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Zn and Cu accumulation in sugarcane crop as influenced by resource based organic farming

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Abstract

A field experiments was conducted at Organic Farm, Navsari Agricultural University, Navsari" during the years 2019-20 and 2020-21. The experiment was conducted using the RBD (factorial concept) with three replications. Two factors were tested in which one factor was spacing (S_1: 90 cm and S_2: 60 - 120 - 60 cm paired row with dhaincha green manuring) and another factor was compost levels (M_1: NADEP compost @ 100 % RDN, M_2: NADEP compost @ 75 % RDN, M_3: NADEP compost @ 50 % RDN and M_4: NADEP compost @ 25 % RDN + sugarcane trash @10 t/ha + jeevamrut @ 2000 l/ha.). Zn and Cu content of cane and trash, were affected significantly by the compost treatments in pooled analysis. Significantly higher content of these nutrients was observed in treatment M_1 as compared to remaining treatments.

Keywords: Sugarcane Crop, Organic Farming, NADEP Compost

Introduction

India ranks 9th in terms of land under organic cultivation and 1st in terms of total number of organic producers. In India, the total area under organic farming is 4.50 million hectares from which 3.60 million tonnes of certified organic products are produced including all varieties of food products *viz.,* oilseeds, sugarcane, cereals and millets, cotton, pulses, medicinal plants, tea, fruits, vegetables etc. The export of organic products also earns handsome revenue to the state. The organic food export realization for 2017-18 was around INR 4255.28 crore (Anon., 2024a) [1]. Among all the states, Madhya Pradesh has the biggest certified area under organic production (33.33 %) followed by Maharashtra (26.58 %). Gujarat (21.25 %), Rajasthan (12.88 %) and Odisha (1.86 %). These five states represent largest for approximately 95.90 % of a land under organic farming in India (Anon., 2024a) [1]. Sikkim has called itself an organic state, however, due to its limited geographical size its contribution of a national organic area is only 1.36 %. Organic agriculture is gaining popularity in India, in 2003-04. Registered organic farming area in India was 42,000 ha and it has expanded about 26 times in the five years. By March 2010, India has certified more than 4.48 million hectares as organic. In Gujarat, a total of 29566 farmers engaged organic farming on 48,518 acres of land (Yada, 2012) [11].

Sugarcane belongs to the family poaceae and tropical sugarcane originated from Oceania (New Guinea) while Indian cane (*Saccharum spontaneum* L.) originated from North Eastern India. The word *Saccharum* is derived from the Sanskrit word "sharkara" and it indicates its Indian origin. Brazil led the world in sugarcane production. Sugarcane is an important agro-industrial commercial crop which plays pivotal role in national economy and sustains sugar industry. It is extensively grown in tropical and sub-tropical regions of India as cash crop. Besides sugar and gur production, sugarcane produces several valuable by products like, ethanol used as a fuel, alcohol used by pharmaceutical industry, bagasse used for paper and chip board manufacturing and press mud used as a rich source of organic matter and nutrients for crop production. India is second largest sugarcane producer after Brazil, grown in an area of 4.73 million hectares with total production of 376.9 million tonnes of cane with average productivity of 68 tonnes per hectare and the average sugar recovery of 10.23 %. Considering area, Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Bihar, Andhra Pradesh and Gujarat are the major sugarcane growing states. Gujarat produces only 3.72 per cent sugarcane from 4.65 per cent area of India. In Gujarat sugarcane area, production, productivity and sugar recovery, were 2.23 lakh hectare, 17.44 million tones, 78.31 t/ha and 11.09 %, respectively (Anon., 2024b) [2]. Surat, Navsari, Valsad, Bharuch, Tapi, Narmada, Bhavnagar, Rajkot, Junagadh and Jamnagar are the important sugarcane producing districts of Gujarat.

NADEP method of making miracle compost was first invented by a farmer named N. D. Pandharipande (also popularly known as "Nadepkaka") living in Maharashtra (India). This method becomes quite popular among the farmers in western India. In dryland conditions, organic manures play a great role as they not only supply balanced nutrients but also retain substantial amount of moisture. Traditionally, farmers used to apply farmyard manures to crops grown under rainfed condition. No scientific procedures are followed for preparing the manure and as a result the quality of the manure used to be very poor. Compost can be prepared from wide range of organic materials including dead plant material such as crop residues, weeds, forest litter and kitchen waste and prepared within very short period 90-120 days. Compost making is an efficient way of converting all kinds biomass into high value fertilizer that serves as a good alternative to farmyard manure, especially for crop-growing households without livestock (Kumawat *et al*., 2017) [7]. The NADEP compost content approximately 23.44 % (O.C.), 1.23 % (N), 0.92 % (P), 1.09 % (K), 1017 ppm (Fe), 35.42 ppm (Mn), 53.17 ppm (Zn), 29.16 ppm (Cu) and C:N ratio of NADEP compost is 9.06 (Khuwaja *et al.,* 2018) [5] addition of this compost improves physical, chemical and biological property of soil.

