China

Nutrient Balance in a Long-Term Fertilizer Trial in a Red Soil of Yunnan

By Dai Rongshu and Hong Lifang

A 14-year (1978-91) experiment conducted on a low yielding, red, acid soil in Yunnan Province, China, clearly demonstrates the role of balanced fertilization in manure-based fertilizer systems. Nitrogen (N), phosphorus (P), potassium (K) and farm manure were applied in various treatments to compare response.

SPRING GROWN CORN rotated to fallow or a green manure crop was fertilized with either 1) 30 t/ha farm manure and 135 to 150 kg P_2O_5 (MP), 2) 135 kg P_2O_5 (P), 3) 30 t/ha farm manure (M), or 4) no nutrients, check (CK). The manure and P fertilizer (single superphosphate) were applied as basal dressings at the time when corn seedlings were planted. All plots received 200 kg N/ha. During years 7 through 14, each treatment was split with one-half receiving 150 to 210 kg K_2O/ha as K_2SO_4 and the other half receiving no potash.

Phosphorus data in **Table 1** show that a significant P deficiency existed in this red, acid soil. Statistical analysis of the data indicate that the order of P availability for the four treatments was P>MP>M>CK. The data also indicate that with continual use of P fertilizers soil-P levels were improved. When only manure or no fertilizer was applied, levels of soil-P remained low.

Table 1. Soil nutrient status after 14 years of treatment based on nutrient input/output studies.

	Soil nutrient status at year 14, kg/ha		
Treatment	N	P_2O_5	K_2O
MP	-	surplus	-70
P	-	1,416	-279
M	surplus	-123	surplus
CK[1]	surplus	-22	surplus

[1]Few grain produced on the ears.

Potassium data in **Table 1** reveal the dynamic interaction of P fertilizers on the availability of soil K. The availability of soil K was found to be lowest in the MP and P treatment plots, less than half the soil K content in the CK treatment. However, soil-K levels were highest in the manure treatment. In general, the availability of soil-K among the treatments is ranked as M>CK>MP>P. The reasons relate to nutrient input and nutrient export from the field according to the yield achieved.

The important finding is that after eight successive years of applying P fertilizers, K became very limiting. Long-term, large (30 t/ha) applications of farm manure

Table 2. Average P and K content of corn plants during the final six-year period.

Nutrient	Plant part	Farm manure and P fertilizer	P fertilizer only	Farm manure only
P,%	Grain	0.216	0.235	0.187
	Stem	0.033	0.049	0.025
	Leaf	0.087	0.107	0.088
K,%	Grain	0.33	0.35	0.32
	Stem	1.01	0.42	1.43
	Leaf	1.09	0.48	1.65

Note: Growth in the CK treatment was poor, resulting in abnormal P and K contents. Thus this treatment was eliminated from the comparison.

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could only partially alleviate the K deficiency. Balanced fertilization practice through the application of both P and K fertilizers is essential for maintaining productive soils, even when farm manures are applied.

The P and K content of grain, stem and leaf tissue determinations during the final five-year period of the study are shown in **Table 2.**

The data indicate adequate P supply and availability to corn only when P fertilizers or P-enriched manures were applied. Data support the findings in **Table 1** and as indicated by the amount of growth the corn achieved under the various fertility treatments.

In the last year of the trial, leaf and stem tissue K contents of PK-fertilized corn were 1.11 percent and 0.59 percent, respectively. When P fertilizers were applied without K, the K content of leaves and stems declined dramatically to 0.19 percent and 0.21 percent, respectively.

Long-term effects of unbalanced fertilization practices on corn yields are depicted in **Figure 1** for the MP, P and M treatments. Corn receiving annual applications of 30 t/ha farm manure produced low but slightly increasing grain yields because both P and K supply were insufficient. The addition of P fertilizers initially increased yields between the years 1978-1985, but from 1986-1991 yield gradually decreased because of K deficiency resulting from the earlier high yields depleting soil K levels. The MP treatment produced significantly superior yields that became increasingly higher with time. To further explain the need for balanced fertilization, the CK plots which received only N

THE CHECK treatment (foreground) had poor growth of corn. While manure plus P plots were better, balanced fertilization including K produced the best results.

