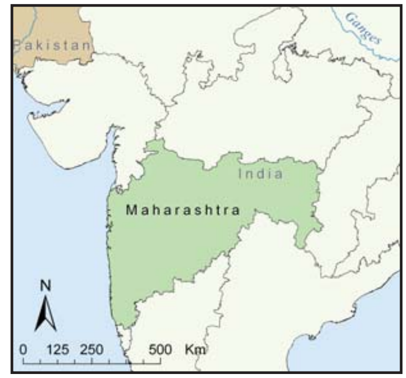
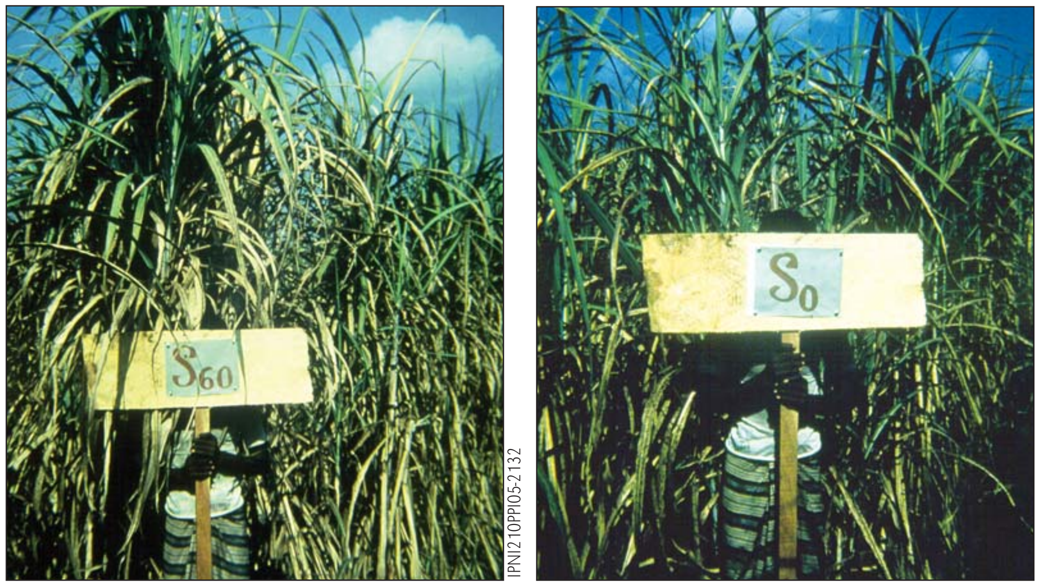
Meeting the Nutrient Demands of Modern Sugarcane Varieties

By D.B. Phonde, P. S. Deshmukh, M.W. Pawar, P.V. Ghodake, B.V. Undare, Harmandeep Singh Khurana, and Aliaksei Shcharbakou



Traditional practice within the average sugarcane field in Maharashtra is producing yields that are far below their potential. This study tests the current fertilization recommendation scheme with a modern crop variety to determine the viability of increasing the supply of nutrients that are commonly known to be either yield limiting or entirely avoided by growers.

In the western State of Maharashtra, the sugarcane agro-industry is second only to cotton in terms of economic importance. The crop has brought many desirable changes in social, economic, educational, and political life throughout its rural areas. High yields are possible and the three planting seasons, and ratoon crops sprouted from a previously harvested crop, can produce 200 to 270 t/ha. However, the state's average cane yield is only 85 t/ha. An important part of bridging this yield gap is adequate nutrient supply. Numerous research reports indicate that nutrient deficiencies are increasingly prevalent in cane-growing soils of Maharashtra amidst a lack of emphasis on maintaining soil fertility (Phonde et al., 2005). The impact of high-yielding varieties is an additional concern, as current nutrient recommendations should consider both the potential for both declining soil fertility as well as increasing crop demand.



From the IPNI Photo Archive (circa 1990): Sulfur application at 60 kg/ha provides a large growth response (left) in the sugarcane variety of the day. The zero S control is shown on the right.

The study below was designed to evaluate the effects of macro-, secondary-, and micro-nutrients on crop yield, quality and economics on a new high-yielding sugarcane variety. Previous yield trials with this variety show a 20% yield advantage compared to other commonly used varieties.

