

# Better Crops

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# International



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**Phosphorus and Sulfur Fertilization of Corn in the Northern Pampas (Argentina)**

**Corn Response to Potassium in Liaoning Province (China)**

**Fertilization of Plantain in High Densities (Colombia)**

**and much more...**

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**Our Cover:** Photos from various articles in this issue appear on the front page, representing the diversity of crops and regions where research programs are in progress.

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# Phosphorus and Sulfur Fertilization of Corn in the Northern Pampas

By Hugo Fontanetto, Oscar Keller, Rubén Inwinkelried, Norberto Citroni, and Fernando García

**Research shows that higher phosphorus (P) rates are needed for high yielding corn in the northern Pampas of Argentina. Sulfur (S) responses are significant in intensively cropped soils.**

This study evaluated the effect of S fertilization on corn yields and its interaction with P fertilization under no-tillage in central Santa Fe province.

Nitrogen (N) and P are commonly deficient for crop production in this area of the country. Preliminary work indicated that S may also be deficient in these soils. High crop yields and intense row crop production have decreased native soil fertility because rates of nutrient extraction are usually higher than nutrient application. Although P deficiency has been recognized in the area, P application rates are usually low. It is also expected that responses to S could generate higher demands for nutrients such as P.

Sulfur, essential for plant growth and development, is considered a secondary nutrient because it is generally required in lower amounts than N, P, and potassium (K). Most of the S in soil is in organic form. Thus, decreases in soil organic matter will lower S availability. High yield production systems that sustain soil organic matter content and fertilizer management practices which replace S and other nutrients removed in the grain and stover are critical to maintaining efficient cropping systems.

## Materials and Methods

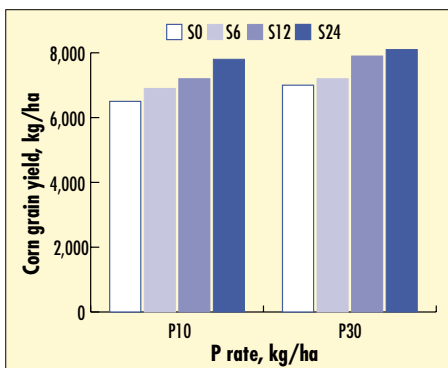
A field experiment was established at San Carlos, Santa Fe, an area with an intense cropping history and reported responses to N and P in crops such as corn, wheat and grain sorghum.

Corn, *cv. Tilcara*, was planted September 9, 1998 at a density of 62,000 seeds/ha in 70 cm rows. Soybean was the previous crop. At planting, the soil contained 3.0 percent organic matter, 0.16 percent total N, 6.8 parts per million (ppm) nitrate-N ( $\text{NO}_3\text{-N}$ ), 19.4 ppm P (Bray-1), 7.0 ppm sulfate-S ( $\text{SO}_4\text{-S}$ ), and had a pH of 6.2. Available soil water was 82 mm, and 612 mm of precipitation fell between August 1998 and March 1999.

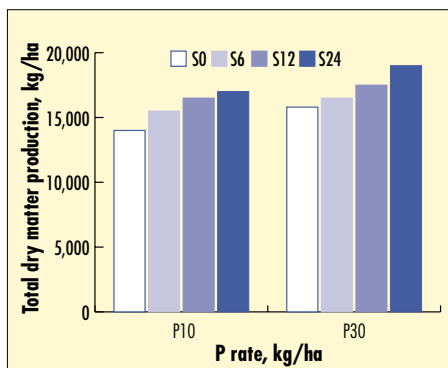
Treatments included two P rates: 10 kg P/ha (P10), the rate generally used in the area, and 30 kg P/ha (P30), a replacement rate based on expected



Experimental corn trial in vegetative stages, San Carlos, Santa Fe.



**Figure 1.** Grain yield for the different P and S combinations at San Carlos, Santa Fe. Tukey value (5%) 301 kg/ha; CV 9%.



**Figure 2.** Dry matter production at harvest at San Carlos, Santa Fe. Tukey value (5%) 545 kg/ha; CV 11%.

corn yield. Phosphorus rates were combined with four S rates: 0, 6, 12, and 24 kg/ha (S0, S6, S12, S24), in a factorial arrangement. The experiment used small plots (3.5 x 10 m) in a randomized complete block design with three replications. Phosphorus was applied as triple superphosphate (TSP), S as ammonium sulfate [(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>]. Calcium nitrate [Ca(NO<sub>3</sub>)<sub>2</sub>] was used to bring the N rate of all treatments up to 90 kg/ha.

### Results and Discussion

Phosphorus and S fertilization significantly increased grain yields and total dry matter production at harvest. The highest values for both variables were observed with the 30 kg P/ha and 24 kg S/ha rates. There was no interaction between P and S for either grain yield or dry matter (Figures 1 and 2). The harvest index (grain yield/total dry matter production) averaged 0.45 and was not affected by P or S fertilization.

Grain yield response to S fertilization was 67, 69, and 48 kg per kg S applied for the S6, S12, and S24 rates, respectively. Such a response may be expected from the lower levels of soil SO<sub>4</sub>-S at planting and the previous history of intense cropping that could decrease labile organic S pools. Average response to P was 26 kg grain per kg of P. This response was significant even though soil test P was medium to high, indicating that higher rates than normal should be considered for a sustainable and profitable corn production system.

The use of low P rates results in soil P losses. In this experiment, it is estimated that 20 kg P was removed by the 6,500 kg/ha grain produced by the P10 and S0 treatment. Thus, a soil P loss of 10 kg was generated. Application of 30 kg P contributed to soil P buildup even with high yields; an extraction of 24 kg P in grain was estimated for the P30 and S24 treatment (8,160 kg/ha).

### Economic Analysis

The net margin for the different P and S combinations was estimated



Experimental corn trial during grain filling, San Carlos, Santa Fe.

from nutrient and crop prices, nutrient rates, and yield responses. The calculation assumed Argentina prices as of December 1999: US\$1.50/kg P, US\$0.89/kg S, and US\$0.06/kg corn (includes all discounts for commercialization).

Net margin increased with the increase in P and S rates (Figure 3). The highest net profit was obtained with the P30 and S24 combination. The increase in grain yield will also result in a lower impact from other costs (for example, land, seed, tillage operations, herbicides, insecticides, etc.), and thus higher profits.

### Conclusion

This study has shown that with any high yielding crop, the use of low P rates results not only in soil P losses but also in decreased profitability. Results also encourage fertilization studies with S. Future research should determine guidelines to predict S deficiencies. Ongoing field experiments at other locations of the Pampean region of Argentina indicate a weak relationship between soil SO<sub>4</sub>-S availability at planting and S fertilization response. **BCI**

*Hugo Fontanetto and Oscar Keller are research agronomist and extension agent, respectively, with EEA INTA Rafaela, CC 22, (2300) Rafaela, Santa Fe, Argentina; e-mail: hfontanetto@inta.gov.ar. Rubén Inwinkelfried and Norberto Citroni are private consultants based at Rafaela, Santa Fe, Argentina. Fernando García is Director, Latin America, Southern Cone, PPI/PPIC (INPOFOS), Av. Santa Fe 910, (B1641ABO) Acassuso, Argentina, e-mail: fgarcia@ppi-ppic.org.*

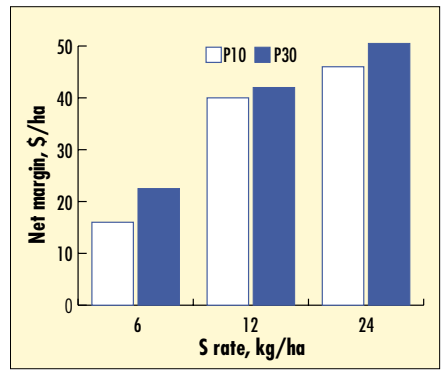
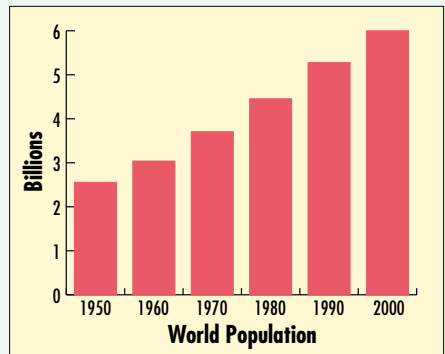


Figure 3. Net margin for the P and S treatments evaluated in the experiment at San Carlos, Santa Fe.

