



Effect of integrated nutrient management on yield attributes and yield of maize hybrid

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Abstract : The effect of organics and fertilizer levels with foliar spray on hybrid maize (*Zea mays* L.) NK-6240 was evaluated during winter seasons of 2011-12 and winter 2012-13 at Tamil Nadu Agricultural University, Coimbatore. The experiments were laid out in Split Plot Design with three replications. In the main plot, three organic sources were tried (FYM, biochar and vermicompost) and sub plot comprised of seven treatments having combinations of two fertilizer levels (100 % and 75 % of recommended dose of fertilizers) along with foliar spray of 1 or 2 per cent polyfeed (19:19:19 NPK) and pink pigmented facultative methylotrophic bacteria (PPFM). The results of the study revealed that application of vermicompost @ 5 t ha⁻¹ significantly increased the yield attributes and yield of maize followed by FYM 12.5 t ha⁻¹. Among the fertilizer level with foliar spray treatments, application of 100 per cent RDF with foliar spray of 2% poly feed spray significantly (P =0.05) enhanced the yield attributes and grain yield. The interaction effect between organics and fertilizer levels with foliar spray on maize grain yield was significant. In both the years of study, vermicompost application along with soil application of 100 per cent RDF with 2 per cent poly feed as foliar spray recorded the highest grain yield of 9293 and 8830 kg ha⁻¹ and stover yield of 13403 and 12802 kg ha⁻¹, during 2011-12 and 2012-13, respectively. From the result of the study, application of vermicompost @ 5 t ha⁻¹ along with 100 per cent RDF (150:75:75 kg NPK ha⁻¹) with foliar spray of 2 per cent poly feed on 30th and 45th DAS may be recommended for increasing hybrid maize yield, particularly in the study area.

Key Words : FYM, Grain yield, Maize, NPK levels, Polyfeed, Vermicompost, Yield attributes

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INTRODUCTION

In India, maize occupies third place among the cereals after rice and wheat and it is cultivated over an area of 8.71 million hectares with a production of 21.57 million tonnes and the average productivity is 2476 kg ha⁻¹. In Tamil Nadu, maize is cultivated in an area of 0.30 million hectares with a production of 1.57 million tonnes and the productivity is 5173 kg ha⁻¹ (Agricoop, 2011 - 12).

Maize expresses its full genetic potential when it is grown in an ideal environment with optimum soil fertility. Newly evolved hybrids with good yield potential show positive

response to high levels of NPK fertilizers. Sustainable crop yield levels could be achieved only by applying appropriate combination of organic manures and inorganic fertilizers (Kalaiyaran, 2011). Earlier reports by Rajesh (2011) in redgram and Saravanan *et al.* (2013) in cotton indicated positive response for foliar application of polyfeed (19:19:19 NPK). The response of crops to nutrients varies widely from place to place, depending on the fertility level of soil and other environmental conditions. Hence, the present study was undertaken to study the effect of combined application of organics, inorganic fertilizer along with foliar fertilization on yield attributes and yield of hybrid maize.

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MATERIAL AND METHODS

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, India to study the influence of organic and inorganic sources of nutrients along with foliar fertilization on yield attributes and yield of hybrid maize in winter 2011-12 and 2012-13. NK-6240 maize hybrid was used in the field trials. The soil of the experimental field was sandy clay loam in texture, belonging to *Typic Ustropept*. The nutrient status of soil at the start of experiment was low in available nitrogen (165 kg ha⁻¹), medium in available phosphorus (17.2 kg ha⁻¹) and high in available potassium (452 kg ha⁻¹) with the pH of 8.2. The organic material were analysed prior to use in the experiments. The nutrient content of vermicompost was 1.40 per cent N, 0.72 per cent P and 1.00 per cent K. The nutrient content of FYM was 0.55 per cent N, 0.35 per cent P and 0.60 per cent K, while biochar had 0.11 per cent N, 0.11 per cent P and 2.65 per cent K. The field experiment were laid out in Split Plot Design with three replications. In the main plot were three organic treatments *viz.*, M₁ - FYM 12.5 t ha⁻¹, M₂ - biochar 5 t ha⁻¹ and M₃ - Vermicompost 5 t ha⁻¹ and sub plot comprised of seven (7) fertilizer levels with foliar spray treatments, *viz.*, S₁-100 per cent recommended dosage of fertilizer (RDF), S₂ -100 per cent RDF + foliar spray of pink-pigmented facultative methylophilic bacteria (PPFM) 10⁶ dilution, S₃ -75 per cent RDF + foliar spray of pink-pigmented facultative methylophilic bacteria (PPFM) 10⁶ dilution, S₄ - 100 per cent RDF +1 per cent foliar spray of poly feed (19:19:19 NPK), S₅ - 75 per cent RDF +1 per cent foliar spray of poly feed, S₆ - 100 per cent RDF + 2 per cent foliar spray of poly feed and S₇ - 75 per cent RDF +2 per cent foliar spray of poly feed. The poly feed and PPFM foliar spray treatment were imposed on 30th and 45th days after sowing (DAS) of maize crop as per the treatment schedule. The experimental field

was ploughed using tractor drawn mould board plough, followed by two harrowing. Then individual plots of 8.0 m x 6.0 m were formed. The required quantity of FYM, biochar and vermicompost was applied as per treatment schedule and organics was incorporated in the soil using spade. Then ridges were formed at 60 cm spacing within each plot. The seeds of hybrid maize NK 6240 were dibbled on one side of the ridge with the plant spacing of 25 cm distance. The maize crop was sown on 15.12.2011 and 01.12.2012 and harvested on 04.04.2012 and 22.03.2013, respectively during the two years of study. The fertilizer schedule recommended at present for hybrid maize in Tamil Nadu *i.e.* 150:75:75 kg ha⁻¹ was taken as 100 recommended NPK level. Full dose of P, K and 25 per cent N was applied as basal, the balance 50 per cent N was applied on 30th DAS and remaining 25 per cent was applied on 45th DAS, as per treatments. The following yield attributes and yield observation was recorded at harvest: cob length (cm), cob girth (cm), number of grain rows cob⁻¹, number of grains row⁻¹, cob weight (g), hundred grain weight (g), shelling percentage, harvest index, grain yield (kg ha⁻¹) and stover yield (kg ha⁻¹). The analysis of variance (ANOVA) was done in split plot design for various observations. The significance of treatment differences was tested by F (Variance ratio) test. Critical difference (CD) at 5 per cent level of significance (P=0.05) was worked out for comparison and statistical interpretation of treatments as per Gomez and Gomez (1984). The data on the effect of treatments on yield attributes and yield of maize are presented in the Table 1a, 1b, 2 and 3.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Table 1a : Effect of organic source, fertilizer levels and foliar spray on cob length (cm), cob girth (cm), number of grain rows cob⁻¹, number of grains row⁻¹ of hybrid maize

Treatments	Cob length (cm)		Cob girth (cm)		Number of grain rows cob ⁻¹		Number of grains row ⁻¹	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
M ₁	17.91	17.45	15.72	15.84	13.41	13.33	38.4	36.30
M ₂	17.41	16.55	15.44	15.18	12.80	12.82	36.89	34.63
M ₃	18.01	17.67	15.96	16.22	13.63	13.55	39.04	37.40
SEd ±	0.17	0.28	0.09	0.23	0.21	0.23	0.45	0.55
C.D. (P=0.05)	0.47	0.79	0.26	0.65	0.60	0.47	1.26	1.55
S ₁	16.71	16.45	15.09	15.39	12.63	12.70	37.03	35.14
S ₂	17.45	16.69	15.58	15.52	12.83	12.87	37.59	35.51
S ₃	16.57	16.09	14.64	14.78	12.59	12.56	36.44	34.96
S ₄	18.64	18.08	16.33	16.28	13.89	13.78	39.12	37.19
S ₅	17.70	17.17	15.78	15.69	13.35	13.31	38.34	35.87
S ