International Journal of Plant & Soil Science

33(22): 289-295, 2021; Article no.IJPSS.76158
ISSN: 2320-7035

Effect of Foliar Application of NPK and Micronutrient (Zn and Fe) on the Yield and Quality of Sugarcane Crop

Roohi[1], Kiran K. Khokhar[1], Vijay Kumar[1] and Kanika Pawar[1*]

[1]Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Karnal-132001, Haryana, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i2230707
Editor(s):
(1) Dr. Francisco Cruz-Sosa, Metropolitan Autonomous University, México.
(2) Prof. Al-kazafy Hassan Sabry, National Research Centre, Egypt.
Reviewers:
(1) Gusikit, Rhoda Bernard, University of Jos, Nigeria.
(2) Omar Maghawry Ibrahim, Arid Lands Cultivation Research Institute, Egypt.
Complete Peer review History: http://www.sdiarticle4.com/review-history/76158

Original Research Article

Received 25 August 2021
Accepted 03 November 2021
Published 08 November 2021

ABSTRACT

The foliar application of nutrients help the plant leaves to readily absorb the applied nutrients through the nutrient solution and increases the nutrient use efficiency and thus improves the crop yield. The field experiment was conducted for two consecutive years to find out the affect of foliar spray of NPK and micronutrient on cane yield, yield parameters and juice quality of sugarcane during 2019-20 and 2020-21.The present study was carried out on clay loam soils of Research farm of Regional Research Station, CCS Haryana Agricultural University, Karnal, Haryana. The research revealed that cane yield and yield parameters i.e., cane length, and cane weight was significantly affected with the foliar spray of NPK and micronutrient but non-significant effect was observed for cane girth and number of internodes. With respect to juice quality parameters viz., commercial cane sugar (CCS) %, pol % and sugar yield, significantly affected with foliar spray of NPK and micronutrient. The highest cane yield, cane weight and cane length was recorded with the foliar application of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ +1% $FeSO_4$ (78.16 t/ha, 1.21 kg and 207.3 cm) followed by foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+ 2.5% urea recorded 76.75 t/ha, 1.20 kg and 207.1 cm, respectively. The lowest cane yield (70.68 t/ha) was recorded with the application of recommended dose of fertilizer (RDF) alone. The highest CCS % (12.16), pol % (17.36) and sugar

**Corresponding author: E-mail: kanikapawar@gmail.com;*

yield (9.51 t/ha) was observed in the treatment 2% NPK + 0.5% $ZnSO_4$ +1% $FeSO_4$. Thus, foliar application with NPK and micronutrient could significantly improve the cane yield, yield parameters and juice quality of sugarcane crop.

Keywords: Foliar application; juice quality; micronutrients; NPK; sugarcane.

1. INTRODUCTION

Sugarcane is one of the most important commercial crops cultivated worldwide. It is a heavy feeder crop and requires very large quantity of nutrients which must be applied through fertilizers to obtain optimum yield on sustainable basis [1]. Micronutrient deficiency is one of the significant factor which may restrict yield of sugarcane crop and creates disturbances in the physiological as well as metabolic processes of the crop [2]. Mono cropping, intensive cultivation, use of high yielding varieties, use of micronutrient free fertilizers and unavailability of organic manure may result in appearance of multi-micronutrient deficiencies in plants [3].

