Roundup® Ready 2326
Soil sampling:	Half-ac grid (Fig.1 and 2)
P fertilizer rate:	Blanket-rate of 30 lb P_2O_5/ac at Lamesa and 45 lb P_2O_5/ac at Ropesville. Variable P rates: 8 – 48 lb P_2O_5/ac at Lamesa and 32 - 49 lb P_2O_5/ac at Ropesville
Planting date:	May 10, 2000 at Lamesa and May 6, 2000 at Ropesville
Harvest date:	October 4, 2000 at Lamesa and October 2, 2000 at Ropesville
Irrigation:	LEPA on a 3.5 day schedule at 75% estimated cotton ET replacement

Results:

Cotton responded to P fertilizer in all three landscape positions of the precision agriculture site at Lamesa (Table 1). Historically, the greatest yields have been observed in the bottomslope where re-distribution of water and nutrients occurs. Variable-rate (VRT) and blanket-rate resulted in lint yields greater than zero-P in both sideslopes. In the bottomslope, only the variable-rate treatment affected lint yields. The south-facing sideslope had the lowest lint yields in 2000. This may be due to the greater amount of blowing observed there and to faster soil water evaporation. The Micro-Trak® yield data was less variable than the hand-picked lint data and only the machine data showed P fertilizer response (Table 1 and 2).

At Ropesville, P response was not observed in the calcareous Portales soil but was evident in the Amarillo soil. On average, however there was no difference in lint yield between the two soil types. Presumably in the Portales soil applied P fertilizer was adsorbed on $CaCO_3$ or precipitated out as a calcium phosphate. Phosphoric acid (18-0-0) was the P source used in this study, which visually strongly with the soil on the Portales soil at Ropesville, but not with the Amarillo soil at either site. Next season, we plant to use ammonium polyphosphate (10-34-0) as the P source, and to use urea ammonium nitrate (32-0-0) to "make-up" a constant N rate.

Preliminary cost and returns economic analysis of the VRT P applications is shown in Table 3. This analysis does not consider the greater cost of grid-soil sampling or of VRT equipment. The

Fig. 1. Half-acre grid soil sampling locations and Mehlich-3 P, AGCARES, Lamesa, TX 2000

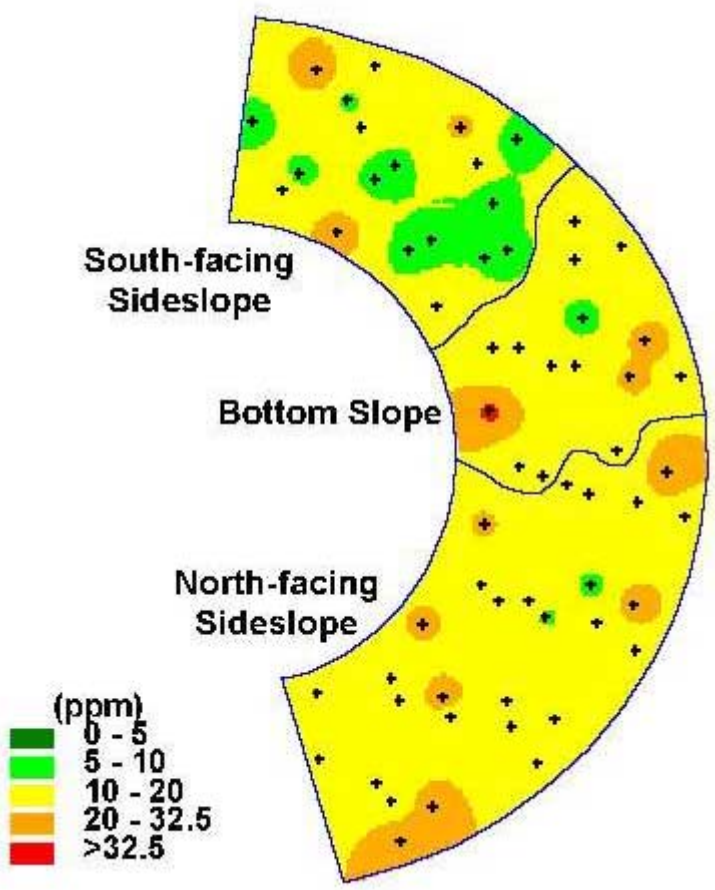


Fig. 2. Variable-rate inputs experimental layout and P fertilizer rates applied (V = VRT, B=blanket-rate, Z=zero-P), AGCARES, Lamesa, TX 2000

