Better Sugarcane Production for Acidic Red Soils

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The region would benefit greatly by considering a fertilization strategy that extends beyond traditional practice.

Sugarcane plantings in the southern sub-tropical province of Guangxi have experienced rapid expansion. Recent estimates place the harvested area at well over 0.5 million (M) ha. This region is well suited for sugarcane production, particularly in the central parts of the province. However, low fertilizer input and poor fertilizer management have limited cane yields to only about 45 to 60 t/ha. Sugarcane yields in the region have the potential to reach 90 to 150 t/ha. This study determined balanced fertilization's contribution towards reaching high yield and quality goals.

Study sites are indicated in the southern province of Guangxi.

Two field trials were situated within the sugarcane production base, one in the suburb of Nanning and one in Laibin County. Soils at the two sites were derived from quaternary red earth. At Laibin, the test soil was siliceous and silty, while in Nanning the soil is described as red. Six treatments (**Table 1**) were each applied to a 5.5 m by 4.0 m area. Plant nutrient sources included urea, diammonium phosphate, single superphosphate, potassium chloride (KCl), K-Mag™ ($K_2SO_4 \cdot 2MgSO_4$), calcium (Ca)-magnesium (Mg) phosphate, and Mg sulfate. Nitrogen (N) and potassium (K) were applied in four splits providing 5%, 15%, 25%, and 50% of the total treatment during the basal dressing, seeding, tillering, and cane elongation stages. The other fertilizers were applied basally. Guitang and Taitang crop cultivars were established at 5,000 seed-plants/ha. Sugarcane biomass was recorded at maturity along with percent fiber, sucrose, reducing sugars, and total sugar yield.

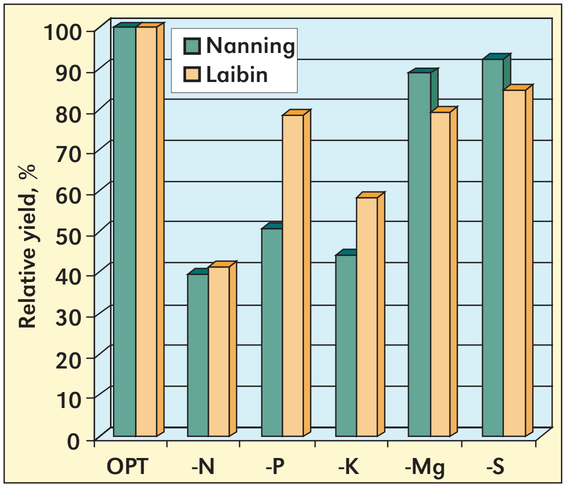
Soil nutrient analysis found fertility to be relatively low in both soils (**Table 2**). The soil near Nanning was acidic and deficient in N, phosphorus (P), K, and Mg.

Table 1. Nutrient application rates (kg/ha) used at Nanning and Laibin, Guangxi.

	N	P_2O_5	K_2O	Mg	S
NP	375	120	–	–	–
NPK	375	120	330	–	–
NPKMg	375	120	330	36	–
NPKMgS	375	120	330	36	60
NPK_2MgS	375	120	660	36	60
NPK_3MgS	375	120	990	36	60

Soil analysis in Laibin found the site to be near neutral, and deficient in N, K, sulfur (S), and Mg. This soil test data was well supported by subsequent pot trials which used sorghum as the indicator plant (Portch and Hunter, 2002). The trials found the relative severity of deficiency for the two locations to be similar at: N > K > P > Mg > S (**Figure 1**).

Figure 1. Relative yield of sorghum grown in pot trials using soils from two study sites.



The impact of balanced fertilization on plant growth was most evident during the fast-growing stage (July to August). Given adequate K, the inclusion of Mg and S allowed for higher plant growth at both locations, as illustrated by data from Laiban (**Figure 2**).

All aspects of cane quality, including single cane weight, cane length, and effective (harvestable) cane number, were positively affected by K, Mg, and S fertilization. But once again, adequate K appeared key to maximizing the response (**Table 3**). In Nanning, cane weight and length were equally as high under complete treatments using either the low (330 kg K_2O/ha) or intermediate (660 kg K_2O/ha) K rates. Effective cane number was significantly higher with the intermediate K rate. In Laiban, the advantage from applying the intermediate rate of K was perhaps even clearer. Given the N, P, Mg, and S rates tested, no advantage was found beyond 660 kg K_2O/ha.

The complete treatment supplying 660 kg K_2O/ha produced the highest cane yield at both sites (**Table 4**). An analysis of the incremental yield response to fertilizer reveals that K alone produced an additional 3.2 t/ha in Nanning and 6.9 t/ha in Laibin. Addition of Mg produced slightly more (0.7 t/ha) in Nanning, but was more significant (2.5 t/ha) in Laibin. The combination of Mg and S increased yield by 3.3 t/ha in Nanning and 5.0 t/ha in Laibin. Lastly, yields were maximized by raising the K rate to 660 kg K_2O/ha, which produced a total yield of 78.8 t/ha in Nanning and 99.9 t/ha in Laiban. Data from