## World Population Reaches 6 Billion

The world's population increased to over 6 billion people on October 12, 1999, according to the United Nations. While the population growth appears to be slowing, it is still adding more than twice as many people as were added annually at the middle of the 20th century.

In 1950, world population reached a total of 2.56 billion. The graph shown here tracks the number at each decade since then. While tremendous progress in food and fiber production has eased concerns in many areas of the world, the challenge of improving practices and developing more efficient crop and soil management systems continues. **BCI**





# Corn Response to Potassium in Liaoning Province

By Y. Lei, B. Zhang, M. Zhang, K. Zhao, W. Qio, and X. Wang

**Corn is an important crop to the northern province of Liaoning. Approximately 1.4 million hectares (M ha), or 47 percent of the province's total cultivated area, is planted to corn. Recent production has been as high as 9.9 million tonnes (M t), or 58 percent of the total cereal crop produced. The introduction of improved crop varieties and increased availability and use of nitrogen (N) and phosphorus (P) fertilizers were key factors in improving yields and production, but these practices also depleted soil potassium (K). This study emphasizes the need for high levels of available soil K throughout the corn-growing season.**

Liaoning province has made good progress in increasing availability of mineral fertilizer, but crop yields stagnated as a result of unbalanced fertilization with respect to K. In efforts to maximize crop yields during the period from 1978 to 1990, the province rapidly increased N and P use from 1.47 and 0.57 to 1.97 and 0.74 M t, respectively. However, at the same time, K use increased only from 14,000 to 25,000 t. Problems associated with soil K deficiency are becoming more widespread throughout the province.



Mr. Y. Lei (at left) is shown at maximum yield research trial in Liaoning province.

The Canpotex/PPIC Balanced Fertilization Demonstration Program was initiated by the Soil and Fertilizer Institute of the Liaoning Academy of Agricultural Sciences to resolve this problem. Results indicate that judicious use of K improves N and P fertilizer use efficiency while providing farmers better profit opportunities.

## Effect of Fertilizer K on K Uptake and Corn Yield

The field experiment, conducted on a meadow soil, used three rates of K (0, 112.5 and 225 kg  $K_2O$ /ha) applied along with constant rates of 300 kg N/ha and 150 kg  $P_2O_5$ /ha. A control treatment with no fertilizer was also included.

Grain yields from K and zero-K treatments were significantly different. Comparing NPK treatments with the control and NP treatment, respectively, average increases in grain yield ranged between 17.3 and 23.2 percent with 112.5 kg  $K_2O$ /ha, and 20.1 to 26.2 percent with 225 kg  $K_2O$ /ha (Table 1).

**Table 1.** Corn yield response to fertilizer K, K concentration by corn, and soil K status, Liaoning.

Fertilizer treatment	Grain yield, t/ha	K concentration, %			Available soil K		Slowly available K	
		-----K concentration, %-----			0-20 cm	20-40 cm	0-20 cm	20-40 cm
		Grain	Stem	Leaf	----- mg K/100 g soil -----			
Control (CK)	7.71b	0.2172	0.75	0.68	9.8	8.8	60.6	60.0
NP	8.10b	0.2169	0.81	0.86	9.4	8.3	61.5	60.8
NPK1	9.50a	0.2122	0.86	0.72	8.8	8.5	59.8	58.1
NPK2	9.73a	0.2154	1.41	1.02	12.4	9.2	61.2	59.1

\*Yields followed by different letters are significantly different at the 5 percent level.

Potassium concentrations in the corn stem and leaves were related to the respective fertilizer treatments (Table 1). Potassium concentrations in plant stems and leaves increased with K application rates. The highest rate of K increased the K concentration in the stem to almost double the level found with the control. Despite this, grain K concentration did not appear to be related to K application rates. Data also indicated that stem K concentration was 3.5 to 6.5 times greater than levels found in grain.

The product of yield and K concentration in the harvested portion determines K removal. Therefore, adequate K fertilizer rates required for maintaining soil K levels are related to the amounts of K removed from the field. This experiment points to the importance of returning crop residue to the corn field in order to maintain soil K fertility.

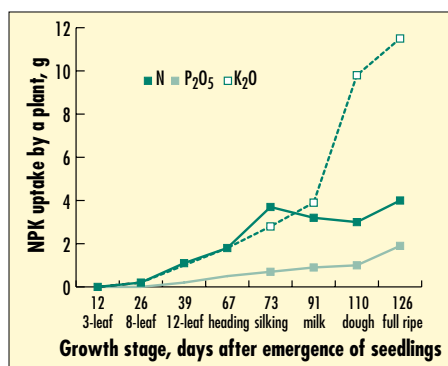
### Available and Slowly Available Soil K

Soil K status in the 0 to 20 cm and 20 to 40 cm depths shows available K to be highest in the treatment with the highest rate of K application, reflecting the amount of applied K (Table 1). Available K was lower in the NP treatment than in the control, which may be reflecting the effect of crop removal since corn yield was higher in the NP treatment than in the control. Similarly, the first addition of K (NPK1) further increased yields and K removal, thereby lowering available K. The higher K addition (NPK2) increased yields above the NPK1 level, but sustained good available K rates. Changes in slowly available K within the two soil depth positions and amongst treatments were not significant. This underscores how difficult it is to affect soil K levels at depth through short-term K fertilizer applications.

### Nutrient Uptake by Corn

To characterize N, P and K uptake by corn in Liaoning province during various plant growth stages, plant samples were taken throughout the growing period and analyzed. The results are presented (Figure 1).

Plant uptake of N, P and K increased throughout the growth period. The three nutrients reached their highest accumulated level at the ‘full



**Figure 1.** NPK uptake by corn during various physiological stages, Liaoning, China.



Mr. Y. Lei at corn field in Liaoning.

ripe' (mature) stage. At this stage, the aerial portion of each corn plant had accumulated 3.9 g N, 1.65 g P<sub>2</sub>O<sub>5</sub>, and 11.1 g K<sub>2</sub>O. The ratio of NPK uptake was approximately 1:0.42:2.85, showing the high K requirement of corn.

Peak N uptake occurred between the heading and silking stages. The amount of N uptake during this period was 46.4 percent of the total N accumulated and averaged 0.3 g N/plant/day. Peak P uptake occurred between the milk and full ripe stages, was 65.4 percent of the total P accumulated, and averaged 0.03 g P<sub>2</sub>O<sub>5</sub>/plant/day. Peak K uptake occurred between the milk and dough stages, was 68.6 percent of the total K accumulated, and averaged 0.4 g K<sub>2</sub>O/plant/day.

These data clearly demonstrate the need for adequate levels of N, P and K to be available to the crop throughout its growing period. This in turn requires adequate application of mineral fertilizers to ensure these needs are met.

### Potassium Uptake by Corn as Influenced by K Application

The K absorption pattern in corn was influenced by fertilizer treatments (Figure 2). Fertilization with N and P stimulated K uptake by corn, but the addition of K to the NP treatment further enhanced K uptake and increased both dry matter and yield of the corn crop. Potash application made more K available for crop absorption.

### Seasonal Variation of Available Soil K

Available soil K was influenced by fertilizer treatment, corn growth, and seasonal changes (Figure 3). In the control, change in available K was relatively small, varying between 12.4 and 15.6 mg K/100 g soil, with the highest value appearing on July 26. The NP treatment showed a similar trend as higher temperatures and abundant rains in July appeared to affect soil K release. However, the pattern of available soil K was different in the balanced NPK treatment. It ranged from 9.4 to 22.4 mg K/100 g soil, with the highest value occurring before July 20. Available soil K in the NPK treatment after July 20 was actually lower than either the control or NP treatments. This difference may be due to higher corn growth under balanced fertilization, creating greater nutrient uptake after July 20, thus reducing available soil K levels.

