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Research Paper

Evaluation of combination of organic sources for organic maize (*Zea mays*) production

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*) seasons of 2013, 2014 and 2015 on red sandy loam soil of Mandya, to study the effect of different organic manures on growth and yield of maize (*Zea mays* L.) under irrigated condition in Cauvery Command Area of Karnataka.The experiment was laid out in a randomized complete-block design with 3 replications. There were 11 treatments, comprising different levels of compost manure equivalent (75, 100 and 125 kg N/ha) with FYM @ 10 t/ha, *beejamrutha* and *jeevamrutha*. The results indicated that, application of 100% N equivalent compost + FYM @ 10 t/ha + beejamrutha + *Jeevamrutha* @ 500 liter/ha recorded significantly higher grain yield (6.13 t/ha), stover yield (7.84 t/ha), cob length (15.10 cm), number of leaves per plant (12.77) and plant height (226.0 cm), which was closely followed by application of 100% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha and 125% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha. Soil chemical properties, viz. soil *p*H, organic carbon content and electric conductivity, were not influenced by application of the organic manures. However, there was an increasing trend in the soil chemical properties compared to initial soil data. However, application of 100% N equivalent compost + FYM @ 10 t/ha + *beejamrutha* + *jeevamrutha* recorded significantly higher available nitrogen, phosphorus and potassium content in the soil compared to the other treatments.

Kew words **:** *Beejamrutha*, Compost, FYM, *Jeevamrutha*, Maize, Vermicompost

Maize is the third most important crop after rice and wheat in India. The area under maize in India (9.4 million ha with 2.5% cumulated annual growth rate) as well as in Karnataka (1.3 million ha with 8.17% cumulated annual growth rate) which is increasing year by year owing to its wide adoptability, low pest and diseases, easy in cultivation and also its requirement for poultry industry. As maize demands nutrients continuously in large amounts and use of large quantity of chemically formulated fertilizers alone is not only feasible but also costly to the resource-poor farmers, as majority of the maize is grown by small and marginal farmers. Apart from this, use of chemical fertilizers has resulted in progressive rise in multi-nutrient deficiencies, nutrient imbalances, deterioration of soil health and productivity. Although the organic manure contains plant nutrients in small quantities compared to fertilizers, they influence in building up of organic matter, good soil aggregation, permeability of soil and related physical properties in addition to long-lasting supply of several macro and micronutrients, vital plant-promoting substances apart from increasing the density of microbes in the soil (Palaniappan and Siddeswaran, 1994). This helps in maintenance and possible improvement of soil fertility and health for sustaining crop productivity. Keeping this in view, a field experiment was conducted to study the influence of organic manures on soil fertility and productivity of irrigated maize.

MATERIALS AND METHODS

A field experiment was conducted during the rainy (*kharif*) seasons of 2013, 2014 and 2015 at Zonal Agricultural Research Station, V.C. Farm, Mandya, (12°34.3' N, 76°49.8' E, 697 m above mean sea-level) Karnataka. The soil was red sandy loam, comprising maximum sand content (76.0%) with bulk density of 1.36 g/cc. The soil *p*H was 7.80 (neutral in reaction). The initial soil analysis indicated that it was low in organic carbon (0.32%), available nitrogen (225 kg/ha), medium in phosphorus (18.2 kg/ha) and potassium (133 kg/ha). Since the rainfall re-

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ceived during cropping seasons in all the 3 years was not sufficient, maize was grown under irrigated condition. The experiment was carried out in a complete randomized block design with eleven treatments and 3 replications. The treatments included were, T_1, 75% N equivalent compost; T_2, 100% N equivalent compost; T_3, 125% N equivalent compost; T_4, 100% N equivalent compost + FYM @ 10 t/ha; T_5, 75% N equivalent compost + *beejamrutha*; T_6, 100% N equivalent compost + *beejamrutha;* T_7, 125% N equivalent compost + *beejamrutha*; T_8, 75% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 liter/ha; T_9, 100% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha; T_{10}, 125% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha; and T_{11}, 100% N equivalent compost + FYM @ 10 t/ha + *beejamrutha* + *jeevamrutha* @ 500 litres/ha. The recommended dose of nutrients is 150 : 75 : 40 kg NPK/ha.

