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.

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

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 However, these experiments were characterized by addition of low rates of N and P. Unpublished data from local sugar cane companies have shown large application rates of N, P and K increase sugar production in some of these areas.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.

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 Azucar, CENGICAÑA). 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.

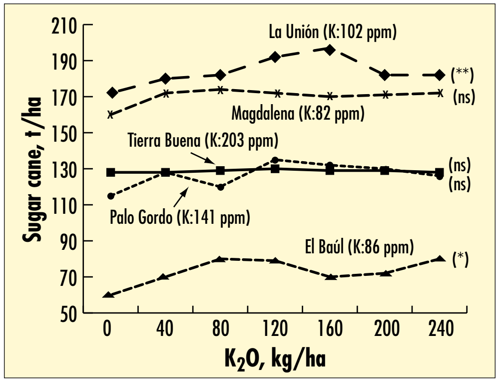

Figure 1. Sugar cane response to K in Andisols (La Unión, Palo Gordo and El Baúl), a Mollisol (Tierra Buena), and an Entisol (Magdalena), Guatemala.

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_2O/ha) with four replications were evaluated. All the treatments included applications of 150 kg N/ha and 120 kg P_2O_5/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_2O/ha rates.

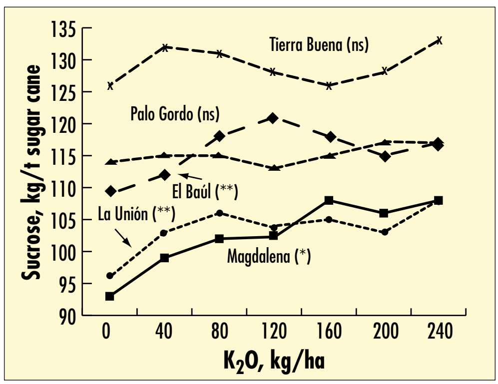

Figure 2. Sucrose response to K in Andisols (La Unión, Palo Gordo and El Baúl), a Mollisol (Tierra Buena), and an Entisol (Magdalena), Guatemala.

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

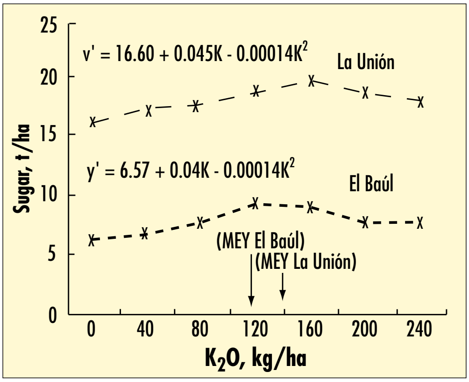

Figure 3. Regression model for K response in sugar cane production used to estimate MEY. The MEY calculations were based on the following values presented as quetzales (Q), the official currency of Guatemala. K_2O = Q 3.30 per kg; sucrose = Q 570 per t.

K_2O/ha. There was no effect in Palo Gordo and Tierra Buena, which was likely due to the high soil K contents present.

Figure 3 shows the sugar yield response curves and the K rate needed for maximum economic yield (MEY) at responsive sites. Maximum economic yield is that point on the yield curve where the last increment of K pays for itself. It is calculated from the derivative of the response function 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 (CENGICAÑA), located at Santa Lucía, Escuintla, Guatemala. E-mail: cengican@concyt.gob.gt

This project was partially financed by the PPI/PPIC Mexico and Northern Central America Program (INPOFOS).

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.*