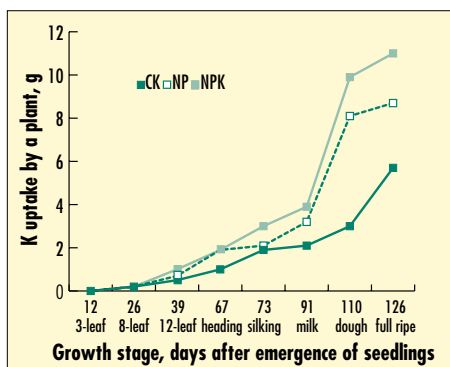


Figure 2. Effect of fertilizer application on K uptake by corn during various physiological stages, Liaoning, China.

### Conclusions

Potash increased corn yield significantly, by 17 to 20 percent, when compared with the NP treatment. Corn has a large K requirement under

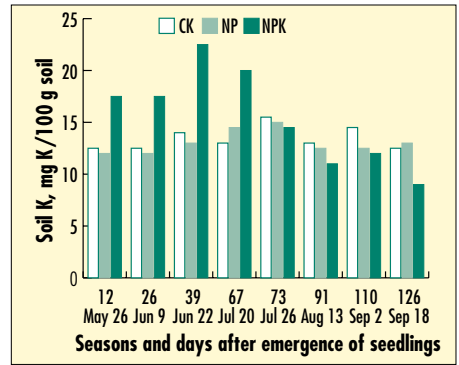


high yield production practices. The NPK uptake ratio was about 1:0.42:2.85 at the full ripe stage. Although total K uptake increased throughout the growing period, peak K uptake appeared between the milk and dough stages. The amount of K uptake during this time was 68.6 percent of the total K accumulated. These data point to the need for high levels of available K throughout the growing season.

The concentration of K in the stem and leaf was observed to be 3.2 to 6.5 times higher than levels found in grain. Therefore, the practices of recycling crop residue and adequate K fertilization should be combined to maintain high soil K levels, as well as to maximize crop yields.

Available soil K was influenced by fertilizer treatment, corn growth, and season. Potash application increased available soil K before July, which was subsequently reduced by greater plant uptake after July. Available soil K was higher in summer than in spring and autumn due to higher temperatures and abundant rainfall. **BCI**

*The authors are staff of the Soil and Fertilizer Institute of the Liaoning Academy of Agricultural Sciences, Shenyang, Liaoning, People's Republic of China.*



**Figure 3.** Seasonal fluctuations in available soil K, Liaoning, China.

## Dr. Kaushik Majumdar Joins PPIC Staff as Deputy Director, India Programme

Dr. Kaushik Majumdar has joined the staff of PPIC-India Programme as Deputy Director, Eastern India. He will work from the newly inaugurated office in Calcutta, West Bengal. Dr. Majumdar received his B.Sc. (Ag) Hons. degree at Visva-Bharati University in 1984. He continued with graduate study at Bidhan Chandra Krishi Viswavidyalaya (BCKV) and earned his M.Sc. (Ag) degree in Agricultural Chemistry and Soil Science in 1987. He joined Rutgers University, in the U.S., in 1988 as a Teaching/Research Assistant and completed his Ph.D. in Soil Mineralogy/Soil Chemistry in 1993.

In 1994, Dr. Majumdar rejoined BCKV as a Research Associate, and later moved on to the Potash Research Institute of India (PRII) in 1995 as a Soil Mineralogist. During his tenure as Soil Mineralogist at PRII, Dr. Majumdar did extensive work on potassium dynamics of Indian soils. Dr. Majumdar will direct programmes in agronomic research and education related to market development for potash and phosphate in West Bengal, Bihar, Orissa, and Assam of eastern India and the north eastern states of India. **BCI**



## Corn Response to Potash on a Gongzhuling Black Soil, Jilin Province

By Zhang Kuan, Wu Wei, and Wang Xiufang

**Potash fertilizer applied to moderately fertile black soil of the north-eastern province of Jilin failed to increase corn yields in the 1950s and 1960s. Thus, any yield improvements in this region have been achieved, in part, through use of nitrogen (N) and phosphorus (P) fertilizers, improved crop varieties, and native soil potassium (K) supply. Limited use of K fertilizer and continued nutrient removal have gradually depleted K levels to the point where, during the past two decades, soils and crops in Jilin have shown response to K.**

Experiments were conducted at three locations in Liufangzi township, Gongzhuling city, Jilin province, to show the positive effect of K fertilizer on corn production in this northeastern province of China.

All treatments in each field (Tables 1, 2 and 3) were arranged in a randomized complete block design with four replications. Treatments occupied 40 m<sup>2</sup>, with each ridge 0.6 to 0.65 m apart. Organic matter content of the experimental soils ranged from 1.8 to 2.2 percent, pH from 6.2 to 6.5, available N, P and K between 89 to 101, 10 to 20.5, and 113 to 139 mg/kg, respectively.

Corn varieties were Danyu 13, Yedan 13, and Yedan 12, each planted at its optimum plant population of 45,000, 70,000, and 70,000 plants/ha, respectively. Experimental fields were plowed, fertilized and ridged in spring. Fertilizer sources for N, P and K were urea, triple superphosphate (TSP) and potassium chloride (KCl). All P and K and one-third of the N were applied basally, while the remaining N was top-dressed at one time. Fields were seeded in late April by horse-drawn single body seeders. Weed control was carried out by hand, while pesticides were used for disease and pests. The three trials were conducted under rain-fed conditions.

The systematic approach used for measuring initial soil nutrient status (Portch, 1988) determined all three experimental soils to be deficient in K with slightly different K fixation patterns. Thus, examination of crop response to K fertilizer involved using constant levels of N and P<sub>2</sub>O<sub>5</sub> that were prescribed according to site-specific yield potentials. Profits were



Mr. Wu Wei is shown in corn field in Gongzhuling.

calculated on the basis of the following Yuan/kg values: N=2.39; P<sub>2</sub>O<sub>5</sub>=1.63; K<sub>2</sub>O=1.5; and corn=0.5 (8.2 Yuan=1 US\$). Tables 1, 2 and 3 present the three-year average corn yield results.

### Profit-based Potassium Fertilizer Recommendations

Potash application increased corn yields harvested from all three fields. Yield increases ranged from 294 to 1,950 kg/ha with a best average yield increase of 1,633 kg/ha for the three fields. (Yields in Field 1 were not significantly different.) The relative yield increases ranged between 3.4 to 25.6 percent, which was consistent with results of pot experiments conducted earlier with the same soils.

The most profitable yield was not always the highest yield since the added cost of K fertilizer did not always produce that value in additional crop. The most profitable, therefore, recommended rates of K application for fields 1, 2 and 3 were 150, 150, and 169 kg/ha K<sub>2</sub>O, respectively, giving respective profits of 589, 560, and 338 Yuan/ha.

### Conclusions

Using the systematic approach to determine the soil nutrient status as proposed by the PPI/PPIC China Program disproved local scientific and official opinion that K supplies are adequate in these northern China soils. In fact, the black soils of moderate fertility at Liufangzi, Gongzhuling city had already become deficient in K and were limiting corn production.

The application of 150 to 169 kg/ha K<sub>2</sub>O could increase corn yield by 1,200 to 1,600 kg/ha (12 to 21 percent). These data show that, at the recommended rate of potash, 1 kg of K<sub>2</sub>O increases corn yield by 10.8 kg. Net profit to farmers was increased by 338 to 589 Yuan/ha. If this recommendation could be used on only 20 percent of the corn crop grown on similar black soils, 751,000 t of additional corn would be produced, providing farmers an additional 228 M Yuan in income. **BCI**

*The authors are staff of the Soil and Fertilizer Institute, Jilin Academy of Agricultural Sciences, China.*

### Reference

Portch, S. 1988. *Greenhouse/Screenhouse Soil Nutrient Survey Procedures. (Mimeograph), Potash & Phosphate Institute, Hong Kong.*

**Table 1.** Average corn yield responses and net profit to K applications (Field 1), Gongzhuling city, Jilin.

Treatments N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O, kg/ha	Average yield, kg/ha	Yield increase, kg/ha	Net profit, Yuan/ha	Coefficient of variation, %
200-100-0	8,614	—	—	3.71
200-100-75	8,908	294	34	11.40
200-100-150	10,242	1,628	589	7.11
200-100-225	9,861	1,247	286	10.96
LSD <sub>0.05</sub> = 1,774.				

**Table 2.** Average corn yield responses and net profit to K applications (Field 2), Gongzhuling city, Jilin.

Treatments N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O, kg/ha	Average yield, kg/ha	Yield increase, kg/ha	Net profit, Yuan/ha	Coefficient of variation, %
360-120-0	7,614	—	—	9.91
360-120-150	9,183	1,569	560	4.07
360-120-300	9,564	1,950	525	6.95
LSD <sub>0.05</sub> = 1,416.				

**Table 3.** Average corn yield responses and net profit to K applications (Field 3), Gongzhuling city, Jilin.

Treatments N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O, kg/ha	Average yield, kg/ha	Yield increase, kg/ha	Net profit, Yuan/ha	Coefficient of variation, %
240-120-0	10,026	—	—	6.58
240-120-113	10,615	589	125	3.40
240-120-169	11,208	1,182	338	1.00
240-120-263	10,626	600	-94	3.57
240-120-375	11,346	1,320	98	0.73
LSD <sub>0.05</sub> = 981.				

# Effect of Plant Density and Nutrient Management on Plantain Yield

By Sylvio Belalcázar and José Espinosa

**Plantain (*Musa paradisiaca* L.) is a staple and inexpensive food grown in the tropical and subtropical areas of Latin America. Plantain consumption in the region has been increasing steadily in recent years, with Colombia having the highest consumption rate. Colombia cultivates more than 400,000 ha and has a total annual plantain production of around 1.7 million tonnes (M t). Inadequate inputs and low technology management practices combine to be the main causes for its poor average yield of 6 t/ha.**

Population growth and the consequent demand for more food have encouraged the search for innovative methods of production that can obtain higher sustainable yields. High plant density can significantly increase yield per unit area. Successful examples include high-density coffee and cocoa production systems. Research work conducted in the last seven years has documented yield increases of up to 300 percent where plantain plant populations were increased from the traditional 1,000 plants/ha to 3,000 plants/ha.

An added benefit of high-density plantain cultivation is a lower incidence of yellow sigatoka (*Micosphaerella musicola*) and black sigatoka (*Micosphaerella fijiensis*), two of the most important diseases affecting the crop.

High plant population increases the length of the production cycle and reduces bunch weight, but the negative effect of these factors is outweighed by the higher number of bunches per unit area. These results have attracted the attention of plantain growers, extension personnel, and researchers in several countries of Latin America. Starting in 1992, the National Agricultural Research Institute of Colombia (CORPOICA) initiated a research program to investigate high-density plantain cultivation. Some of the results from this program are discussed here.



Increasing plant density from 1,000 up to 3,000 plants/ha has resulted in higher yields in research.

## High-Density Plantain: A New Option

Traditionally, plantain has been treated as a semi-perennial crop grown with different plant arrangements in the field according to agro-

ecological zone and grower objective. Plant population varies from 1,400 to 1,600 plants/ha. The plantation is kept in the field for several ratoons using sucker plants that originate from the mother plant. Plant population and plant vigor decrease rapidly after the first harvesting cycle. Growers pay little attention to the crop and harvest every time bunches are ready. This small but continuous cash income has prevented any change in the approach to plantain cultivation.

The high population approach treats the plantation as an annual crop (i.e., one harvest only). This is an unorthodox way of handling plantain and differs radically from traditional cultivation. All plants are eliminated after harvest, and a new stand is planted using new corms. It has been demonstrated that keeping this type of plantation for more than one cycle is not economical. This new technology is normally quite difficult to introduce because of grower resistance to the elimination of an apparently good stand to establish a new one.

Results from work conducted in several experimental sites indicate that an increment in the number of plants per hectare reduces the yield per plant and increases the total time to harvest. Growers typically wait an extra three to five months for harvest with plant densities of 3,300 to 5,000 plants/ha compared to using normal densities of 1,400 to 1,600 plants/ha (Table 1). However, data also indicate that these negative effects are completely offset by the higher yields obtained per unit area. Semi-commercial plots have confirmed these results, and growers are adopting this new technology faster than expected.

Data in Table 1 also indicate that the number of harvested plants decreases as plant population increases. This is a direct effect of plant competition. In high population systems, it is important to eliminate all plants that have not developed normally during the first two to three months after planting. Plants that have fallen behind never recuperate and have to compete with the plants growing at the normal rate.

The usual plant arrangement in the field is laid out in patterns of



In high-density management, plantain is treated as an annual crop with one harvest.

**Table 1.** Plant population effect on growth factors and plantain yield grown on an Andisol, Quindio, Colombia.

		..... Growth factors .....			..... Yield factors .....		
Plants per site	Plants per ha	Plant height, m	Pseudostem		Mean bunch weight, kg	Total yield, t/ha	Number harvested plants, %
			circumference, cm*	Cycle length, months			
1	1,666	3.5	49	15.5	15.0	23.1	92.6
2	3,332	4.2	50	18.0	14.3	40.4	85.0
3	4,998	4.3	51	20.0	13.3	51.9	78.0

\*One meter from soil surface.



2 x 3 m (i.e., plant spacing within and between rows, respectively). High population can be obtained by planting two or three corms in the same planting hole. This will result in approximate populations of either 3,332 or 4,998 plants/ha. Planting density of 3,332 plants/ha can also be obtained by planting one corm per hole at a spacing of 1.5 x 2 m.

### **Management of High-Density Plantain Crops**

To be efficient and profitable with high-density plantain, it is necessary to consider the following management recommendations.

#### **Seed Size**

This factor is of particular importance since the success of the new plantation depends on the correct selection of the corms to be planted. A practical way of selecting corms is to organize them in homogeneous groups of the same size and weight. This selection of the seed allows uniform growth and development of the plantation. At the same time, a gradient of maturity develops in the field which allows harvesting to occur in order of the size of the corm from which plants developed. Lack of uniformity in the plantation reduces yields significantly.

#### **Plant Uniformity**

Even with the use of uniform corms, there are differences in the size of plants growing in the same planting hole due to a difference in the physiological age of the planted corms. In such cases, it is necessary to remove leaves from tall plants or by cutting the pseudostem. The best time for trimming plants is when the fifth leaf appears, which is approximately 30 to 45 days after the first leaf appears, depending on altitude.

#### **Disease Control**

Control of the two main plantain diseases, yellow sigatoka and black sigatoka, is indispensable. Good control has been obtained by monthly trimming of dead or broken green leaves hanging from the pseudostem and all leaves with necrotic spots covering more than one-third of the lamina. High population plantations have a lower incidence of these two diseases. This could be related to the increase in the length of the pathogen growth cycle induced by the modifications in light and temperature inside high-density plantations.

#### **Nutrient Management**

Fertilizer requirements for plantain in high-density arrangements are greater when compared to conventional planting. Higher yields remove more nutrients and even in soils with high natural fertility these nutrients must be replaced to sustain high yields. The effects of plant density and fertilizer application on plantain yield in two soils from

Colombia with different native fertility status are shown in **Table 2**.

### Conclusion

The advantages of high population density plantain include: the potential to increase yields significantly, synchronize the crop cycle and harvesting with best market conditions, and optimize land use. One hectare of high-density plantain can produce as much as three to five hectares of conventional planting. High-density planting also produces higher numbers of good quality corms that can be used as seed for the next cycle, lowering the incidence of pests, diseases and weeds. Farmers in the plantain producing areas of Ecuador, Colombia and Venezuela are benefiting from this technology. **BCI**

*Dr. Belalcázar is a private consultant formerly with the Colombian Institute of Agricultural Research (CORPOICA), Colombia. Dr. Espinosa is Director, PPI-PPIC Northern Latin America (INPOFOS), Ecuador. E-mail: jespinosa@ppi-ppic.org.*

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**Table 2.** Effects of plant density and fertilizer application on plantain yield in two Colombian soils.

Treatments	Plants per ha	Yield, t/ha	
		Quindío (Andisol)	Magdalena (Inceptosil)
Check	1,666	19.3	7.3
Check	3,332	28.5	15.6
NPK*	3,332	32.7	31.3

\*N = 100; P<sub>2</sub>O<sub>5</sub> = 20; K<sub>2</sub>O = 210 kg/ha, respectively.

