Journal of AgriSearch, **6**(Special Issue):4-7
An Open Access International Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Integrated Effect of Sugarcane Trash Mulch, Pressmud and Zn Nutrition on Soil Fertility and Productivity of Sugarcane in Calcareous Soil

C K JHA*, VIPIN KUMAR AND S K THAKUR

ARTICLE INFO
Received on : 16-04-2019
Accepted on : 24-06-2019
Published online : 09-07-2019

ABSTRACT

The field experiment was conducted to study the effect oftwo levels of Zn (5 & 10 Kg Zn ha^{-1}) of Zneither alone or in combination pressmud cake (PMC) and sugarcane trash (ST) on yield, uptake and fertility status of sugarcane (BO 137) in alluvial calcareous soil under SDF project.The yield attributes and mean cane yield (58.90-76.90 t/ha) variedsignificantly due to different treatments. Sugarcane yield and sugar yield responds well to graded doses of Zn 10 kg ha^{-1}. Further, application of 50% Zn (5 kg ha^{-1}) in combination with PMC+ ST each @ 10 t ha^{-1} recorded highest cane and sugar yield with the magnitude of enhancement to the extent of 30.56 % in cane yield and 36.79 % in sugar yield over RDF. Application of Zn fertilizer along with organic manures significantly increased uptake of nutrientsby sugarcane.Addition of PMC+ST in combination significantly influenced availability of macronutrients (NPK) and micronutrients (Fe, Mn and Cu) in general and Zn in particular. The effect of applied Zn fertilizer was more pronounced with PMC+ST. The organic carbon content of soil increased by 23.80 % in PMC treated plots over control. The application of 100% NPK depleted the fertility status of soil. Thus, integrated use oforganic and inorganic nutrient sources (RDF + PM 10 t ha^{-1} + ST 10 t ha^{-1} along with 50 % Zn (5 kg Zn ha^{-1}) was found beneficial for sustaining productivity of sugarcane in calcareous soil of Bihar.

KEYWORD
Pressmud, Sugarcane trash, Zn, Sugarcane, Productivity

INTRODUCTION

Sugarcane(*Saccharum* spp complex hybrid) is a multiple product commodity, provides food, feed, fuel, fibre, fodder, foreign exchange and organic manure. Recycling of sugar industry wastes can be gainfully utilized to enhance sugarcane productivity and reduce the cost of cane production on account of fertilizers. Continuous use of heavy doses of fertilizers and plant protection chemicals potentially impaired the soil microbial activity, leading to poor soil health (Singh *et al.,* 2007).The alluvial sandy loam calcareous soils of Bihar are deficient in Zn and low in organic matter. To control Zn deficiency, the Zn fertilizers are used but the efficiency of applied Zn adversely affected in calcareous soil due to change in form of Zn in presence of free calcium carbonate. A great part of applied Zn remains in soil as unutilized by the crop to which they are applied (Patel *et al.,* 2003). Therefore, it would be desirable to optimize the nutrient-use efficiency and curtail the cost of Zn fertilizer for making the system more remunerative. Zn is known to involve in the metabolic activities, controlling auxin levels and nucleic acid in plants thereby contributing towards growth and development of plants (Rana and Singh, 2003). The use of organic manure in combination with inorganic fertilizers improved the productivity and soil fertility of sugarcane plant-ratoon system in calcareous soil.

Pressmud is an organic by-product obtained from sugarcane juice before crystallization of sugar and it is produced @ around 3% of weight of cane in sulphitation factories and 7% in carbonation factories. Pressmud have a great potential in supplying the nutrients and organic matter. On an average pressmud contains 1.0 to 3.0 per cent N, 0.6 to 3.6 per cent P, 0.3 to 1.8 K per cent and 33-46 percent organic carbon small quantities of micronutrients. Sugarcane produces large amount of foliage and trash produced @ 10-20% of total biomass. About 5-8 tonnes of trash can be obtained from one ha of sugarcane. Every ton of sugarcane trash contains about 5.4 N, 1.3 P_2O_5, 3.1 Kg of K_2O and small quantities of micronutrients. Sugarcane trash management is important for improving soil organic carbon and fertility status of soil underneath intensive rice-wheat–sugarcane-cropping system.