Maize (Hybrid) 'Hema' was sown in June 2013, 2014 and 2015 with a spacing of 60 cm × 30 cm using a seed rate of 15 kg/ha. The seeds were soaked with *beejamrutha* over night and then dried under shade before sowing. The manures were supplied in the form of compost (prepared by using cattle shed waste) and vermicompost (prepared by using cattle shed waste and crop residues). The liquid organic formulations *beejamrutha* and *jeevamrutha* were prepared as per the procedures given by Palekar (2006). *Beejavamrutha* was prepared by soaking 5 kg of local cowdung in 20 litres water and 50 g lime in 1 litre water overnight. Next day morning squeeze the cowdung into the lime-soaked water and to this add 10 litres local cow urine, stir thoroughly and add lime solution and mix well. *Jeevamrutha* is prepared by mixing 10 kg local cowdung with 10 litres cow-urine, add 2 kg local jaggery, 2 kg pulse flour and handful of garden soil and the volume is made up to 200 litres. Keep the drum in shade covering with wet gunny bag and stir the mixture clockwise thrice a day and incubate. The nutrient content of FYM was 0.58% N, 0.32% P and 0.52% K, of compost was 1.13% N, 0.678% P and 1.13% K, and of vermicompost was 1.1% N, 0.24% P and 0.56% K. The recommended dose of the FYM and compost were applied as basal dose 20 days before sowing. After 30 days after sowing, vermicompost was applied as top dressing @ 1,250 kg/ha and *jeevamrutha* was sprayed 30 days after sowing @ 500 litres/ha. Standard package of practices were adopted. Growth, yield parameters and yield were measured and estimated using standard procedures.

The data collected from the experiment at different growth stages were subjected to statistical analysis. The level of significance used in 'F' and't' test was P= 0.05. Critical difference values were calculated wherever 'F' test was significant.

RESULTS AND DISCUSSION

Growth parameters

The growth parameters, viz. plant height at harvesting and number of leaves/plant at 60 DAS of maize, varied significantly due to application of different organics. Among the different source of organics, application of 100% N equivalent compost + recommended FYM + *beejamrutha* + *jeevamrutha* recorded higher plant height and number of leaves (226 cm and 12.77 respectively) compared to the other treatments (Table 1). This was closely followed by 125% N equivalent compost + *beejamrutha* + *jeevamrutha* and 100% N equivalent compost + *beejamrutha* + *jeevamrutha*. This increase in plant

Table 1. Influence of organic manures on growth, yield, and economics of maize (pooled data of 3 years)

Treatment	Plant height (cm)	Number of leaves	Cob length (cm)	Grain yield (t/ha)	Stover yield (t/ha)	Cost of cultivation (× 10^3₹/ha)	Net returns (× 10^3₹/ha)	Benefit: cost ratio
T_1	177.7	8.87	12.10	3.51	5.24	51.83	5.73	1.11
T_2	189.2	10.13	13.93	4.60	6.05	58.30	16.50	1.28
T_3	178.1	10.00	13.07	4.76	6.46	64.76	12.71	1.20
T_4	192.4	10.93	13.80	5.18	7.12	73.30	11.13	1.15
T_5	183.8	10.13	14.00	4.87	6.43	54.83	24.26	1.44
T_6	191.5	9.87	14.33	4.14	6.05	61.30	6.45	1.10
T_7	177.0	10.53	14.10	4.45	6.21	67.76	4.83	1.07
T_8	191.4	10.00	14.67	4.97	6.70	56.83	23.98	1.42
T_9	202.6	11.67	14.80	5.64	7.41	63.30	28.31	1.45
T_{10}	194.4	11.30	14.47	5.66	7.46	69.76	22.33	1.32
T_{11}	226.0	12.77	15.10	6.14	7.84	51.83	5.73	1.26
SEm±	3.5	0.23	0.30	0.12	0.19	-	-	-
CD (P=0.05)	10.5	0.71	0.90	0.35	0.56	-	-	-

Details of treatments are given under materials and methods

height and number of leaves may be owing to higher N availability throughout the crop-growth period owing to its slow release. Manjhi *et al.* (2016) also reported similar increase in maize growth parameters with the application of organics.

Yield parameters

The application of different sources of organic did not influence the yield-attributing parameters, viz. test weight, number of rows/cob and number of grains/row significantly. Hence the data were not included here. However, the cob length was influenced significantly. The longer cob was observed in application of 100% N equivalent compost + recommended FYM + *beejamrutha* + *jeevamrutha* (15.10 cm) compared to the other treatments. This was closely followed by 125% N equivalent compost + *beejamrutha* + *jeevamrutha* and 100% N equivalent compost + *beejamrutha* + *jeevamrutha*. This increased cob length was mainly attributed to diversion of more photosynthates to reproductive parts. Similar increase in maize yield parameters with the application of FYM and vermicompost was also reported by Dhiman (2014).