# Fertilization of Plantain in High Densities

By José Espinosa and Sylvio Belalcázar

**Research in the main plantain producing areas in Colombia has confirmed that plant density cultivation produces greater yields than traditional plant populations. However, nutrient management information under these high-density systems is lacking. Data are presented for field experiments conducted from 1995 to 1998, which refine fertilizer recommendations for high-density plantain cultivation.**

Factorial experiments with different plant densities were conducted for two consecutive crop cycles in Piedmont soils of the eastern plains of Colombia. These soils are alluvial, coarse to medium textured, and are representative of the primary plantain-producing zone. They are characterized by having low potassium (K), calcium (Ca), and magnesium (Mg) contents.

**Table 1.** Plantain response to plant population and fertilization at El Castillo, Meta, Colombia.

Application rate, kg/ha			Fruit yield, t/ha			
			1996		1997	
K <sub>2</sub> O	CaO	MgO	Plant density		Plant density	
			High <sup>1</sup>	Low <sup>2</sup>	High	Low
0	0	0	27.65	25.89	14.74	12.63
70	0	0	35.32	32.45	17.54	11.42
140	0	0	40.89	32.76	20.64	14.85
210	0	0	41.86	34.11	21.69	18.50
280	0	0	42.91	34.40	17.95	18.61
350	0	0	41.27	34.07	24.59	19.99
210	150	0	40.68	33.71	21.33	20.40
210	300	0	40.09	34.79	22.80	16.10
210	0	30	42.46	33.01	21.69	18.45
210	0	60	38.52	34.11	19.16	18.50
210	0	90	37.12	35.12	19.72	17.06

<sup>1</sup>High plant density = 3,333 plants/ha (plants at 3.0 x 2.0 m, 2 seeds per site).  
<sup>2</sup>Low plant density = 2,666 plants/ha (plants at 2.5 x 1.5 m, 1 seed per site).  
 Initial soil tests for K, Ca and Mg = 0.14, 3.31 and 0.48 cmol (+)/kg, respectively.  
 150 kg N/ha and 20 kg P<sub>2</sub>O<sub>5</sub>/ha were applied to all treatments.

## Plantain Response to Fertilization

Yield responses to K, Ca and Mg fertilizer application at El Castillo are presented in Table 1. Response to nitrogen (N) and phosphorus (P) at this site was minimal. The marked yield difference between 1996 and 1997 was due to the climatic effect of El Niño in 1997.

Soils at the site were flooded intermittently and water saturation had a significant effect on fruit yield.

Results from a factorial experiment testing the effect of N, K and sulfur (S) on the yield of high-density plantain grown on an Inceptisol at Caribia, Colombia, are shown (Table 2). Soils in this region are

characterized by having medium to low K and S contents. They are representative of the plantain growing area located on the Caribbean coast of Colombia. This trial showed a positive response to K, but highest fruit yields occurred only when N, K and S were applied together.

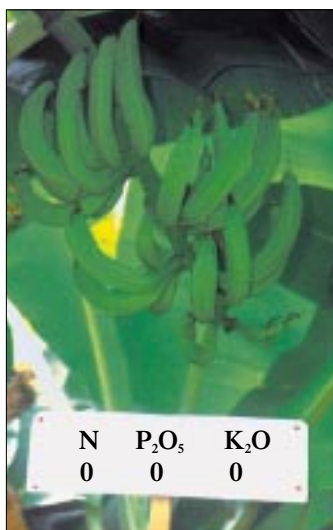
A simple economical analysis was conducted in selected treatments of the Caribia study (Table 3). The data indicate an excellent response to nutrient application and a profitable balance when inputs and outputs are computed.

### Soil Testing as a Tool for Fertilizer Recommendations in Plantain

These studies in high-density plantain have demonstrated a good response to N, K, and S fertilization in the main plantain growing areas of Colombia. However, response was not uniform in all soils due to the initial nutrient content of the soil. One general fertilizer recommendation has traditionally been used for low-density plantain production systems, but this practice is not the most effective approach to nutrient management. Fertilizer recommendations based on soil analysis and calibrated response curves are more efficient and profitable. High-density plantain systems have been proven profitable, and the use of soil analysis is a best management practice (BMP) that fits well in the system.

The experiments reported above were designed to calibrate yield response with nutrient application and soil testing. Relative yields were used in the calibration since the magnitude of response was different in different sites due to climatic conditions, management, and soil type. This point is illustrated in the K response data obtained in two different plant densities in the same crop cycle at El Castillo (Table 1). Plant population controlled the magnitude of the response, but the trend was similar and provided a comparable critical level.

The K calibration for high-density plantain using data from all experimental sites is presented (Figure 1). The calibrated critical



Response of plantain to fertilization has not been uniform. Soil analysis and calibrated response curves are more efficient management tools for developing recommendations.

**Table 2.** Plantain response to plant population and nutrient rates at Caribia, Magdalena, Colombia.

Fertilizer application rate, kg/ha			Fruit yield, t/ha
N	K <sub>2</sub> O	S	
0	0	0	18.33
0	210	0	27.83
50	210	0	27.91
100	210	0	31.49
150	210	0	33.08
200	210	0	35.01
150	70	0	30.31
150	140	0	33.83
150	210	0	33.08
150	280	0	37.33
150	350	0	39.60
150	210	30	33.33
150	210	60	38.58
150	210	90	44.66

All treatments received a uniform application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha.  
 Population = 3,333 plants/ha (plants at 2.0 x 1.5 m, 1 seed per site).  
 Initial soil test: P = 18 mg/kg, K = 0.12 cmol(+)/kg, S = 6 mg/kg.

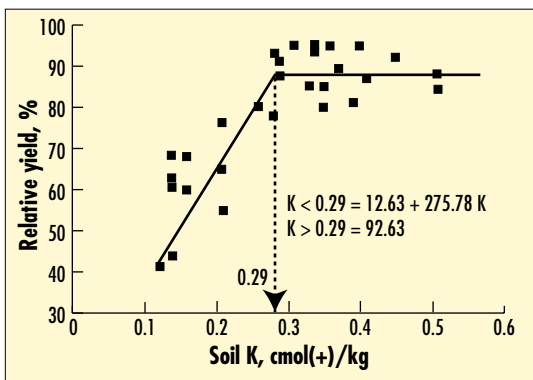


Figure 1. Calibrated K critical level for plantain in Colombian soils.

Plantain at high densities produces profitable yields. However, this production system requires high management input to be successful. Use of good seed, establishment of high plant population, effective culling, and proper nutrition are essential. Data from several experiments conducted in the plantain growing areas of Colombia have

level is 0.29 cmol(+)/kg of soil with a soil test that uses ammonium acetate as the K extractant.

Calibrated yield data from all experiments were used to develop fertilizer recommendations for high-density plantain (Table 4).

## Conclusions

Table 3. Balanced nutrition effect on high-density plantain yield and income in an Inceptisol from Caribia, Magdalena, Colombia.

Fertilizer applied, kg/ha				Yield, t/ha	Gross income	Fertilizer cost	Other inputs	Hand labor	Net income
N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S						
0	0	0	0	18.3	1,283	0	403	391	489
150	40	210	0	33.1	1,896	167	403	391	935
200	40	210	0	35.0	2,450	199	403	391	1,457
150	40	350	0	39.6	2,770	207	403	391	1,769
150	40	210	90	44.6	3,126	197	403	391	2,135

Table 4. Recommended fertilizer rates for plantain at high densities based on soil analysis, Colombia.

Soil nutrient rating	Soil test rating					Fertilizer recommendation				
	P	S	K	Ca	Mg	P <sub>2</sub> O <sub>5</sub>	S	K <sub>2</sub> O	CaO	MgO
	mg/kg		cmol(+)/kg					kg/ha/yr		
Low	< 8	< 6	< 0.2	< 3	< 1	40	90	280	300	80
Medium	9-15	6-12	0.2-0.3	3-6	1-3	20	45	210	150	40
High	> 15	> 12	> 0.3	> 6	> 3	0	0	140	0	0

Nitrogen fertilizer application at a rate of 200 to 250 kg/ha/year in each situation.

demonstrated a high response to N, K and S. Soil analysis is a BMP needed in a successful high-density plantain system. This experimental work provides the basis for developing fertilizer recommendation that can be used in extensive plantain production. **BCI**

Dr. José Espinosa is Director, PPI-PPIC Northern Latin America (INPOFOS), Quito, Ecuador. Dr. Sylvio Belalcázar is a private consultant formerly with the Colombian Institute of Agronomic Research (CORPOICA), Colombia.