The sugarcane trash have a great potential to supply organic matter and its addition in soil was found beneficial for increasing cane yield and maintaining soil health (Singh *et al.,* 2015). Addition of organic matter is known to enhance the forms and Zn availability of applied Zn by chelating Zn. The soil environment changed with the release of organic acids and other microbial products during decomposition of organics. The integrated use of organic and inorganic plant nutrient sources not only recycles organic waste but also conserves rich pool of nutrients resources, which can reduce the sole dependence on chemical fertilizers. Keeping above considerations in view, the present experiment was formulated to see the integrated effect of organics with inorganic fertilizers with graded dose of Zn on productivity and soil fertility of sugarcane.

MATERIALS AND METHODS

The field experiment was conducted to study the effect of pressmud, sugarcane trash and graded doses of Zn either alone or in combination on yield, uptake and quality of sugarcane (BO 137) under Zn stress condition in calcareous soil under SDF project during 2011-12.The farm is situated at 25°98' N latitude, 85°67' E longitude and at an altitude of 52.0 m above mean sea level. The climatic condition

Sugarcane Research Institute, Pusa, Dr. Rajendra Prasad Central Agricultural University, Bihar, Pusa, Samastipur, Bihar, India
*Corresponding Author Email:ckjsri1975@ gmail.com

of area was sub-tropical and the mean annual rainfall is about 1200 mm most of which is received during May to October. The mean annual temperature is 24.5^{0C} with maximum 38.6^{0C} during April and minimum 7.4^{0C} in January. The initial soil was moderately alkaline (pH 8.18), EC 0.26 dS $m^{-1}$and low in organic carbon (0.41%).The N, P and K content of initial soil was 222, 19.8 and K 112 kg ha^{-1}. The micronutrient Zn, Fe, Mn and Cu ppm were 0.56, 6.25, 4.12 and 0.82 ppm, respectively. The treatments consisted of recommended dose of fertilizers RDF (150 –33 – 50 kg N–P–K kg ha^{-1}) either alone and its combination with pressmud cake (PMC) and sugarcane trash (ST) applied @ 10 and 20 t ha^{-1} with two doses of Zn (5 & 10 Kg Zn ha^{-1} in RBD. The trash was chopped and moistens with water and uniformly incorporated in soil before one week of sowing.

The PMC was applied in furrow at planting. The recommended dose of fertilizer 150–85–60 kg N–P_2O_5–K_2O /ha were applied through Urea, DAP and MOP. The basal dose of Zn was supplied through $ZnSO_4$ as per technical programme.

The half dose of the nitrogen was applied as basal and remaining half dose in two equal splits. The bio-compost was analyzed and used as source of organic manure. Soil samples were collected before planting and after harvest of crop. The processed surface soil samples (0-30 cm) were collected and analyzed. Soil sample were analyzed for pH and EC in 1:2 soils: water ratios (Jackson, 1967). The organic carbon was estimated by chromic acid digestion method (Walkey and Black, 1934). The available N was estimated using alkaline permanganate method (Subbiahand Asijia, 1956), available P by double beam spectrophotometer (Olsen *et al.*, 1954) and available K was determined by flame photometrically (Jackson,1967). The micronutrients were analyzed using AAS by DTPA method (Lindsay and Norvell, 1978). Whole plant was analyzed for N, P, K, Zn, Mn and Fe content using standard procedure and their uptake was calculated. The cane juice quality viz. brix, pol and purity were determined and CCS was calculated as per method given by Spencer and Meade (1964).