Although, micronutrients are needed in an exceptionally little amount but their consistent supply to the crop has to be ensured. The micronutrient deficiency is nowadays widespread especially of zinc and iron throughout the country and that of manganese and boron in specific areas. Over mining of micronutrients from soil reserve due to enhanced food production accentuated the micronutrient deficiencies which brought sharp reduction in productivity, crop quality as well as animal and human health. The basal application of nutrient may not satisfy the nutrient requirement of the crop and is found to be less effective than foliar application. There are certain environmental factors which affect the availability of nutrient to plant in soil application such as zinc. Because of high pH, lime or heavy texture, crop roots are unable to absorb zinc from the soil [4]. But in foliar application, those factors could be avoided and this could increase the availability of macro as well as micronutrient because of rapid absorption by plants. Foliar application is an effective approach to supply micronutrient to the plant, where solution containing one or more nutrient is sprayed on the foliage of plant [5]. Foliar application is mostly preferable over soil application. Around 90% fertilizer use efficiency of crop can be obtained through foliar application while 95% content of nutrient solution can be found in the small portion of root within 60 minutes [6]. So, this helps the plants to readily absorb the nutrient present in the solution by leaves and increase the nutrient use efficiency. Various studies confirmed the positive response of foliar application of micronutrient in different crops such as wheat [7], maize [6] and soyabean [8]. So, the present study has been conducted to know the effect of foliar spray of NPK and micronutrient on cane yield, yield parameters and quality of sugarcane crop in clay loam soils.

2. MATERIALS AND METHODS

A field experiment was conducted to study the "Effect of foliar spray of NPK and micronutrients on cane yield, yield parameters and juice quality of sugarcane in clay loam soils" during 2019-2020 and 2020-2021. Investigation was carried out at Regional Research Station, Chaudhary Charan Singh Haryana Agricultural University, Karnal, Haryana situated at 29°43'42.19" N latitude, 76° 58'49.88" E longitude and at an altitude of 253 meters above mean sea level (Fig. 1). Initial representative soil sample from the experimental site was collected from depth of 0-15cm before the layout. The soil of the experimental site was neutral to alkaline and non-saline in nature, low in organic carbon, available P and K. The micronutrients Zn (1.19 mg/kg), Fe (12.28 mg /kg), Mn (6.15 mg/kg) and Cu (1.62 mg/kg) were analyzed as per the standard procedure [9].

The experiment was laid out in randomized block design (RBD) consisting of eight treatments with three replications. The variety used was CoH160. The recommended dose of fertilizer for plant crop was 150-50-50 NPK kg/ha. The experiment consists of following eight treatments.

