Indian Journal of Agronomy **61** (3): 404–406 (September 2016)

Research Communication

Analysis of sugarcane (*Saccharum officinarum*) yield and quality in response to fertilizer application

SHUBHAM LAMBA[1], VIJAY KUMAR[2] AND K.S. GREWAL[3]

Regional Research Station, CCS Haryana Agricultural University, Karnal, Haryana 132 001

Received : July 2015; Revised accepted : July 2016

ABSTRACT

An experiment was conducted during 2013–14 at the Regional Research Station, Karnal, Haryana, to study the effect of various combinations of fertilizers on yield and quality of sugarcane (*Saccharum officinarum* L.). The experiment was conducted in randomized block design, comprising 12 treatments, viz. control (no fertilizer), N (150 kg N/ha), NP (50 kg P_2O_5/ha), NPK (50 kg K_2O/ha), NPKS (40 kg S/ha), NPK + Zn (25 kg $ZnSO_4$/ha), NPK + Fe (3 foliar sprays of 1% $FeSO_4$), NPK + Mn (3 foliar sprays of 0.5% $MnSO_4$), NPKS + Zn, NPKS + Zn + Fe, NPKS + Zn +Fe + Mn and soil test based fertilizer application. Sugarcane yield, yield parameters, juice quality and sugar yield were found significantly affected by the treatments. The application of N, NP, NPK, NPKS and NPKS + Fe + Zn + Mn significantly increased cane yield compared to the control and the increase was in order of 27.4, 34.8, 39.3, 42.2 and 46% respectively. Similarly, the application of N, NP, NPK, NPKS and NPKS + Fe + Zn + Mn significantly increased sugar yield compared to the control, being 31.4, 39.2, 46.6, 50.6 and 57.2% respectively.

Key words : Crop production, Micronutrients, NPK, Quality, Quantity, Sugar, Sugarcane

Cultivation of crops with high-nutrient demand results in huge economic loss, if nutrients are not being added judiciously. Sugarcane is not an exception; it is high-nutrient demanding crop removing nearly 208 kg N, 53 kg P, 280 kg K, 6.3 kg Fe, 1.2 kg Mn and 0.6 kg Zn from the soil by an average crop producing 100 t/ha of sugarcane (Malavolta, 1994). With the intensive cultivation, soils are getting depleted in the availability of nutrients hence becoming less fertile; the low fertility of soil is one of the important limiting factors in sugarcane productivity. In India, sugarcane-growers apply N and P only and generally do not apply K, secondary nutrients and micronutrients. Consequently, they face huge economic loss and sugar industries observe less sugar recovery per unit of sugarcane which is serious emerging issue in front of sugar industries since they are always unaware that the sugarcane they are procuring is properly fed with nutrients or not which is directly related to the sugar production in the industry. Sugarcane in particular has great influence on the Indian agriculture and economy, as it is the only major source of sugar in the country as well as sugarcane-processing industries generates huge employment. The area under sugarcane is presently around 4.4 million ha, with an average productivity of 68 t/ha. The highest production of 355 million tonnes of cane was recorded during 2006–07 cropping season from an area of 5.15 million ha (IISR, Lucknow, 2007). With the increasing population the area under cultivation is decreasing as well as farmers are shifting from sugarcane cultivation to other crops because sugarcane yields are hard to predict because of seasonal climate variability (Everingham *et al*., 2007) as well as huge nutrient demand of sugarcane, declining nutrient status of soil, perennial nature of crop and fear of disease and insect-pest infestation.

Judicious use of fertilizers generally helps in proper management of resources as well as results in increased profitability to the farmers. Healthy crop fetches good money to farmer as well as produce enough sugar which is always desirable for farmers and also sugar industry's point of view. Keeping the above facts in view, an experiment was conducted to study the response of sugarcane to different fertilizer combinations in respect of yield and juice quality.

The experiment was conducted at Regional Research

Based on a part of M.Sc. (Agriculture) thesis of the first author, submitted to the CCS Haryana Agricultural University, Hisar (unpublished).