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**High-density plantain** production requires more management, but increased yield and profit are possible.

## Manual on the Nutrition and Fertilization of Banana Now Available

The 54-page publication, *Manual on the Nutrition and Fertilization of Banana*, is now available in English translation. It emphasizes modern concepts of soil fertility and mineral nutrition in banana production, particularly diagnostic procedures which allow for the development of practical fertilizer recommendations for high yields. It summarizes information generated from more than 15 years of work conducted by the Costa Rican Banana Growers Association. The Manual is presented from a perspective of efficient and economic use of mineral fertilizers and an objective evaluation of organic amendments and their contribution to the success of the banana production system. The manual has previously been available in Spanish, and is popular with a range of readers including farm managers, researchers, technicians, students, and others.

The publication (Item #95-1025) is available at a cost of US\$20.00 per copy, plus shipping. For more information, contact: Circulation Department, PPI, 655 Engineering Drive, Suite 110, Norcross, Georgia 30092 U.S.A. Phone (770) 825-8082, fax (770) 448-0439, e-mail: [circulation@ppi-far.org](mailto:circulation@ppi-far.org), or check the website at either [www.ppi-far.org](http://www.ppi-far.org) or [www.ppi-ppic.org](http://www.ppi-ppic.org).

**BCI**

# Sugar Cane Response to Potassium Fertilization on Andisol, Entisol, and Mollisol Soils of Guatemala

By Ovidio Pérez and Mario Melgar

**This research examines the potential for improved sugar cane yield and quality in Guatemala through increased potassium (K) use in combination with adequate nitrogen (N) and phosphorus (P) rates. A critical soil test K level for the major sugar cane-producing region of Guatemala is also suggested.**

Guatemala's sugar cane region is located on its southern coastland in volcanic lowlands and coastal valleys. In the upper and middle parts of the region, high amounts of precipitation are common. Andisols and sandy soils with low K levels dominate.

In contrast, the alluvial soils of the coastal valley generally have moderate levels of K. Most sugar cane growers do not consider application of K in their fertilization program, although K is extracted in large amounts by the crop. In fact,

sugar cane requires more K than N.

Preliminary results from a regional study on N, P, and K use in sugar cane showed a small but consistent crop response to K fertilization on soils with low K levels (Pérez and Melgar, 1998). However, these experiments were characterized by addition of low rates of N and P. Unpublished data from local sugar cane companies have shown large application rates of N, P and K increase sugar production in some of these areas.

Therefore, the objective of this study was to acquire more information on response to different rates of K fertilization when adequate N and P were added. The specific objectives were to: 1) determine the effect and optimum rates of K for sugar cane production; 2) determine the N and K interaction on sugar cane yield; and 3) determine critical K levels of the typical sugar cane soils of Guatemala.



Andisols with low soil K levels are common in the sugar cane production area of Guatemala.

**Table 1.** Effect of K on sugar cane yield, sugar content, and juice purity.

Place	Sugar cane yield	Sugar content	Juice purity
El Baúl	*	**	**
La Unión	**	**	**
Palo Gordo	NS	NS	NS
Magdalena	NS	*	NS
Tierra Buena	NS	NS	NS

\*\* , \* = Significant at 1% and 5%, respectively; NS = Non significant.

Research was conducted by the Guatemalan Center for Research and Training on Sugar Cane (Centro Guatemalteco de Investigación y Capacitación de la Caña de Azúcar, CENGICANA). It was conducted for one year in the fields of five sugar cane companies; “La Unión” (Cristobal), “Palo Gordo” (Manacales), “Magdalena” (Santa Rita), “Tierra Buena” (Puyumate), and “El Baúl” (Las Delicias). The sugar cane variety CP722086 was used in four locations and Mex 69290 in the other.

Soils at each site were sandy loam and sandy textured Andisols (El Baúl, La Unión and Palo Gordo), a Mollisol (Tierra Buena) and an Entisol (Magdalena). Soil pH ranged from 5.4 to 6.5 and organic matter from 1.99 to 5.42 percent. Extractable soil K ranged from 82 to 203 parts per million (ppm). Seven treatments (0, 40, 80, 120, 160, 200, and 240 kg K<sub>2</sub>O/ha) with four replications were evaluated. All the treatments included applications of 150 kg N/ha and 120 kg P<sub>2</sub>O<sub>5</sub>/ha. All of the applied P, half the K, and 30 kg N/ha were applied at the bottom of the furrow at planting. The remaining K and N were banded and incorporated 60 days after planting.

Four additional treatments were tested to evaluate the N and K interaction at La Unión, El Baúl and Tierra Buena. In addition to 150 kg N/ha, N at rates of 50 and 100 kg/ha were used, in combination with the 0 and 120 kg K<sub>2</sub>O/ha rates.

### Effect of Potassium on Sugar Cane Yield and Crop Quality

The effects of K on sugar cane yield, sugar content, and juice purity are summarized in Table 1 and Figures 1 and 2. Average sugar cane yield and sugar content differed greatly among sites. There were significant yield and sugar content responses to K fertilization in El Baúl and La Unión soils where K contents were 86 and 102 ppm, respectively. No sugar cane yield response was measured in Magdalena despite its low soil K content of 82 ppm, although there was a significant increase in sugar content. There was no response to K in Palo Gordo and Tierra Buena where soil K levels were 141 and 203 ppm, respectively. Although El Baúl had the lowest potential for sugar cane production, K fertilization increased yield at this site by 20 t/ha.

Sugar content increased by 11 kg sucrose per ton of sugar cane at El Baúl, La Unión, and Magdalena with K fertilization (Figure 2). At Magdalena, the highest sugar yield response was obtained with 160 kg

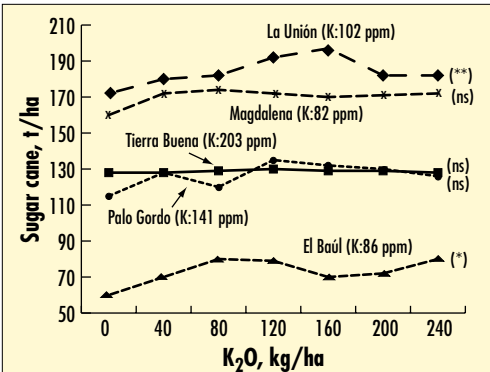


Figure 1. Sugar cane response to K in Andisols (La Unión, Palo Gordo and El Baúl), a Mollisol (Tierra Buena), and an Entisol (Magdalena), Guatemala.

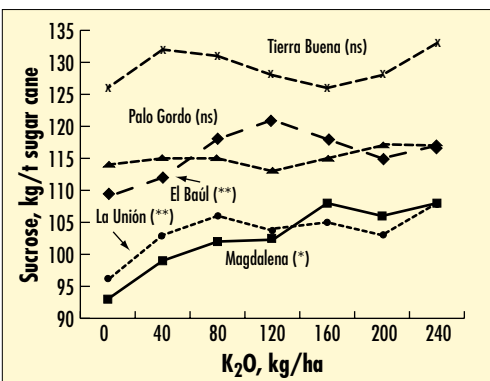
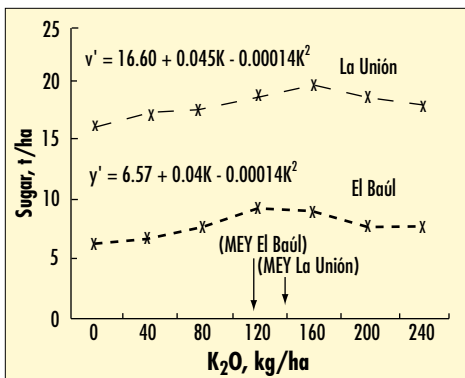


Figure 2. Sucrose response to K in Andisols (La Unión, Palo Gordo and El Baúl), a Mollisol (Tierra Buena), and an Entisol (Magdalena), Guatemala.