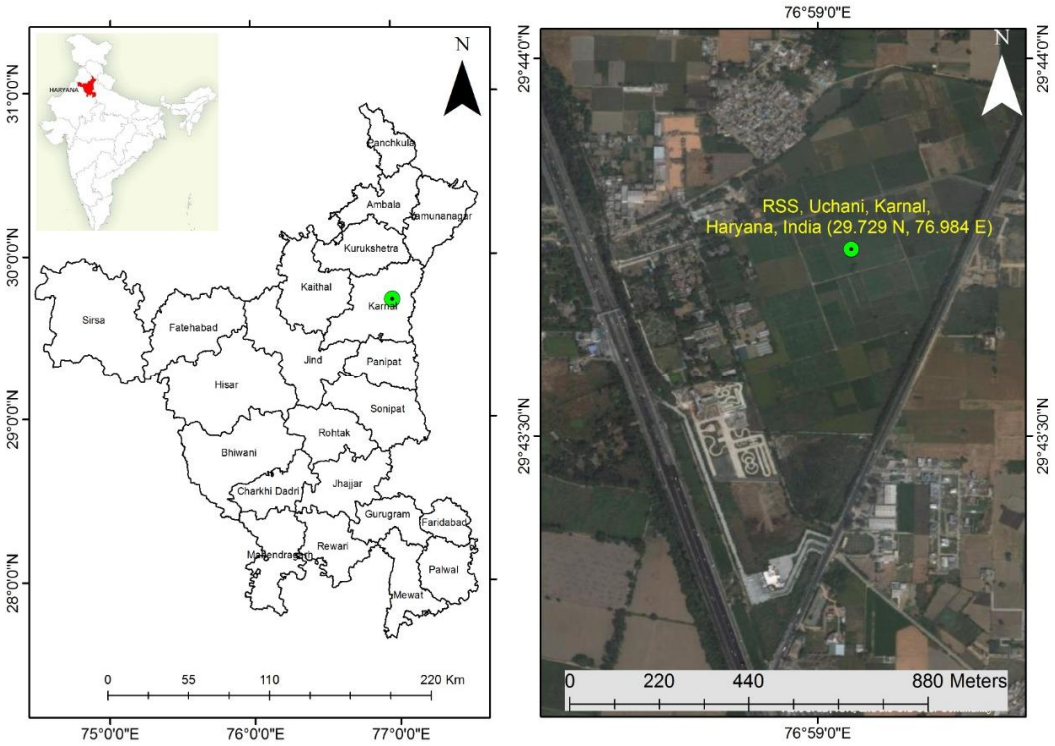

Fig. 1. Map of study area

List 1. The experiment consists eight treatments

T_1	RDF + Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+2.5 % Urea
T_2	RDF + Foliar spray of 0.5% $ZnSO_4$ +2.5 % Urea
T_3	RDF + Foliar spray of 1% $FeSO_4$+2.5 % Urea
T_4	RDF+ 2.5 % Urea
T_5	RDF+ 2% NPK
T_6	RDF + 2% NPK +Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$
T_7	RDF +Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+ lime 0.5%
T_8	RDF alone

Three foliar sprays of each treatment were done at an interval of 15 days in the month of May and June. All agronomic practices such as irrigation, weeding, earthing up and other cultural practices were followed as per the package and practices of CCS HAU, Hisar. The crop was harvested and samples were collected for quality analysis viz., Sucrose %, purity % and sugar yield in the month of January of both years. Sucrose (%) was estimated by Horne's dry lead acetate clarification method [10]. Purity (%) was determined by Spencer and Meade [11]. Sugar yield (t/ha) was calculated by using the formula: Cane yield (t/ha) ×CCS %/100. The cane length, cane weight, number of internodes and cane girth from each plots were recorded.

3. RESULTS AND DISCUSSION

The effect of foliar spray of NPK and micronutrient on yield parameters, yield and juice quality parameters of sugarcane crops are discussed briefly.

3.1 Effect of Foliar Application of NPK and Micronutrients on Yield Parameters and Cane Yield

All the growth parameters studied i.e. cane weight, cane length, no. of internodes and cane girth were influenced by the foliar spray of $ZnSO_4$, $FeSO_4$ and NPK (19:19:19) when compared to RDF (T_8) and the data pertaining to

growth parameters are presented in Table 1. Higher cane weight (1.21 kg) was recorded by the foliar spray of 2% NPK + 0.5% $ZnSO_4$ +1% $FeSO_4$(T_6) followed by 1.20 kg cane weight as a result of the foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+ 2.5% urea (T_1). However, lowest cane weight (0.94 kg) was recorded by T_8 to which only RDF was applied. Likewise, maximum cane length (207.3 cm) was again recorded by T_6 receiving foliar spray of 2% NPK + 0.5% $ZnSO_4$ +1% $FeSO_4$ which was statistically at par with the cane length recorded by T_1 (207.1 cm) and T_7 (206.5cm). Minimum cane length (191 cm) was reported in the treatment to which RDF alone was applied. Number of internodes and cane girth recorded by different treatments was found non- significant.

Perusal of data revealed that cane yield was positively influenced with the foliar spray of Fe and Zn. The foliar application of 2% NPK + 0.5% $ZnSO_4$ + 1% $FeSO_4$ (T_6) documented highest cane yield (78.16 t/ha) followed by foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+ 2.5% urea (T_1) which recorded cane yield of 76.75 t/ha. However, minimum sugarcane yield was recorded in T_8 to which only RDF was applied (70.68 t/ha). These results can be attributed to the foliar application of micronutrient and NPK, where applied zinc micronutrient is directly involved in the synthesis of tryptophan, a precursor of Indole acetic acid, and the formation of enzymes that are responsible for cell growth and elongation [12]. Normal growth of the plant can be affected due to non-availability of nutrients but foliar application avoids the nutrient fixation and makes it available to the plant on time. Plant biomass significantly increased with the foliar application of nitrogen and phosphorus. Kumar et al. [13] also documented the effectiveness of three sprays of 2.5% Urea in the month of May and June basal along with RDF and recorded significant increase in cane yield ranges from 56.90 to 60.78 t/ha in first plant crop and 71.90 to 75.89 t/ha in second plant crop. Kumar et al. [14] described the importance of potassium as an enzyme activator in plant metabolism i.e., photosynthesis, starch formation and translocation of protein and sugar in sugarcane.