A split-plot design field study with three replications was carried out from 2009 to 2011 at Manjari and Warna in Maharashtra. Main treatments included a state recommended fertilizer dose (RDF) of 340-170-170 kg N-P_2O_5-K_2O/ha, which was tested against 125%, 150% and 175% of the RDF (**Table 1**). Sub-treatments included a control with NPK but no secondary or micronutrients, as well as five combinations of S, Fe, Zn, B, and Mn—each applied at its recommended rate.

Results

Cane yields increased significantly with increasing rates of NPK compared to the RDF (**Table 1**). While the highest cane yield at Manjari was obtained with 150% RDF treatment, the highest yield at Warna was obtained with 175% RDF. In Manjari, S3 (S+Fe+Zn) significantly increased cane yield over the control, but yields were not significantly different from the application of S alone. In Warna, S4 (S+Fe+Zn+B) significantly increased cane yields over the control, but its effect was not significantly different from S3.

Abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; S = sulfur; Fe = iron; Zn = zinc; B = boron; Mn = manganese; CCS = commercial cane sugar; ₹ = Indian Rupee.

Commercial cane sugar yields, on the other hand, showed no significant response to NPK application rates above the RDF or to further addition of secondary and micronutrients (**Table 1**). Juice quality parameters such as brix and pol (**Table 2**) as well as purity and CCS % (not shown) responded in a similar manner. Ayub et al. (1999) obtained similar results in their research where sugarcane yields increased with the application of higher fertilizer rates, but there was no change in the CCS yields or any of the juice quality parameters.

The economics of NPK fertilization followed a pattern similar to cane yields (**Table 3**) with significantly higher net returns obtained with 150% and 175% RDF treatments in Manjari and Warna, respectively. Similarly, S, Fe, Zn and B (S4) gave the best economic response to fertilization at Manjari, while S, Fe, Zn, B, and Mn (S5) gave the best economic response at Warna. Thus, a balanced fertilization approach that included the site-specific application of secondary- and micro-nutrients proved superior to just the application of NPK alone.

Summary

Cane yields and net returns increased with NPK application beyond that currently recommended for sugarcane in

Table 1. Cane and commercial cane sugar (CCS) yields as affected by different rates and nutrient combinations at Manjari and Warna, Maharashtra, India.

Treatments	Cane yield, t/ha Manjari	Cane yield, t/ha Warna	Cane yield, t/ha Mean	CCS yield, t/ha Manjari	CCS yield, t/ha Warna	CCS yield, t/ha Mean
NPK (M)						
M1 (100% RDF)	92.9a	92.0a	92.5	12.8a	14.0a	13.4
M2 (125% RDF)	99.4b	93.6b	96.5	11.3a	14.8a	13.1
M3 (150% RDF)	107c	98.1c	102	11.3a	15.4a	13.3
M4 (175% RDF)	108c	105d	107	13.3a	15.6a	14.4
Secondary and Micronutrients (S)						
Control	99.0a	94.4a	96.8	13.0a	14.3a	13.6
S1 (S)	102ab	94.8a	98.1	12.2a	14.5a	13.3
S2 (S+Fe)	99.5a	96.6a	98.0	11.8a	14.4a	13.1
S3 (S+Fe+Zn)	103b	97.3abc	100	11.5a	16.1a	13.8
S4 (S+Fe+Zn+B))	105b	99.1bc	102	12.1a	15.7a	13.9
S5 (S+Fe+Zn+B+Mn)	104b	101c	102	12.4a	14.8a	13.6
Interaction M x S						
	NS	NS	-	NS	NS	-

Means in the same column followed by the same letter are not significantly different at p = 0.05.
Recommended fertilizer rates include: 340-170-170 kg N-P_2O_5-K_2O/ha; 60 kg S/ha, 25 kg $FeSO_4$/ha; 20 kg $ZnSO_4$/ha; 5 kg Borax/ha; 10 kg $MnSO_4$/ha.
Control included 425-210-210 kg N-P_2O_5-K_2O/ha.
High-yield variety (Co VSI 9805)

Table 2. Response of sugarcane to levels of NPK, secondary, and micronutrients on Brix and Pol (sucrose) % at Manjari and Warna, Maharashtra, India.