**Figure 3.** Regression model for K response in sugar cane production used to estimate MEY. The MEY calculations were based on the following values presented as quetzales (Q), the official currency of Guatemala.  $K_2O = Q \ 3.30$  per kg; sucrose = Q 570 per t.

and the ratio of fertilizer cost to sugar price. In this case, an average price of 3.30 quetzales per kg of  $K_2O$  and 630 quetzales per ton of sugar in the field were used to calculate  $K_2O$  rates of 120 kg/ha for El Baúl and 140 kg/ha for La Unión. (Note: One Guatemalan quetzal = US\$0.13.)

Potassium fertilization also affected the quality of sucrose. **Table 2** shows the relationship between increasing juice purity and higher rates of applied K at La Unión and El Baúl.

High rates of N alone did not increase average sugar cane production; on the contrary, in two of the three sites studied, sugar cane yield decreased due to high N application. At Tierra Buena, where the level of K in the soil was high, none of these effects were observed.

## Conclusions

Potassium applications significantly increased sugar cane yield and sugar content in Andisols and Entisols when soil test K was less than 102 ppm. Optimizing  $K_2O$  rates at approximately 140 kg/ha may increase sugar yield by at least 2.8 t/ha. A consistent sugar yield increase was observed when N and K were applied to Andisols with low K content. This suggests that K improves N utilization by the plant and may be a limiting factor for sugar production in these areas. The critical level for K response in these soils was around 102 ppm of extractable K. Soils with extractable K higher than 140 ppm did not respond to K fertilization. **BCI**

**Table 2.** Effect of K on purity of juice (%) for two fields in Guatemala.

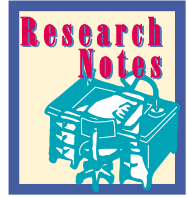
$K_2O$ rate, kg/ha	Purity of juice, %	
	La Unión	El Baúl
0	84.3	87.0
40	88.9	89.2
80	90.2	90.9
120	88.5	91.4
160	89.2	90.5
200	90.4	89.5
240	89.4	90.8

*Ing. Perez has responsibility for the Agronomy Program, and Dr. Melgar is General Director, Guatemalan Center for Research and Training on Sugar Cane (CENGICANA), located at Santa Lucía, Escuintla, Guatemala. E-mail: cengican@concyt.gob.gt*

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## Other Reading

*Perez, O. and M. Melgar. 1998. Sugar cane response to nitrogen, phosphorus and potassium application in Andisol soils. Better Crops International. 12(2):20-24.*



## Indonesia: Stover and Potassium Management in an Upland Rice-Soybean Rotation on an Indonesian Ultisol

The objective of the study was to determine the effects of potassium (K) fertilization and stover management on crop yields and soil properties of a Typic Kanhapludult. A six-crop rotation, including cowpea, rice and soybean, was grown over a two-year period. Muriate of potash (KCl) was applied at rates of 70 and 250 kg K/ha to the first crop (only) and as a total of 250 and 600 kg K/ha to several crops. The effect of stover removal was evaluated for each K rate.

Results indicated that stover should be returned to the field when possible, since it substantially reduces the need for K fertilizer in a rice-soybean cropping system. For example, when stover was returned to the study field, a one-time application of 75 kg K/ha sustained up to six sequential plantings of the three crops over a period of 24 months. When stover was removed, an additional 35 to 45 kg K/ha per crop was required to maintain soil K above the critical levels for rice and soybean. Other results of the research:

- Researchers suggested that when stover is removed, lower K rates to each crop rather than large single applications can reduce luxury K uptake.
- Manure can be used to replace some of the K at a rate of about 1 tonne per 18 kg of KCl fertilizer.
- Stover removal hastened the depletion of soil magnesium (Mg).

**BCI**

*Source: Dierolf, T.S. and R.S. Yost. 2000. Agron. J. 92:106-114.*

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You can reach the Potash & Phosphate Institute (PPI), Potash & Phosphate Institute of Canada (PPIC), and Foundation for Agronomic Research (FAR) online. Use one of the following as a URL to reach the website: [www.ppi-ppic.org](http://www.ppi-ppic.org) or [www.ppi-far.org](http://www.ppi-far.org).

There is increasing variety and diversity of information now available in electronic form at PPI/PPIC/FAR, with more additions and changes to the website coming soon. Current and back issues of *Better Crops with Plant Food*, *Better Crops International*, *News & Views*, and other publications are available as pdf files.

For further information, contact PPI headquarters by phone at (770) 447-0335 or fax, (770) 448-0439. **BCI**

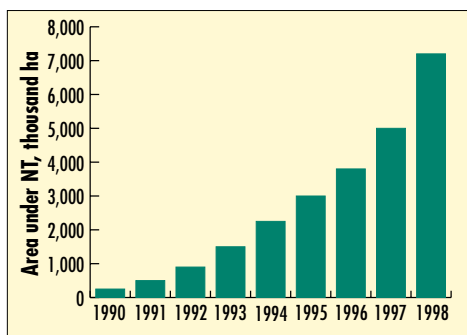


## No-Tillage in the Pampas of Argentina: A Success Story

By Fernando O. García, Martín Ambroggio, and Victor Trucco

**No-tillage (NT) in Argentina has developed into a successful management system in the Pampas region. AAPRESID (Asociacion Argentina de Productores en Siembra Directa), a national no-tillage farmer and agronomist association, has driven this expansion with the collaboration of the Instituto Nacional de Tecnologia Agropecuaria (INTA) and other agricultural institutions and companies. Sustainable higher yields under NT require improved nutrient management.**

The Pampean region, originally a temperate subhumid grassland, is the main cropland area of Argentina with approximately 34 million ha, one third cropped to annual cereal and oil crops. The region includes part of Buenos Aires, La Pampa, Santa Fe, Córdoba, and Entre Ríos provinces. Mean annual temperature is 17 to 18°C in the north and 14°C in the south. Average annual precipitation varies from 500 to 600 mm in the southwest to more than 1,000 mm in the northeast, mainly concentrated between December and March, with July and August being the driest months (Hall et al., 1992).



**Figure 1.** Evolution of the area planted under no-tillage in Argentina during the period 1990-98.

Source: AAPRESID (1999).

Soils are classified as Mollisols of udic and thermic regimes. The most representative soils in a northeast-southwest transect are Vertic Argiudolls, Typic Argiudolls, Typic Hapludolls, and Entic Hapludolls according to the gradient of precipitation and texture of the parent material (loess). The southern Typic Argiudolls are associated with soils developed over caliche (calcium carbonate) with depth limitations for root development.

### The Growth of No-Tillage in Argentina

The first experiences under NT in Argentina started at INTA experiment stations at Anguil (La Pampa) and Pergamino (Buenos Aires) in the 1960s (Panigatti, 1998). The main problems observed at that time were related to weed control, residue management, and seeding equipment. Introduction of the herbicide glyphosate, the development of planters and drills, and the technologies developed and adapted by INTA and other governmental and private institutions have allowed the sustained increase of area under NT since the early 1990s (Figure 1).

**Table 1.** Area under NT for several annual crops in the main producing provinces/regions of Argentina during the 1998/99 growing season.

Province/ Region	Crop						Total ha
	Wheat	Soybean	Corn ha	Sorghum	Sunflower	Ann. Forages	
Santa Fe	291,300	1,492,700	225,700	62,000	27,300	19,700	2,118,700
Buenos Aires	518,300	829,700	286,500	8,700	106,200	155,000	1,904,400
Córdoba	230,600	1,035,900	352,100	97,000	130,300	118,100	1,964,000
Entre Ríos	135,500	187,600	93,800	21,100	33,800	87,000	558,800
La Pampa	57,400	600	83,100	16,700	58,800	93,000	309,600
Santiago del Estero	2,400	92,800	39,100	27,500	—	500	162,300
Northwest	28,700	138,100	65,500	3,900	—	4,100	240,300
Northeast	3,000	5,100	2,300	1,500	—	—	11,900
Total under NT	1,267,200	3,782,500	1,148,100	238,400	356,400	477,400	7,270,000
Total area	5,870,415	6,873,930	3,522,280	809,700	3,302,310	2,517,600	22,896,235
Percent under NT	22	55	33	29	11	19	32

Source: AAPRESID (1999).

Presently, the total area under NT is estimated at 7.2 million ha, which represents more than 30 percent of the total annually cropped area (AAPRESID, 1999).