Rakkiyappan et al. [15] evaluated the response of sugarcane to foliar application of ferrous sulphate (2%) and found foliar application of Fe more effective than soil application for improving the iron content of leaf and it also have a direct impact on the sugarcane crop's growth [16,17]. Similar results were outlined by Balaji et al. [18]; Singh et al. [19] and Aslam et al. [20]. It was generally attributed to increased number of millable canes, number of internodes, average cane length and cane weight. On the similar line, Wang et al. [21] also reported 24.8 per cent increase in cane yield over control with the application of micronutrient.

Table 1. Effect of foliar spray of NPK and micronutrients on growth parameters and yield of sugarcane crop (Pooled data of year 2019 and 2020)

Treatments		Single Cane Weight (kg)	Cane Length (cm)	No. of internodes	Cane Girth (cm)	Cane Yield (t/ha)
T_1	RDF + Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+2.5 % Urea	1.20	207.1	18	2.66	76.75
T_2	RDF + Foliar spray of 0.5% $ZnSO_4$ +2.5 % Urea	1.12	201.3	17	2.60	73.26
T_3	RDF + Foliar spray of 1% $FeSO_4$+2.5 % Urea	1.11	200.3	17	2.60	73.77
T_4	RDF+ 2.5 % Urea	0.98	192.7	17	2.56	72.01
T_5	RDF+ 2% NPK	1.07	195.7	17	2.48	72.83
T_6	RDF + 2% NPK +Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$	1.21	207.3	18	2.68	78.16
T_7	RDF + Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+ lime 0.5%	1.18	206.5	18	2.65	75.41
T_8	RDF alone	0.94	191.0	16	2.48	70.68
CD at 5%		0.07	4.2	NS	NS	1.53

3.2 Effect of Foliar Application of NPK and Micronutrients on Juice Quality of Sugarcane

It is very much clear from the data presented in Table 2 that all the qualitative attributes studied i.e. CCS %, pol % and sugar yield (t/ha) were significantly affected by the foliar application of NPK, Zn and Fe. The foliar spray of 2% NPK (19:19:19) + 0.5% $ZnSO_4$ +1% $FeSO_4$ in T_6 recorded maximum CCS% (12.16) followed by 11.75% recorded with the application of 0.5% $ZnSO_4$ + 1% $FeSO_4$ + 2.5% urea (T_1). Increase in CCS content with foliar application of micronutrient is likely to be attributed to an increase in sucrose synthase and sucrose phosphate synthase activity. Maximum pol % (17.36) was recorded by T_6 receiving foliar spray of 2% NPK + 0.5% $ZnSO_4$ +1% $FeSO_4$ and found on par with 0.5% $ZnSO_4$ + 1% $FeSO_4$+ 2.5% urea (T_1) recorded 16.63 %. Pawar et al. [22] also reported increase in CCS % with the foliar application of phosphorus @ 8kg/ha (14.39%) and zinc (14.15%) as compared to control (13.68%).

Similarly, maximum sugar yield was also recorded by T_6 which was found to be 9.51 t/ha followed by 9.01 t/ha recorded by T_1 to which foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$ + 2.5% urea was applied. Lowest CCS (10.41%), pol (15.27%) and sugar yield (7.36 t/ha) was recorded in RDF alone (T_8). On similar lines, Ghaffar et al. [3] observed an increase in sugar yield with foliar application of zinc and iron in planted sugarcane. A significantly higher sugar yield was observed with the foliar application of micronutrients which might be due to higher cane yield and CCS per cent obtained. Regression model was developed which indicates the relation between sugar yield and cane yield (Fig. 2).

Table 2. Effect of foliar spray of NPK and micronutrients on qualitative attributes (Pooled data of year 2019 and 2020)

Treatments		CCS %	Pol %	Sugar yield (t/ha)
T_1	RDF + Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+2.5 % Urea	11.75	16.63	9.01
T_2	RDF + Foliar spray of 0.5% $ZnSO_4$ +2.5 % Urea	11.39	16.61	8.36
T_3	RDF + Foliar spray of 1% $FeSO_4$+2.5 % Urea	11.41	16.52	8.40
T_4	RDF+ 2.5 % Urea	11.05	15.93	7.95
T_5	RDF+ 2% NPK	11.31	16.38	8.24
T_6	RDF + 2% NPK +Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$	12.16	17.36	9.51
T_7	RDF + Foliar spray of 0.5% $ZnSO_4$ + 1% $FeSO_4$+ lime 0.5%	11.62	16.62	8.76
T_8	RDF alone	10.41	15.27	7.36
CD at 5%		0.40	1.08	0.38

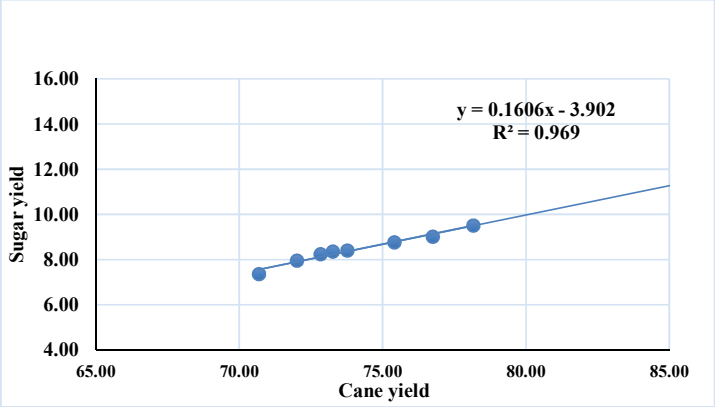

Fig. 2. Relation between cane yield (t/ha) and sugar yield (t/ha) of sugarcane as affected by foliar application of NPK and Micronutrient

According to Naga Madhuri et al. [2] micronutrients have considerable impact on the sugarcane quality. With three per cent $FeSO_4$ spray, the highest sugar yield (15.05 t/ha) was found, followed by two percent spray over control.