Crop residue incorporation in soil is very important source of organic manure. Sugarcane crop produces 10-12 t of dry leaves per ha per year which contains appreciable amount of NPK and other micro and secondary nutrients. In India about 376.9 million tonnes of sugarcane is produced of which trash contributes 10 % of total biomass. The soil incorporation of sugarcane trash releases nutrients after decomposition. This may build up the nutrients in soil and changes physical properties of the soil. With decomposition of trash in the soil, the organic acids are produced which would help in solublilzing the nutrient in the soil and increasing their availability (Kumar and Sagwal, 1998) [6]. Sugarcane trash is one of the most commonly available farm wastes in sugarcane growing areas. About 8-10 t of trash can be obtained from one hectare of sugarcane and contains about 5.4 kg N, 1.3 kg P_2O_5 and 3.1 kg K_2O in one tonne of sugarcane trash and small quantities of micronutrients. The proper decomposition of sugarcane trash will be accelerated with the use of liquid organic fertilizer (Shukla *et al.*, 2008) [10]. Parameswaran *et al.,* (1995) [8], observed 0.40 per cent N, 0.13 per cent P and 0.40 per cent K in sugarcane trash with C: N ratio of 113:1.

Materials and methods

The experiment was conducted using the RBD (factorial concept) with three replications. Two factors were tested in which one factor was spacing (S_1: 90 cm and S_2: 60 - 120 - 60 cm paired row with dhaincha green manuring) and another factor was compost levels (M_1: NADEP compost @ 100 % RDN, M_2: NADEP compost @ 75 % RDN, M_3: NADEP compost @ 50 % RDN and M_4: NADEP compost @ 25 % RDN + sugarcane trash @10 t/ha + jeevamrut @ 2000 l/ha.).

Table 1: Plant analysis methods

Parameters	Methods/Formula	References
N	Micro Kjeldahl	Jackson (1973) [4]
P	Spectrophotometer	Jackson (1973) [4]
K	Flame photometer	Jackson (1973) [4]
Fe, Mn, Zn and Cu	Atomic Absorption Spectrophotometer	Jackson (1973) [4]

Results and discussion

Zinc content of cane and trash (mg/kg)

Result pertaining to Zn content (mg/kg) in cane and trash of sugarcane at harvest as influenced by different treatments is presented in Table 2. Content of Zn in cane and trash was not affected significantly by the spacing treatments during individual years and in pooled data analysis. However, spacing treatment S_2 recorded comparatively higher Zn content in cane and trash as compared to that observed in S_1during the year 2019-20, 2021-21 and in pooled analysis.

Similar to spacing treatments, content of Zn in cane and trash of sugarcane was not affected significantly by the compost treatments during individual years and in pooled data analysis (Table 2). However, compost treatment M_1 recorded comparatively higher Zn content in cane and trash followed by M_2, M_3 and M_4 during the year 2019-20, 2021-21 and in pooled analysis.

Year as well as interaction effect of S x M, Y x S, Y x M, Y x S x M did not exert any significant effect on Zn content in cane and trash of sugarcane at harvest during individual years and in pooled data analysis (Table 2).

Copper content of cane and trash (mg/kg)

Result pertaining to Cu content (mg/kg) in cane and trash of sugarcane at harvest as affected by different treatments is presented in Table 3. The result revealed that the content of Cu in cane and trash was not affected significantly by the treatments of spacing and compost as well as year and their interactions.

In case of nutrient content in cane and trash of sugarcane, none of the spacing treatment had significant effect on it. However, among the different nutrients, content of N and P_2O_5 in cane and trash and Fe content in trash were affected significantly by the compost treatments. Content of all these nutrients in cane and trash was higher in M_1 followed by M_2, M_3 and M_4. For better understanding the overall impact of the compost treatment on nutrient content, the cumulative content of the entire nutrient (N to Cu) in sugarcane (cane + trash) was calculated and presented in Fig 1. The figure also indicated that the nutrient content in sugarcane follows the rate of their application *i.e.* higher the rate of application, higher the nutrient content and *vise-versa*. Similar results in sugarcane were also reported earlier by Edmilson *et al.* (2005) [3] and Patel (2006) [9].

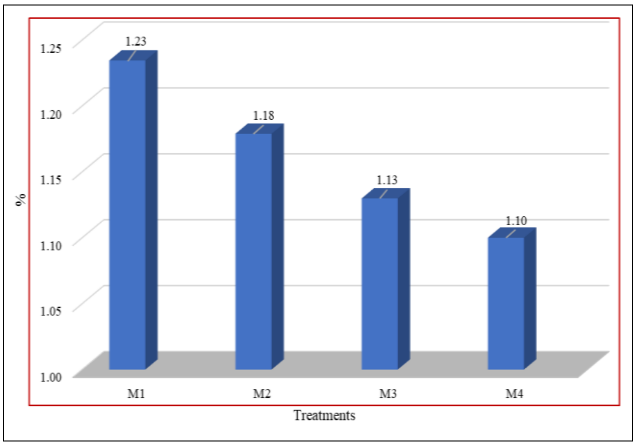

Fig 1: Total nutrient content (N to Cu) in sugarcane (Cane + Trash) under compost treatments