Table 1: Effect of zinc sulphate, sugarcane trash and pressmud on yield attributes and yield of sugarcane

Treatments	Germination (%)	Tillers (000 t ha^{-1})	Cane height (cm)	Cane weight (g)	NMC (000 ha^{-1})	Yield (t ha^{-1})	Sugar yield (t ha^{-1})
T_1 - RDF (Control)	31.5	111.8	178.5	720	69.7	58.9	6.74
T_2 -RDF+ Zn 10 kg ha^{-1}	33.7	145.2	212.4	805	84.2	74.9	8.82
T_3 - RDF + Zn 5 kg ha^{-1}	32.0	138.9	210.2	798	80.8	68.7	8.09
T_4 -RDF + ST @ 20 t ha^{-1}	34.9	124.7	182.7	731	75.6	60.2	7.17
T_5- RDF + PMC 20 t ha^{-1}	36.7	142.7	211.1	810	87.6	70.6	8.31
T_6 -RDF + PMC 10 t ha^{-1} + ST 10 t ha^{-1}	35.2	139.5	200.6	788	79.5	66.3	7.80
T_7-RDF + PMC 10 t ha^{-1} + ST 10 t ha^{-1} + Zn 5 kg ha^{-1}	37.8	147.5	215.6	817	93.0	76.9	9.22
SE dm (±)	1.77	6.80	3.22	13.15	3.57	3.89	0.25
CD (P=0.05)	N.S	20.95	9.91	40.53	10.99	11.98	0.76

RDF (150 –33 – 50 kg N–P–K kg ha^{-1}); PMC -Pressmud cake; ST- Sugarcane trash

Uptake of nutrients

The integrated use of Zn along with organics significantly increases nutrient uptake by sugarcane (Table2). The uptake of nutrients by sugarcane followed the similar trend as yield. The uptake of Zn by sugarcane increased significantly in treatment receiving Zn either alone or in combination with ST+PMC. The addition of ST alone resulted in significant reduction in macro and micro nutrients uptake by sugarcane. PMC was more effective as compared to ST for supplying nutrients to sugarcane plant. This could be attributed to immobilization of available nutrients in ST treated plots having high C: N ratio (85:1). Further, application of organic and inorganic nutrient sources (RDF + PM 10 t ha^{-1} + ST 10 t ha^{-1}) along with 5 kg Zn ha^{-1} (supplying 50% Zn) recorded maximum nutrients uptake by sugarcane. The result indicated that Zn uptake in sugarcane can be improved with addition of PMC @ 20 t/ha either alone or in combination of PMC + ST along with 50% of recommended dose of Zn fertilizer (Rana and Singh, 2003).

Soil properties:

The application of PMC and ST either alone or in combination with inorganicfertilizer revealed significant treatment differences (Table 3). Addition of organic manure significantly reduced pH and increased the organic carbon and available nutrient content of soil after harvest. However, the effect of treatment on EC was found non-significant. The treatment T_5 receiving 100% NPK along with PMC @ 20 t/ha recorded highest amount of organic carbon, available macro (NPK) and micronutrient (Fe, Zn, Mn and Cu) content of soil. The organic carbon content of soil increased by 23.80 % in T_5 over control (T_1). The mean value for macro nutrients varied from N, 210-236, P_2O_5, 20.2-26.40, K_2O, 118-145 kg ha^{-1}. The overall data indicated that addition of organics in T_5, T_6 and T_7 resulted in significant improvement in fertility status of soil over control receiving 100% NPK only. The result indicated that application of 100% NPK depleted the fertility status of soil.The available Zn content of soil increased significantly with application of graded levels of Zn. In general, integrated

Table 2: Effect of zinc sulphate, sugarcane trash and press mud on nutrient uptake by sugarcane

Treatments	Uptake of nutrients						
	N	P	K	Fe	Zn	Cu	Mn
		(kg ha^{-1})			(g ha^{-1})		
T_1 - RDF (Control)	138.4	13.08	149.0	916.6	491.1	76.24	535.4
T_2 -RDF+ Zn 10 kg ha^{-1}	176.0	16.63	189.5	1203.9	847.7	105.97	730.5
T_3 - RDF + Zn 5 kg ha^{-1}	161.5	15.26	173.8	1087.7	715.5	90.99	647.2
T_4 -RDF + ST @ 20 t ha^{-1}	141.5	13.37	152.3	940.4	637.5	81.54	558.1
T_5 -RDF + PMC 20 t ha^{-1}	165.9	15.68	165.9	1226.2	637.8	108.38	722.5
T_6 -RDF + PMC 10 t ha^{-1} + ST 10 t ha^{-1}	155.8	14.72	167.7	1025.8	554.8	97.79	642.6
T_7-RDF + PMC 10 t ha^{-1} + ST 10 t ha^{-1} + Zn 5 kg ha^{-1}	180.7	17.80	194.6	1300.9	671.3	115.74	784.7
SE dm (±)	5.93	0.50	6.67	52.65	20.74	4.82	33.65
CD (P= 0.05)	18.28	1.55	20.55	162.24	63.92	14.85	103.7

RDF (150 –33 – 50 kg N –P–K kg ha^{-1}); PMC -Pressmud cake; ST - Sugarcane trash

effect of organic and inorganic nutrient sources were found beneficial for maintaining micronutrient status of soil. It was interesting to note that availability of micronutrient (Fe, Mn and Cu) in general and Zn in particular influenced significantly due to application of organics in calcareous soil rich in free calcium carbonate. The highest amount of Zn, Fe, Cu and Mn was recorded in plots receiving ST + PMC in combination in T_7 treatment. Further, application of 50% Zn (5 kg ha^{-1}) applied in combination with PMC+ ST each @ 10 t ha^{-1} recorded highest amount of Zn in soil after harvest. In contrast, significant reduction in micronutrients content of soil was recorded in control (RDF) receiving only inorganic. It may be attributed to the reduction in pH and increased organic matter content of soil in organic treated plots as reflected in present findings, which prevents precipitation and increased mineralization and solubilization of native or applied micronutrients. Soil pH affects solubility concentration in soil solution, ionic form, and mobility of micronutrients in soil, and consequently acquisition of these elements by plant. In addition, soil organic matter forms complexes and there by increases micronutrient mobility and /or plant availability. The overall data indicated that integrated use of organic and inorganic nutrient sources resulted in enrichment of soil fertility in terms of soil available macro and micro nutrients content. Addition of organic manure significantly increased the availability of Zn might be due to its chelating action of organic matter supplied as PMC+ST.The results are in conformity with the findings of Jha *et al*. (2015)

Table 3: Effect of zinc sulphate, sugarcane trash and press mud on soil properties after sugarcane harvest

Treatments	pH	EC (dS m^{-1})	Organic carbon (%)	Available nutrients (kg ha^{-1})			DTPA extractible micro nutriments (ppm)			
				N	P_2O_5	K_2O	Fe	Zn	Cu	Mn
T_1 - RDF (Control)	8.19	0.25	0.42	210	20.2	118	7.0	0.69	0.77	4.2
T_2 -RDF+ Zn 10 kg ha^{-1}	8.16	0.27	0.43	214	21.3	121	7.2	0.95	0.82	4.3
T_3 - RDF + Zn 5 kg ha^{-1}	8.08	0.26	0.43	215	21.5	120	7.1	0.83	0.74	4.5
T_4 -RDF + ST @ 20 t ha^{-1}	7.95	0.28	0.51	215	22.4	130	7.3	0.70	0.82	4.8
T_5 -RDF + PMC 20 t ha^{-1}	7.81	0.32	0.66	236	26.4	145	8.0	0.77	0.87	5.3
T_6 -RDF + PMC 10 t ha^{-1} + ST 10 t ha^{-1}	7.91	0.28	0.51	229	24.5	135	7.6	0.72	0.85	5.0
T_7-RDF + PMC10 t ha^{-1} + ST 10 t ha^{-1} + Zn 5 kg ha^{-1}	7.90	0.29	0.52	231	24.9	139	7.7	0.90	0.86	5.0
SE dm (±)	0.066	0.026	0.023	6.49	0.64	2.42	0.19	0.025	0.018	0.16
CD (P= 0.05)	0.205	NS	0.071	20.21	2.00	7.45	0.60	0.078	0.055	0.49

RDF (150 –33 – 50 kg N –P–K kg ha^{-1}); PMC - Pressmud cake; ST Sugarcane trash

CONCLUSION

Thus, integrated use of organic and inorganic nutrient sources (RDF + PM 10 t ha^{-1} + ST 10 t ha^{-1} along with 50 % Zn (5 kg Zn ha^{-1}) was found beneficial for sustaining productivity of sugarcane in calcareous soil of Bihar.

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