Over 80 percent of the total national area under NT is in the provinces of Santa Fe, Córdoba, and Buenos Aires in the Pampean region (Table 1). The province of Entre Ríos has greatly increased NT in the last three years with approximately 50 percent of the total cropped area under NT, mainly because of the introduction of soybean varieties resistant to glyphosate. Other regions in the country with high adoption of NT are the northwest provinces of Tucumán and Salta.

Highest NT adoption has been with soybean at approximately 55 percent of the total soybean area (Table 1). Seventy percent of the double-cropped soybean area (after wheat harvest) is planted under NT. Corn and sorghum follow soybean with the next highest adoption at approximately 30 percent of their respective total cropped areas. For wheat and other winter crops, the area under NT is estimated at approximately 20 percent of the total area dedicated to these crops. Sunflower is the crop least affected, occupying about 10 percent of its total area (AAPRESID, 1999).

The growth of NT in the Pampas has been based on technical as well as economic aspects. The direct costs for establishing crops such as corn, soybean and wheat under NT are lower than or similar to conventional tillage (Table 2), and the income is greater because of higher yields (Table 3). Several studies have shown greater and more stable fertilization responses for NT, especially under low water availability.

**Table 2.** Direct costs for corn, soybeans and wheat under conventional and no-tillage in the Pampas region.

Crops	Direct costs	
	Conventional tillage	No-tillage
	US\$/ha	
Corn	226	209
Soybean	184	169
Wheat	122	121

Source: Agromercado, September 1999.  
Does not include harvest and commercialization costs.

### AAPRESID: A Net of Innovative Farmers

AAPRESID has driven the expansion of the NT system with the

**Table 3.** Corn and soybean yields under different tillage systems. Field experiments at EEA INTA Marcos Juárez (Córdoba) and EEA INTA Famaillá (Tucumán).

	EEA Marcos Juárez – Corn yields, kg/ha <sup>1</sup>		
	Conventional tillage	Reduced tillage	No-tillage
Corn/soybean rotation	8,467	8,988	9,334
	EEA Famaillá – Corn yields, kg/ha <sup>2</sup>		
	Conventional tillage	Vertical tillage	No-tillage
Corn/soybean rotation	3,072	2,874	3,352
Soybean/soybean/corn rotation	3,038	2,991	3,232
Continuous soybean	2,647	2,841	2,969

Source: Ferrari, 1998 and Sánchez et al., 1998.  
<sup>1</sup>Typic Argiudoll  
<sup>2</sup>Typic Haplustoll

support of INTA and several agricultural companies and institutions. The objective of the association is to exchange knowledge and experiences on NT systems among farmers and agronomists. To fulfill this purpose, AAPRESID organizes field days, seminars, technical meetings, and an annual congress in which local and foreign specialists, farmers and agronomists participate (Figure 2). The information of these different meetings is reported in publications such as bulletins, books and proceedings.

### Crop Fertilization under No-Tillage

In general, soils of the Pampean region are deficient in nitrogen (N) and phosphorus (P), but well provided with potassium (K), calcium (Ca), and magnesium (Mg) under native conditions. In recent years, sulfur (S) responses have been observed in several crops, mainly in areas under intensive cropping (high grain yields and longer periods under row crop agriculture).

Fertilizer use has sharply increased in Argentina in the last seven years, from 0.3 million tons in 1991 to almost 1.5 million tons in 1998. However, despite this increase, nutrient replacement from fertilization is still much below crop removal in the Pampas. An estimated 25 per-



**Figure 2.** A field day organized by AAPRESID: Seminar presentation (left) and field demonstration (right).

cent of the N and 45 percent of the P exported in grains by the four main annual crops of the Pampas are replaced by fertilization. Fertilizer rates are usually low and, generally, only N and P are applied. The low nutrient replacement has resulted in a considerable decrease of the native soil fertility; thus, fertilization is a necessary practice to get optimum yields.

Field trials conducted by AAPRESID in collaboration with other institutions (INTA, INPOFOS, AACREA) and several companies have shown significant responses to N, P and S fertilization under conditions in which farmers usually will not fertilize or use reduced nutrient rates.

Fertilization trials carried out at southern Santa Fe show excellent responses to P. A soybean trial (Figure 3) compares the usual practice of fertilization [70 kg/ha diammonium phosphate (DAP) at planting] with an extra application of 150 kg/ha DAP as a pre-plant in a low P soil. A wheat trial (Figure 4) showed the need for balancing preplant N and S with adequate P to obtain higher yields and increased fertilizer use efficiency.

Higher yields obtained under NT require improved nutrient management. AAPRESID is working with INTA, INPOFOS and fertilizer companies in a series of long-term fertilization experiments to improve crop nutrition in high yielding cropping systems. **BCI**

Dr. García is Director, PPI/PPIC Latin America Southern Cone (INPOFOS) Av. Santa Fe 910, (B1641ABO) Acassuso, Argentina, email:fgarcia@ppi-ppic.org. Mr. Ambrogio is Technical Coordinator and Dr. Trucco is President of AAPRESID, Paraguay 777, 8th floor Office 4(2000) Rosario, Argentina, www.aapresid.com.ar, aapresid@bcr.com.ar

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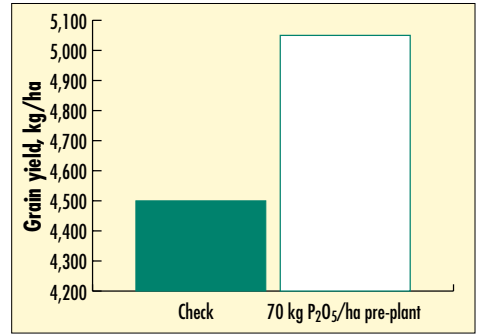


Figure 3. Response of full-season soybean to pre-plant P fertilization (D. Sebastian farm, Santa Fe). Both treatments had 32 kg P<sub>2</sub>O<sub>5</sub>/ha applied at planting. Source: AAPRESID

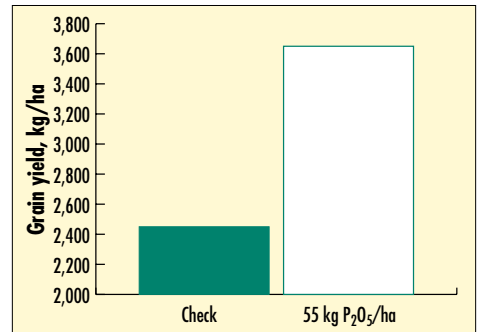


Figure 4. Response of wheat to P fertilization (Nonino farm, Santa Fe). Both treatments had 120 kg/ha of urea and 80 kg/ha of ammonium sulfate applied at pre-planting. Source: AAPRESID

## *To Be Useful, Information, like Water, Must Flow*

**One of the most important opportunities we all have is to make a positive change in the world in which we live.** The basis for change is having...and using...information. Think about it. Our world is changing faster than ever before, with rate of change continuing to accelerate because we know more today than we did yesterday. Those sectors of the world economy which are changing faster are information intensive, where information is shared, consumed, digested, and synthesized. Does your information go through this 'metabolic' process?

**What information do you get and give?** Is it the right information? What can be done with it to innovate agriculture? There are lots of questions that each and every one of us faces. The challenge to information flow...sending it...receiving it...and using it, is and will be the platform on which agriculture's worldwide success takes place.

**Many people see information as power, and indeed it is.** I propose that just how powerful any piece of information is depends on how much it is shared...used. If it is valuable to you in your country, just think how beneficial it can be to others. That is what I mean by flowing information...receiving it and sending it. *When water stands still it stagnates. So does information.*

**The challenge for all agriculturists having a global view and vision of a better world is to determine how they configure themselves into the information age.** PPI and PPIC have long recognized the need for information flow. That is the purpose of this and all our publications. Of course, the capacity to flow information depends on our research cooperators, our friends. We need commitments from scientists around the world to share their information. *Be an agent of change, for positive and progressive agricultural developments. Begin by sharing your information.*

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Printed on recyclable  
paper with soy ink.

A handwritten signature in black ink, appearing to read 'Mark D. Stauffer'.

Dr. Mark D. Stauffer  
Senior Vice President  
International Programs, PPI  
and President, PPIC