Table 4.21: Effect of different treatments on Zn content in cane and trash

Treatments	Zn content (mg/kg)					
	Cane			Trash		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Factor I: Spacing						
S_1-(90 cm)	22.5	23.4	22.9	24.0	24.0	24.0
S_2-(60-120-60 cm with GM)	22.8	24.1	23.5	24.0	24.9	24.5
S Em±	0.4	0.5	0.4	0.3	0.4	0.3
CD at 5 %	NS	NS	NS	NS	NS	NS
Factor II: Compost levels						
M_1-Com. @ 100 % RDN	24.1	25.1	24.6	24.8	25.1	25.0
M_2-Com. @ 75 % RDN	22.6	23.6	23.1	24.1	25.0	24.5
M_3-Com. @ 50 % RDN	21.8	23.6	22.7	24.0	24.0	24.0
M_4-Com. @ 25 % RDN + ST @ 10 t/ha + JM @ 2000 l/ha	22.0	22.6	22.3	23.1	23.8	23.5
S Em±	0.6	0.7	0.5	0.4	0.6	0.4
CD at 5 %	NS	NS	NS	NS	NS	NS
CV (%)	7.4	7.4	8.7	4.5	6.2	6.1
S x M						
S Em±	0.9	1.0	0.8	0.6	0.8	0.6
CD at 5 %	NS	NS	NS	NS	NS	NS

Pooled	S Em±	CD at 5 %	S Em±	CD at 5 %
Y	0.4	NS	0.3	NS
Y x S	0.5	NS	0.4	NS
Y x M	0.8	NS	0.6	NS
Y x S x M	1.1	NS	0.8	NS

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

Table 4.22: Effect of different treatments on Cu content in cane and trash

Treatments	Cu content (mg/kg)					
	Cane			Trash		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Factor I: Spacing						
S_1-(90 cm)	6.35	6.52	6.44	7.46	7.68	7.57
S_2-(60-120-60 cm with GM)	6.18	6.50	6.34	7.38	7.69	7.54
S Em±	0.14	0.12	0.11	0.11	0.12	0.09
CD at 5 %	NS	NS	NS	NS	NS	NS
Factor II: Compost levels						
M_1-Com. @ 100 % RDN	6.73	6.77	6.75	7.64	7.79	7.72
M_2-Com. @ 75 % RDN	6.20	6.54	6.37	7.45	7.71	7.58
M_3-Com. @ 50 % RDN	6.11	6.44	6.28	7.32	7.64	7.48
M_4-Com. @ 25 % RDN + ST @ 10 t/ha + JM @ 2000 l/ha	6.01	6.29	6.15	7.27	7.60	7.44
S Em±	0.19	0.16	0.15	0.15	0.17	0.13
CD at 5 %	NS	NS	NS	NS	NS	NS
CV (%)	7.48	6.13	8.16	5.00	5.52	6.07
S x M						
S Em±	0.27	0.23	0.21	0.21	0.24	0.19

<table>
<tr><td>CD at 5 %</td><td colspan="2">NS</td><td colspan="2">NS</td><td colspan="2">NS</td><td colspan="2">NS</td><td colspan="2">NS</td><td colspan="2">NS</td></tr>
<tr><td>Pooled</td><td colspan="3">S Em±</td><td colspan="3">CD at 5 %</td><td colspan="3">S Em±</td><td colspan="3">CD at 5 %</td></tr>
<tr><td>Y</td><td colspan="3">0.11</td><td colspan="3">NS</td><td colspan="3">0.09</td><td colspan="3">NS</td></tr>
<tr><td>Y x S</td><td colspan="3">0.15</td><td colspan="3">NS</td><td colspan="3">0.13</td><td colspan="3">NS</td></tr>
<tr><td>Y x M</td><td colspan="3">0.21</td><td colspan="3">NS</td><td colspan="3">0.19</td><td colspan="3">NS</td></tr>
<tr><td>Y x S x M</td><td colspan="3">0.30</td><td colspan="3">NS</td><td colspan="3">0.26</td><td colspan="3">NS</td></tr>
</table>

GM: Green Manuring, Com.: NADEP Compost, ST: Sugarcane Trash, JM: Jivamrut

Conclusion

- Treatment effect of spacing on Zn and Cu content of cane and trash was non-significant in pooled analysis.
- Significantly higher content of these nutrients was observed in treatment M_1 as compared to remaining treatments.
- Year effect was non-significant on Zn and Cu in cane as well as trash and during the year 2019-20 as well as 2020-21.
- Interaction effect of S x M, Y x S, Y x M, Y x S x M did not exert any significant effect on content of any nutrients in cane and trash at harvest during individual years and in pooled analysis.

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