[1]**Corresponding author Email:** shubham.hau@gmail.com
[1]Research Scholar, [3]Principal Scientist, Department of Soil Science, CCS Haryana Agricultural University, Hisar 125 004; [2]Principal Scientist, Regional Research Station, CCS Haryana Agricultural University, Karnal 132 001

Station, Karnal (29º 43’42.19' N, 76º 58’49.88' E, 253 m above mean sea-level) of the CCS Haryana Agricultural University. Sugarcane seeds (setts) of variety ‘CoH 119’ were sown in furrows on 24 March 2013. The initial composition of soil consisted of organic carbon (0.36%), available N (125.3 kg/ha), available P (10.2 kg/ha), available K (129.2 kg/ha), available S (12.2 kg/ha), available Fe (3.7 ppm), available Mn (2.6 ppm) and available Zn (0.9 ppm). The design of plot was randomized block. Experimental field was then divided into 3 equal parts (replications) and denoted as R1, R2 and R3. Each replication was further divided into 12 equal plots of size 6 m × 6 m. In each plot nutrients were added as: control (no fertilizer); N_{150}; N_{150} P_{50}; N_{150} P_{50} K_{50}; N_{150} P_{50} K_{50} + S_{40}; N_{150} P_{50} K_{50} + Zn_{25}; N_{150} P_{50} K_{50} + F; N_{150} P_{50} K_{50} + Mn; N_{150} P_{50} K_{50} + S_{40} + Zn_{25}; N_{150} P_{50} K_{50} + S_{40} + Zn_{25} + Fe; N_{150} P_{50} K_{50} + S_{40} + Zn_{25} + Fe + Mn; and soil-test-based fertilizer application.

Nitrogen was applied @ 150 kg N/ha through urea, phosphorus @ 50 kg P_2O_5/ha through diammonium phosphate, potash @ 50 kg K_2O/ha through muriate of potash, sulphur @ 40 kg $CaSO_4$/ha and zinc @ 25 kg $ZnSO_4$/ha. All phosphorus, potash, zinc and one-third N were applied at planting and remaining N was applied in 2 equal splits– first at the second irrigation second at the fourth irrigation. The Fe and Mn were sprayed as 3 foliar sprays each of 1% $FeSO_4$ and 0.5% $MnSO_4$. Different yield and quality observations were recorded using standard methods and procedures.

For juice-quality analysis at the harvesting of crop, 10 cane stalk/plot were randomly collected, weighed and passed through a 3-roller sample mill for juice extraction. The crushed juice was analyzed for brix (soluble solids) by brix hydrometer. After clarifying the juice with lead sub–acetate, the sucrose concentration was determined by Polarimeter. The percentage of sucrose and commercial cane sugar (CCS) in juice were determined by the methods of Meade and Chen (1977).

Statistical analysis of the data revealed that various combinations of nutrients resulted in significant variations in the yield parameters that ultimately influenced the final yield of sugarcane. The application of N, NP, NPK and NPKS significantly increased the cane girth, cane height, number of internodes and number of millable canes (NMC) as compared with the control. Treatments based on balanced doses of macronutrients (N, P, K and S) along with micronutrients (Zn, Fe and Mn) resulted in maximum increase in cane girth (24.6%), cane height (23%), number of internodes (29.4%) and NMC (16.3%) compared with the control. As a result of significant increase in the yield parameters under balanced fertilization, 46% more sugarcane yield was observed than that of the control which is owing to fulfilment of nutritional requirements of the plant by feeding balanced fertilizer doses (Table 1). Kumar *et al*. (2004) reported that sugarcane yield was greater in plots with balanced supply of K, S, and Mg along with N and P. The highest cane yield was achieved under combined application NPK + S + Mn. Kumar *et al.* (2014) reported that application of micronutrients like Zn and Fe in addition to NPK fertilizers was necessary to obtain maximum benefits from sugarcane crop, as incorporation of different type of fertilizers and micronutrients can improve soil fertility and hence increase cane yield. Virida and Patel (2010) re-

Table 1. Response of various combinations of nutrients on cane yield and yield parameters of sugarcane

Treatment	Yield and yield parameters				
	Cane girth (cm)	Cane height (cm)	Internodes (Nos.)	NMC ($\times 10^3$/ha)	Cane yield (t/ha)
Control (no fertilizer)	2.18	145	12	72.7	45.61
N	2.33	160	15	76.2	62.83
NP	2.53	166	16	78.4	69.97
NPK	2.68	172	17	81.7	75.16
NPK + S	2.73	177	17	83.1	78.93
NPK + Zn	2.69	172	17	82.0	76.26
NPK + Fe	2.70	172	17	82.3	76.57
NPK + Mn	2.72	172	17	82.3	75.47
NPK + S + Zn	2.78	177	17	83.7	79.20
NPK + S + Zn + Fe	2.84	183	17	85.8	82.97
NPK + S + Zn + Fe + Mn	2.89	188	17	86.9	84.48
Soil-test-based fertilizer application	2.69	171	17	81.3	75.10
SEm±	0.02	1.6	0.3	0.7	1.08
CD (P=0.05)	0.05	4.8	0.9	2.1	3.20

