Corn Yield Response to Phosphorus Fertilization in the Southeastern Pampas

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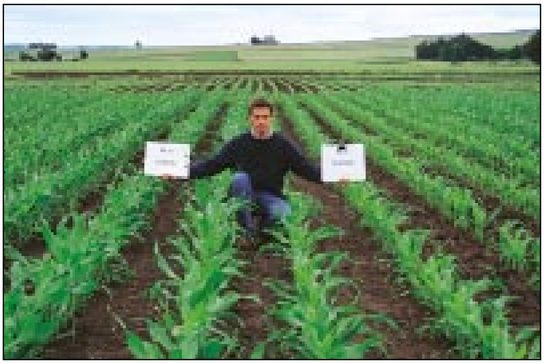
Corn is a major crop in agricultural systems of the southern Pampas of Argentina where soils are low in phosphorus (P) availability. This research suggests a critical soil P level that can help define where profitable responses to P application are obtainable.

The southeastern area of Buenos Aires province in the Argentinean Pampas is characterized by its low soil P availability. Several studies have quantified the effects of P fertilization on the production of pastures (Arosteguy and Gardner, 1978; Berardo and Marino, 1993), as well as grain crops, mainly wheat (Berardo, 1994). Previous research has reported grain yield responses of 1,500 and 500 kg/ha for corn with soil P levels (Bray P-1) of 6 to 7 and 15 to 16 mg/kg, respectively (Darwich, 1984; García et al., 1997). Further information is needed because of the continuous changes in crop management technologies, higher grain yields, and the recent intensification of row crop agriculture. This study evaluated corn yield response to P fertilization in soils of varying Bray P-1 levels generated through previous P application.



On soil with a Bray P-1 level of 8 mg/kg, corn fertilized with P (at left) shows growth response compared to the check treatment at right without P.

Materials and Methods

Research was carried out during the 1997/98 and 1999/00 growing seasons at the Balcarce Experimental Unit of the National Institute of Agricultural Technology (INTA) and the Faculty of Agricultural Sciences (UNMdP). The soil was a typic Argiudoll with an organic matter content of 5.8 percent and pH of 5.9. Treatments were set as a split-plot arrangement in a randomized complete block design with three replications. Main treatments were soil P levels, varying from 5 to 26 mg/kg (Bray P-1). Sub treatments were P fertilization levels (check and 22 kg P/ha). Phosphorus was applied at planting and was banded below the seed as triple superphosphate (0-46-0). Urea was applied at a rate of 120 kg N/ha at planting to avoid N shortages. Corn, cv. Dekalb

Table 1. Soil water availability (SWA) at planting up to a depth of 1 m, monthly precipitation (MP), irrigation (I), and total available water (TAW: SWA+MP+I) during the 1997/98 and 1999/00 growing seasons.

Month	SWA	MP + (I) October	November	December	January	February	March	TAW
	mm							
Dryland 97/98	68	88	109	86	124	50	24	569
Dryland 99/00	74	66	50	66	122	224	34	636
Irrigated 99/00	74	66	50	66+(135)	122+(60)	224	34	831

639, was planted in the first week of October at a density of 70,000 seeds/ha in both seasons. Experiments were conducted under dryland conditions in 1997/98, and under dryland conditions with supplementary irrigation in 1999/00. Soil water availability to a depth of 1 m was determined at planting. Precipitation during the growing period is shown in **Table 1**.

Results and Discussion

Dryland corn yields and yield responses to P fertilization were higher in 1997/98 than in 1999/00 because of higher precipitation during critical crop stages (pre-tasseling to silking) and lower temperatures during early vegetative stages. Supplementary irrigation resulted in significantly higher yields in 1999/00. Check grain yields increased with soil P levels in both years. The following linear regressions between check yields and soil P (Ps) levels were determined:

1997/98 - Dryland	Yield=6,521+74 Ps	r^2 =0.43
1999/00 - Dryland	Yield=5,450+88 Ps	r^2 =0.70
1999/00 - Irrigated	Yield=7,614+195 Ps	r^2 =0.82

Corn yield increased by 74 to 88 kg/ha per unit of Ps under dryland conditions. The response was 2.2 to 2.6 times greater with supplementary irrigation. Yield response to P fertilization was dependent on Ps levels and varied between 700 and 1,300 kg/ha in 1997/98 and 100 to 1,100 kg/ha and 450 to 2,400 kg/ha for dryland and irrigated treatments in 1999/00, respectively. Corn yield response to P fertilization decreased linearly as Ps levels increased according to the following regressions:

1997/98 - Dryland	Yield response=1,311-31 Ps	r^2=0.47
1999/00 - Dryland	Yield response=1,594-77 Ps	r^2=0.98
1999/00 - Irrigated	Yield response=3,347-151 Ps	r^2=0.97

Regressions for expected yield responses in all three experiments allow estimation of critical Ps levels (**Table 2**). Data are also included from 26 experimental field sites conducted between 1991 and 1997 in the southeastern region (García et al., 1997). The desired yield response could be decided as a function of grain and fertilizer prices. Considering Argentina prices of US$1.50/kg P and US$0.065/kg corn (as of October 2000, all discounts for commercialization included), an application of 22 kg P/ha, the rate used in these experiments, cost approximately 510 kg corn/ha. Thus, averaging results from all experimental data, P fertilization produced a profitable margin in soils testing less than 17 mg/kg Bray P-1.

Table 2. Estimated soil P critical levels for different corn yield responses found in three most recent experiments as well as in previously conducted research (García et al., 1997).

Yield response kg/ha	1997/98 Dryland	1999/00 Dryland	1999/00 Irrigated	Garcia et al. (1997)	Average
	Estimated soil P critical levels, mg/kg				
300	33	17	20	26	24
400	30	16	20	22	22
500	26	14	19	17	19
600	23	13	18	13	17
700	20	12	18	8	15

Conclusions

Corn yield and yield response to P fertilization were highly related to soil P and water availability during the growing season. Data from this study along with previous research indicate corn P fertilization can result in profitable margins in soils testing less than 17 mg/kg Bray P-1. **BCI**

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