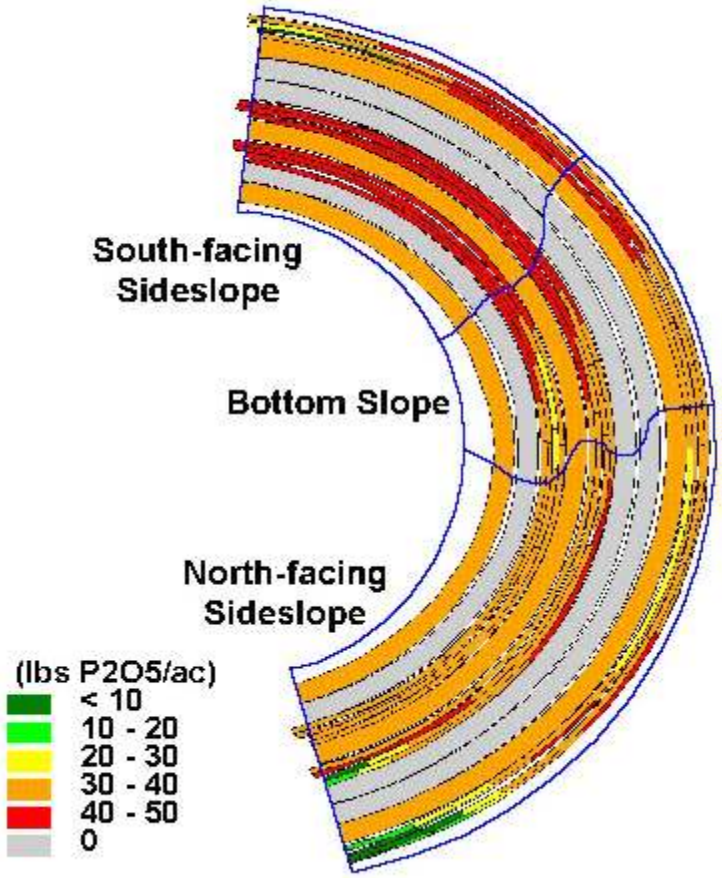


Fig. 3. Half-acre grid soil sampling locations and Mehlich-3 P, Ropesville, TX 2000

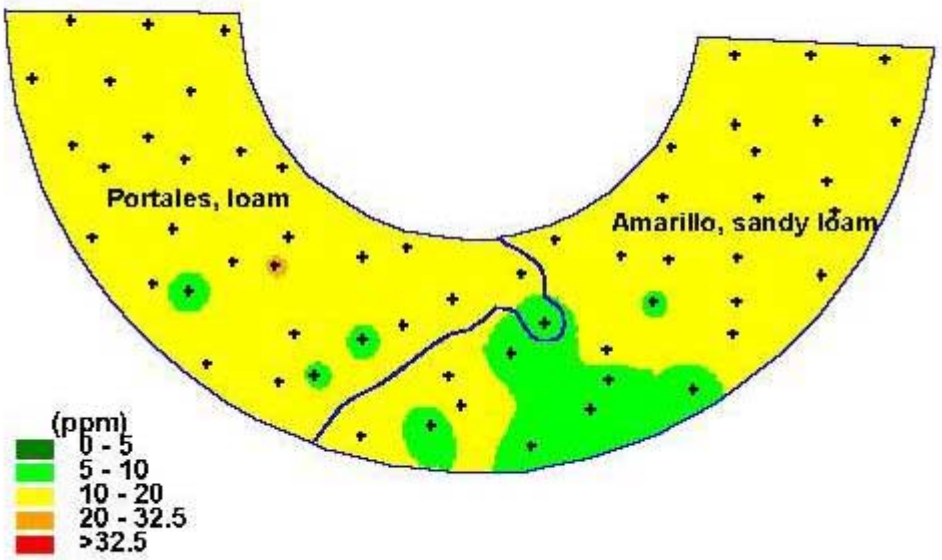
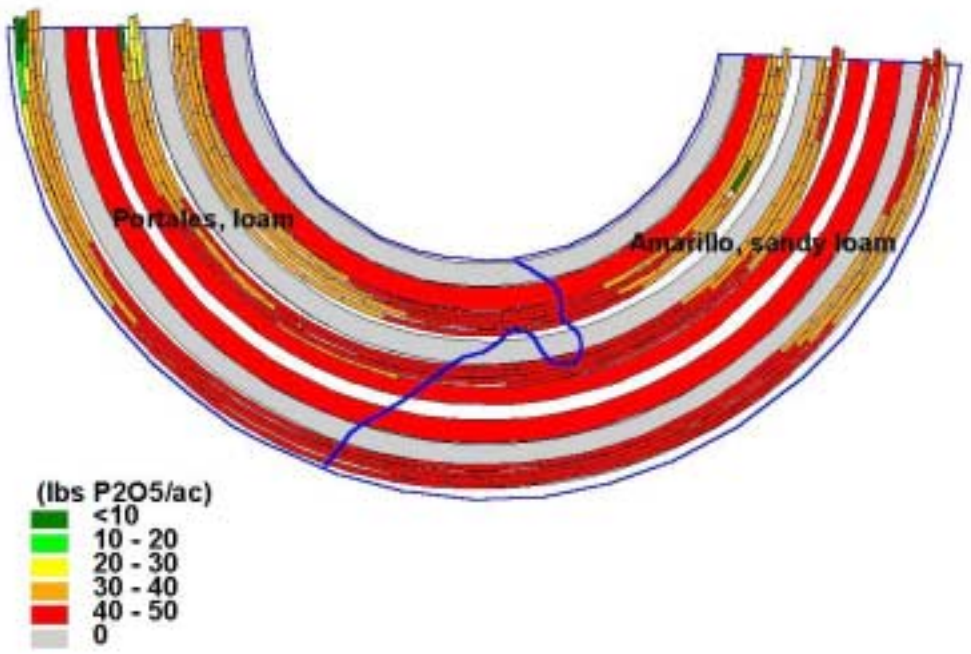