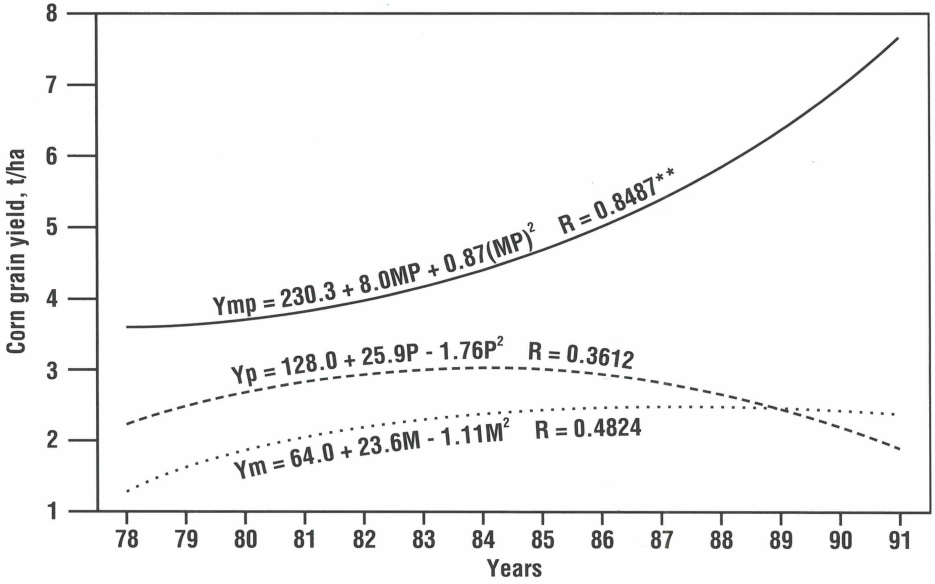


Figure 1. Dynamic curves of corn yield at a long-term location experiment in red soil.

fertilizer produced yields ranging from 60 to 435 kg/ha until 1984, with no yields in the subsequent years.

Potash additions to the long-term P treatments increased yields by an average of 189 kg/ha. Although yield response was not large, statistical analysis of the yield trend shows that with potash additions, the slope of the yield curve was positive (+31.4) compared to a negative slope (-19.4) when no potash was applied. The addition of potash resulted in progressively higher yields.

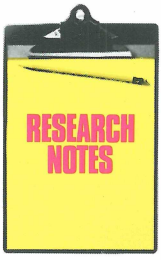
CORN in both plots shown here had P applied. The difference is that the plot at right received K while the one on the left received none.

Similarly, M only for corn did not supply sufficient P, resulting in low and declining yields. The addition of P to the manure increased yields by 2,505 kg/ha and approximately doubled the grain yield.

This long-term experiment has shown that soil fertility and the productive capacity of red, acid soils can be improved by a balanced fertilization program using P and K fertilizers with farm manures. ■

Central America

Regional Corn Grain Yield Response to Applied Phosphorus in Central America



YIELD RESPONSE to phosphorus (P) source, rate and method of application was measured at 33 Central America locations and on three soil orders (Andisols, Inceptisols and Ultisols). Phosphate rock (PR) was applied broadcast preplant without incorporation at rates of 13 and 26 kg/ha. Triple superphosphate (TSP) was band-applied at planting at rates of 13 and 26 kg/ha and broadcast preplant at 26 kg/ha. The previous three treatments were compared to plots where no P was applied.

Averaged over locations, corn grain yield responses to TSP were 380 and 740 kg/ha at application rates of 13 and 26 kg P/ha, respectively. Responses to broadcast PR were 210 and 160 kg/ha at the same rates.

Researchers concluded that the consistent response to P shows that soil P is a yield-limiting factor across a wide range of environments in Central America. The probability of an economic response to applied P is high. ■

Source: William R. Raun and Hector J. Barreto. 1995. Agronomy Journal 87:208-213.