*NMC, Number of millable canes

Table 2. Response of various combinations of nutrients on juice quality parameters and sugar yield

Treatment	Juice-quality parameters and sugar yield					
	Extraction (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	Sugar yield (t/ha)
Control (No fertilizer)	44.7	16.4	13.6	77	9	4.26
N	50.9	17.2	14.4	81	10	6.21
NP	52.1	17.9	14.7	85	10	7.01
NPK	55.1	18.5	15.3	88	11	7.98
NPK + S	56.7	19.2	16.0	90	11	8.62
NPK + Zn	55.8	18.7	15.3	89	11	8.10
NPK + Fe	55.9	18.8	15.3	89	11	8.15
NPK + Mn	55.6	18.9	15.3	89	11	8.04
NPK + S + Zn	58.0	19.4	16.1	90	11	8.90
NPK + S + Zn + Fe	59.3	19.5	16.5	92	12	9.71
NPK + S + Zn + Fe + Mn	61.2	19.9	17.0	93	12	9.96
Soil-test-based fertilizer application	55.2	18.4	15.2	86	11	7.97
SEm±	0.41	0.2	0.12	1.0	0.1	0.31
CD (P=0.05)	1.21	0.6	0.36	3.1	0.3	1.71

*CCS, Commercial cane sugar

ported that NMC, cane girth and cane height were found significantly higher in fertilized plots than in the control plots, in integrated nutrient management experiment on sugarcane.

Sugar yield is analogous to healthy sugarcane crop; balanced fertilized sugarcanes are thick, long and always giving maximum sugar recovery as compared to unbalanced fertilized ones. Statistical analysis revealed that application of N, NP, NPK and NPKS significantly increased the juice-extraction percentage, brix percentage, purity percentage, sucrose content and commercial cane sugar (CCS) as compared with the control. Maximum significant increase in extraction percentage, brix percentage, purity percentage, sucrose content and commercial cane sugar (CCS) was observed under balanced fertilization of macronutrients along with micronutrients to the tune of 27%, 17.3%, 17.5%, 19.7% and 22.1% as compared with the control. As a result of enhancement in juice-quality parameters owing to balanced fertilization, huge increase in sugar yield was observed to the tune of 57.2% as compared with the control (Table 2). Balanced fertilization facilitated smooth functioning of various metabolic and physiological activities in the sugarcane plant that ultimately helped in development of healthy sinks having quality and quantity. Wang *et al.*, (2005) reported that increase in sugar yield; pol and purity percentage owing to micronutrients, especially iron and zinc is attributed to essentiality of these micronutrients for growth of sugarcane. The Fe and Zn are known to play important role in structural and functional integrity of various proteins that enhance the juice quality.

Based on the experimental findings, it can be inferred that sugarcane yield and yield attributes, juice quality and sugar recovery can be enhanced by judicious and balanced application of nutrients. Enhanced sugarcane and sugar yield is always desirable for betterment of farmers' livelihood and sustenance of sugar industries.

REFERENCES

Everingham, Y.L., Inman-Bamber, N.G., Thorburn, P.J. and McNeill, T.J. 2007. A bayesian modelling approach for improving long-lead sugarcane yield forecasts. *Australian Journal of Agricultural Research* **58**: 87–94.

IISR, Lucknow. 2007. *Vision-2025*, 62 pp. Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh.

Kumar, S., Rana, N.S. and Singh, R. 2004. Production potential of spring-planted sugarcane as influenced by intercropping of dual-purpose legumes under *tarai* conditions of Uttaranchal. *Indian Journal of Agronomy* **51**(4): 271–273.

Kumar, S., Kumar, V., Kumar, S., Singh, O. and Kumar, V. 2014. Effect of fertility and weed-management practices on yield potential, nutrient uptake and economics of spring-planted sugarcane (*Saccharum officinarum*). *Indian Journal of Agronomy* **59**(1): 139–144.

Malavolta, E. (Eds). 1994. *Nutrient and Fertilizer Management in Sugarcane,* pp. 104 International Potash Institute, Basel.

Meade, G.P. and Chen, J.C.P. (Eds). 1977. *Cane Sugar Hand book*. John Wiely & Sons, New York.

Virida, H.M. and Patel, C.L. 2010. Integrated nutrient management for sugarcane (*Saccharum* spp. Hybrid complex) plant-ratoon system. *Indian Journal of Agronomy* **55**(2): 147–151.

Wang, J.J., Kennedy, C.W., Viator, H.P., Arceneaux, A.E. and Guidry, A.J. 2005. Zinc fertilization of sugarcane in acid and calcareous soils. *Journal of American Society of Sugarcane Technology* **25**: 49–61.