Fig. 4. Variable-rate inputs experimental layout and P fertilizer rates applied (V = VRT, B=blanket-rate, Z=zero-P), Ropesville, TX 2000



average P fertilizer rate applied in the VRT plots was 38 lb P_2O_5/ac, compared to 30 lb P_2O_5/ac in the blanket-rate plots. Although statistically there was no difference between the VRT-P and blanket-P treatments we did this analysis by calculating a "return to P fertilizer" for each. This preliminary analysis indicates that up to $24/ac return of VRT-P is possible. Lower returns were observed at Ropesville, probably because nearly half of the area did not respond to P. It cost us about $10,000 to retro-fit our liquid fertilizer rig to apply variable-rate. Depending on acres farmed, it may take only a few years before a producer starts saving money on P fertilizer using the VRT approach. The two soil types at Ropesville and the three landscape positions at Lamesa are candidates for "zone sampling". Hopefully on a modest number of soil samples will be need to be taken annually in each zone, and after composting the number of soil analyses at a commercial or state laboratory would only equal to number of zones sampled.

Table 1. Micro-Trak® cotton lint yields (lb/ac) for variable-rate, blanket-rate and zero-rate P fertilizer application, Lamesa, TX, 2000.

Treatment	P_2O_5 rate applied	North-facing sideslope	Bottom-slope	South-facing sideslope	Mean
Variable-rate P fertilizer	8.2 - 48.3	536 a[1]	590 a[1]	485 a[1]	537 a[1]
Blanket-rate P fertilizer	30	540 a	544 b	479 a	521 a
Zero P fertilizer	0	493 b	521 b	434 b	483 b
Mean		523 a[2]	552 a	466 b	

[1] Means in a column followed by similar letter are not different by pairwise comparisons, $p>0.05$

Table 2. Hand-picked cotton lint yields (lb/ac) for variable-rate, blanket-rate and zero-rate P fertilizer application, Lamesa, TX, 2000.

Treatment	P_2O_5 rate applied	North-facing sideslope	Bottom-slope	South-facing sideslope	Mean
Variable-rate P fertilizer	8.2 - 48.3	679 a[1]	759 a[1]	570 a[1]	670 a[1]
Blanket-rate P fertilizer	30	634 a	673 a	564 a	623 a
Zero P fertilizer	0	596 a	665 a	523 a	594 a
Mean		636 a[2]	699 a	552 b	

[1] Means in a column followed by similar letter are not different by pairwise comparisons, $p>0.05$
[2] Means in a row followed by similar letter are not different by pairwise comparisons, $p>0.05$

Table 3. Hand-picked cotton lint yields (lb/ac) for variable-rate, blanket-rate and zero-rate P fertilizer application, Ropesville, TX, 2000.

Treatment	P_2O_5 rate applied	Amarillo sandy loam	Portales clay loam	Mean
Variable-rate P fertilizer	32.4 – 49.4	663 a[1]	622 a[1]	643 a[1]
Blanket-rate P fertilizer	45	637a	606 a	622 a
Zero P fertilizer	0	537 a	607 a	572 a
Mean		613 a[2]	611 a	

[1] Means in a column followed by similar letter are not different by pairwise comparisons, p>0.05
[2] Means in a row followed by similar letter are not different by pairwise comparisons, p>0.05

Table 4. Input application rates and cost and returns of P applications, Ropesville and Lamesa, TX, 2000

	Ave rate of P (lb/ac)	Unit cost of P ($/lb)	Cost of input ($/ac)	VRT cost minus blanket-rate cost ($/ac)	Benefit of VRT with income from $0.60/lb cotton[1]
Treatments			Lamesa		
Variable-rate P	38.4	0.31	11.90	2.60	23.83
Blanket-rate P	30.0	0.31	9.30		
Zero rate	0	0.31	0		
			Ropesville		
Variable-rate P	41.9	0.31	12.99	-0.96	11.15
Blanket-rate P	45.0	0.31	13.95		

[1] Does not consider capital costs of variable-rate application equipment or the greater cost of 0.5-ac grid soil sampling and laboratory analysis for the VRT treatments.