Treatments	Brix, % Manjari	Brix, % Warna	Brix, % Mean	POL, % Manjari	POL, % Warna	POL, % Mean
NPK (M)						
M1 (100%RDF)	19.0a	22.6a	20.6	17.3a	20.8a	19.1
M2 (125%RDF)	19.0a	22.0a	20.5	17.4a	20.6a	19.0
M3 (150%RDF)	18.6a	21.3a	19.9	18.0a	20.0a	19.0
M4 (175%RDF)	19.0a	21.4a	20.2	17.7a	20.0a	18.9
Secondary and Micronutrients (S)						
Control	19.0a	21.5a	20.2	18.2a	20.0a	19.1
S1 (S)	19.0a	21.3a	20.1	17.6a	19.9a	18.7
S2 (S+Fe)	19.2a	21.4a	20.3	17.8a	20.0a	18.9
S3 (S+Fe+Zn)	18.8a	22.9a	20.8	16.8a	21.6a	19.2
S4 (S+Fe+Zn+B))	18.4a	22.2a	20.3	17.9a	20.8a	19.4
S5 (S+Fe+Zn+B+Mn)	18.7a	21.2a	19.9	17.3a	19.7a	18.5
Interaction M x S						
	NS	NS	-	NS	NS	-

Means in the same column followed by the same letter are not significantly different at p = 0.05.

Maharashtra, but the response was site-specific. Cane yield response to secondary and micronutrient application also varied between the two locations. Commercial sugar yield and sugarcane juice quality parameters were not affected by any of the experimental approaches. In summary, a balanced approach that includes the site-specific application of macro- as well as secondary- and micro-nutrients is likely to meet the demands of modern sugarcane varieties and generate better results for growers. BC

Table 3. Economic evaluation of different levels of sugarcane fertilization at Manjari and Warna, Maharashtra, India.

Treatments	Gross returns, '000 ₹/ha	Cost of Cultivation, '000 ₹/ha	Net returns, '000 ₹/ha
Manjari			
NPK (M)			
M1 (100%RDF)	167a	81	86a
M2 (125%RDF)	180b	83	97b
M3 (150%RDF)	192c	86	106c
M4 (175%RDF)	195c	88	107c
Secondary and Micronutrients (S)			
Control	178a	83	95a
S1 (S)	183b	84	99b
S2 (S+Fe)	179a	84	95a
S3 (S+Fe+Zn)	186bc	85	101bc
S4 (S+Fe+Zn+B))	189c	85	104c
S5 (S+Fe+Zn+B+Mn)	187c	86	101bc
Warna			
NPK (M)			
M1 (100%RDF)	166a	81	85a
M2 (125%RDF)	168a	83	85a
M3 (150%RDF)	177b	86	91b
M4 (175%RDF)	189c	88	101c
Secondary and Micronutrients (S)			
Control	170a	83	87a
S1 (S)	171a	84	87a
S2 (S+Fe)	174ab	84	90ab
S3 (S+Fe+Zn)	175abc	85	90ab
S4 (S+Fe+Zn+B))	178bc	85	93bc
S5 (S+Fe+Zn+B+Mn)	182c	86	96c

Means in the same column followed by the same letter are not significantly different at p = 0.05.
*Economic returns and cost of cultivation were calculated using the following: Minimum support price of sugarcane = ₹2.5/kg; Costs of fertilizer N, P, K, S, Fe, Zn, B, and Mn = ₹10.5, 16.5, 7.5, 26.5, 22, 20, 34, and 28/kg, respectively; Labor cost = ₹105/day in addition to irrigation and pesticide costs. US$1= ₹60.

Mr. Phonde (e-mail: dbphonde@rediffmail.com), Dr. Deshmukh, Dr. Pawar, Dr. Ghodake and Dr. Undare are with the Vasantdada Sugar Institute, Pune, Maharashtra, India. Dr. Khurana is Agronomic & Technical Support Specialist, IPNI, Saskatoon, Canada. Dr. Shcharbakou is Director, Agronomy at Uralkali Trading, Singapore.

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