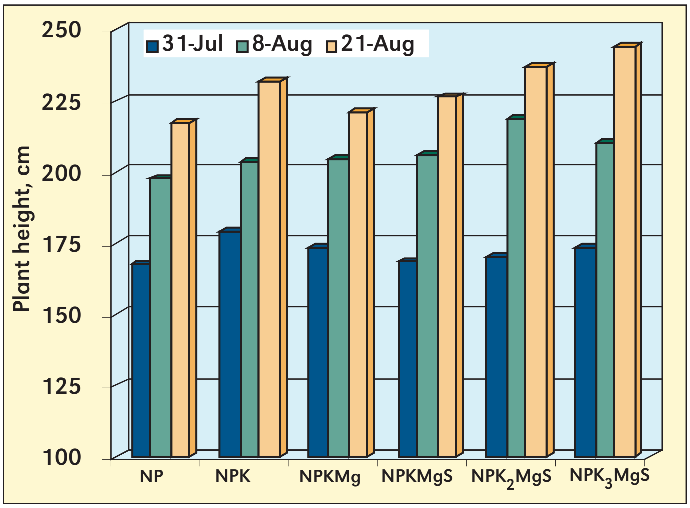


Figure 2. Plant heights measurements from late July to August, Liabin.

Table 2. Soil nutrient status at two sugarcane field sites, Guangxi.

			Available nutrient content, mg/kg					
	pH	O.M., %	N	P	K	S	B	Mg
Nanning	5.0	2.19	47.4	11.6	43.0	18.8	0.21	62.0
Laibin	6.8	1.58	13.7	14.5	70.4	8.0	0.24	100.5

Table 3. Size and numbers of harvestable canes, Guangxi.

	wt/cane, g		Cane diameter, mm		Effective canes/ha	
	Nanning	Laibin	Nanning	Laibin	Nanning	Laibin
NP	1,009	1,770	23.6	26.3	61,800	40,695
NPK	1,102	1,810	24.2	27.3	61,995	43,500
NPKMg	1,206	1,837	24.9	27.6	60,240	44,745
NPKMgS	1,260	1,850	24.9	27.8	58,320	43,245
NPK_2MgS	1,261	1,910	24.9	28.0	63,705	46,275
NPK_3MgS	1,243	1,815	25.1	27.9	59,145	44,250

Table 4. Sugarcane yield and yield increases, Guangxi.

	Nanning		Laibin	
	Yield, t/ha (2-year average)	Yield increase, %	Yield, t/ha (2-year average)	Yield increase, %
NP	66.1	-	80.7	-
NPK	69.3	4.8*	87.6	8.6*
NPKMg	70.0	5.9*	90.1	11.6**
NPKMgS	72.6	9.8**	92.6	14.7**
NPK_2MgS	78.8	19.2**	99.9	23.8**
NPK_3MgS	73.0	10.4**	91.4	13.3**

*, ** Means significantly differ at p=0.05 and p=0.01, respectively.

Table 5. Sugarcane crop quality traits, Laibin.

	Sucrose, %	Fiber, %	Reducing sugars, %	Sugar yield, t/ha
NP	13.60	11.26	2.38	10.97
NPK	14.88	11.54	2.44	13.04
NPKMg	14.95	11.56	1.71	13.47
NPKMgS	14.41	11.46	2.16	13.34
NPK_2MgS	13.86	11.57	2.14	13.85
NPK_3MgS	15.30	11.42	2.26	13.99

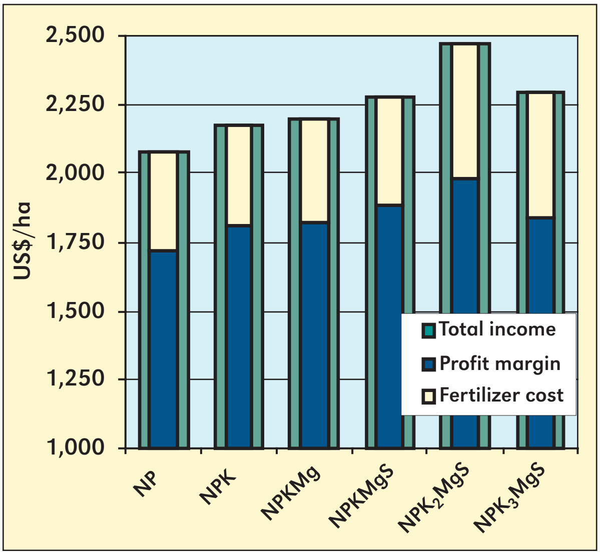


Figure 3. Profit margin comparison (average of 2 years and sites), Guangxi.

Laiban indicate that K had the largest influence on cane sucrose, fiber, and reducing sugar contents (**Table 5**). The effect of Mg and/or S fertilization was more subtle. Although their inclusion did not enhance product quality traits, Mg and S influence on plant growth and yield did result in improved commercial sugar yields. Sucrose content was maximized under the complete treatment using the highest K rate. Ultimately, this treatment produced the highest sugar yield, near 14 t/ha.

There was a steady improvement in net income despite the higher fertilizer costs due to K, Mg, and S input (**Figure 3**). Two years of data from both sites indicate that the complete treatment with 660 kg K_2O/ha is the most profitable. Net income was increased by US$256/ha, or 15%, in Nanning and US$456/ha, or 21%, in Laibin. Any further increase in K application was not justified at these sites due to the combined effect of lower yields and higher input cost.

Fields in southern China respond to significantly higher K application rates for sugarcane. **This research strongly suggests that adequate K in combination with Mg and S improved crop yield, harvestable sugar, and…most importantly…farmer profit margins.** BC

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