4. CONCLUSION

On the basis of the results achieved, it can be concluded that three foliar sprays of 2% NPK + 0.5% $ZnSO_4$ + 1% $FeSO_4$ along with RDF (T_6) at 15 days interval during the month of May and June considerably increases the cane yield and sugar yield over RDF (T_8).There was a significant effect of foliar spray of Micronutrient and NPK on cane length, and cane weight but non-significant on cane girth and number of internodes. With respect to juice quality, CCS % and pol % were also recorded higher in treatment 2% NPK + 0.5% $ZnSO_4$ + 1% $FeSO_4$ (T_6).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Nadaf SA, Patil PL, Dasog GS. Identification of micronutrient constraints in sugarcane growing vertisols of northern transition zone of Karnataka by GIS technique. Karnataka J. Agri. Sci. 2015; 28(1):34-40.
2. Naga Madhuri KV, Sarala NV, Hemanth Kumar M, Subba Rao M and Giridhar V. Influence of Micronutrients on Yield and Quality of Sugarcane. Sugar Tech. 2013; 15(2):187-191.
   DOI: 10.1007/s12355-012-0196-3.
3. Ghaffar A, Ehsanulah NA and Khan SH. Influence of zinc and iron on yield and quality of sugarcane planted under various trench spacings. Pakistan J. Agric. Sci. 2011;48(1):25-33.
4. Kinaci E and Gulmezoglu N. Grain yield and yield components of *triticale* upon application of different foliar fertilizers. Interciencia. 2007;32(9):624-628.
5. Nasiri Y, Zehtab-Salmasi S, Nasrullahzadeh S, Najafi N and Ghassemi-Golezani K. Effects of foliar application of micronutrients (Fe and Zn) on flower yield and essential oil of chamomile (*Matricaria chamomilla* L.). J. Med. Plants Res. 2010; 4(17):1733-1737.
6. Manasa LP and Devaranavadagi SB. Effect of foliar application of micronutrients on growth, yield and nutrient uptake of maize. Karnataka J. Agric. Sci. 2015. 28(4):474-476.
7. Ahmed MA and Ahmed MKA. Growth and productivity of wheat plants as affected by complete foliar fertilizer compound under water stress in newly cultivated sandy land. Arab Univ. J. Agric. Sci. 2005;13(2): 269-284.
8. Hanwate GR, Giri, SN and Yelvikar NV. Effect of Foliar Application of Micronutrients on Nutrient Uptake by Soybean Crop. Indian J. Pure Appl. Biosci. 2018;6(5):261-265.
9. Lindsay WL and Norwell WA. Development of DTPA of Soil Test for Zn, Fe, Mn and Cu. J. Am. Soil Sci. 1978;42:421-428.
10. Iswaran V. Laboratory Handbook for Agriculture Analysis. Today and Tomorrow Printers and Publishers, Desh Bandhu Gupta Road, New Delhi; 1980.
11. Spencer GI and Meade GP. Cane Sugar hand book. 9th ed. G.P. Meade, John Wiley and Sons. Inc. New York. 1963;35-80.
12. Mangrio N, Kandhro MN, Soomro AA, Mari N and Shah ZH. Growth, yield and sucrose percent response of sugarcane to zinc and boron application. Sarhad J. Agric. 2020;36(2):459-469.
13. Kumar V, Singh S, Khatak D. The effect of different methods and time of nitrogen application on sugarcane production and nitrogen use efficiency. Indian Sugar. 2007;56:35-40.
14. Kumar V, Sharma R, Gotal NK and Singh JP. Recommended of use of potassium in sugarcane crop in Haryana. Indian Sugar. 2009;58:25-30.
15. Rakkiyappan P, Thangavelu S and Radhamani R. Effect of ferrous sulphate on sugarcane varieties grown in iron deficient soil. Sugar Tech. 2002;4: 33-37.
16. Forli F, Otto R, Vitti CG, Wylliam do Vale D and Miyake RT. Micronutrients application on cultivation of sugarcane billets. African J. Agric. Res. 2017;12(10):790-794.
17. Nayyar VK, Singh SP and Takkar PN. Response of sugarcane to zinc and iron sources. J. Res. Punjab Agric. Univ. 1984; 21:134-136.
18. Balaji T, Mani S, Saravanan A and Rao TN. Balanced fertilization for maximizing the yield of sugarcane in Periyar Vaigai

command area. Indian Sugar. 2006;56: 43-50.
19. Singh A, Kumar R, Sharma BL. Response of SPMC treated Zn and Cu on yield and quality of sugarcane. Agrica. 2016;5(2): 107-110.
20. Aslam M, Ali Z and Chattha AA. Effect of soil applied micronutrients on the growth and yield of sugarcane. Pakistan Sugar J. 2004;19:2-34.
21. Wang JJ, Kennedy CW, Viator HP, Arceneaux AE, Guidry AJ. Zinc fertilization of sugarcane in acid and calcareous soils. J. Am. Soc. Sugar Cane Technol. 2009; 25:49-61.
22. Pawar MW, Joshi SS and Amodkar VT. Effect of foliar application of phosphorus and micronutrient on enzymatic activities and juice quality in sugarcane crop. Sugar Tech. 2003;5:161.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/76158