Yield

The results indicated that, the grain and stalk yields of maize varied significantly among different levels and sources of organic manures (Table 1). The grain yield and stalk yield were significantly higher with application of 100% N equivalent compost + recommended FYM + *beejamrutha* + *jeevamrutha* (6,135 kg/ha and 7.84 t/ha respectively) compared to the other source of organics. This was closely followed by 125% N equivalent compost + *beejamrutha* + *jeevamrutha* (5,656 kg/ha and 7.46 t/ha respectively) and 100% N equivalent compost + *beejamrutha* + *jeevamrutha* (5,637 kg/ha and 7.41 t/ha respectively). This was mainly owing to the fact that apart from source of nutrient, application of organic manures improved the physico-chemical properties of soil that resulted in better root system with increased absorption of moisture and nutrients from the deeper layers, which in turn enhanced the growth and yield- attributing parameters of maize and finally grain and stalk yields. These results are in line with the findings of Sujatha *et al.* (2008) and Choudhary and Suresh Kumar (2013). Praveen *et al*. (2012) and Suresh Naik *et al.* (2012).

Economics

Among the treatments, application of 100% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha was found superior in obtaining higher net returns (₹28,308/ha) and benefit: cost ratio (1.45) as compared to other treatments. This was closely followed by application of 75% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha. This increased net returns and B:C ratio was mainly owing to reduced cost of cultivation and increased grain yield. Though, the highest cost of production was recorded in application of 100% N equivalent compost + FYM @ 10 t/ha + *beejamrutha* + *jeevamrutha* @ 500 litres/ha (₹79,761/ha), this treatment recorded the highest yield but economically not viable. These results are in line with Mohammad *et al.* (2015).

Soil physico-chemical properties

The soil physic-chemical properties, viz. *p*H, electrical

Table 2. Influence of organic cultivation practices on soil chemical properties after the harvesting of third crop

Treatment	*p*H	EC (dS/m)	Organic carbon (%)	Soil-available nutrients (kg/ha)			Nutrient uptake (kg/ha)		
				N	P_2O_5	K_2O	N	P	K
T_1	7.72	0.325	0.36	231.5	20.8	135.2	145.6	15.2	89.56
T_2	7.35	0.351	0.37	242.3	24.9	152.1	156.9	16.21	92.65
T_3	7.25	0.358	0.36	251.8	33.2	158.9	165.8	17.85	96.32
T_4	6.78	0.341	0.41	269.8	31.3	170.1	150.6	16.25	112.3
T_5	7.85	0.328	0.39	235.6	23.6	135.2	160.2	18.41	105.6
T_6	7.62	0.341	0.38	251.2	28.2	153.6	168.9	18.96	110.5
T_7	7.28	0.351	0.36	261.2	35.6	162.3	160.2	20.12	115.6
T_8	7.00	0.335	0.37	245.6	25.6	142.5	175.6	20.15	118.9
T_9	7.03	0.359	0.39	245.3	33.8	156.3	180.5	22.36	120.3
T_{10}	7.52	0.361	0.41	265.4	35.7	168.5	185.6	23.62	125.6
T_{11}	6.78	0.371	0.42	263.5	32.5	172.3	186.2	24.01	130.2
SEm±	0.31	0.018	0.031	5.65	0.58	7.36	4.68	0.85	5.12
CD (P=0.05)	NS	NS	NS	16.8	1.74	21.9	14.04	2.55	15.35

Initial values: *p*H, 7.80; EC, 0.305 d/Sm; OC, 0.32%; N, 225 kg/ha; P_2O_5, 18.2 kg/ha; K_2O, 133 kg/ha
Details of treatments are given under materials and methods

conductivity and organic carbon were not influenced significantly at the end of the third crop cycle. However, these parameters were enhanced greatly as compared to initial soil-test values. In the present investigation, there was a significant difference among the different sources of nutrient with respect to soil-available nutrients. Application of 125% N equivalent compost + *beejamrutha* + *jeevamrutha* registered significantly higher amount of soil-available nutrients (265.4, 35.7 and 168.5 kg N, P_2O_5 and K_2O/ha respectively) and was at par with 100% N equivalent compost + recommended FYM + *beejamrutha* + *jeevamrutha* (263.5, 32.5 and 172.3 kg N, P_2O_5 and K_2O/ha respectively). This was owing to build up of more amount of organic carbon in the soil and which in turn enhanced the nutrient-supplying capacity of the soil because of build up of more and more soil micro-organisms.

The uptake of major nutrients were significantly higher in application of 100% N equivalent compost + FYM @ 10 t/ha + *beejamrutha* + *jeevamrutha* @ 500 litre/ha (186.2 : 24.01 : 130.2 kg N:P:K/ha) as compared to the other treatments. However, it was on a par with 125% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 liter/ha (185.6 : 23.62 : 125.6 kg NPK/ha) and 100% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha. These results are in line with earlier findings of Praveen *et al*. (2012) and Choudhary and Suresh Kumar (2013).

Application of 100% N equivalent compost + *beejamrutha* + *jeevamrutha* @ 500 litres/ha to maize proved economically superior and ecological viable in improving the maize grain yield coupled with improving soil physico-chemical properties.

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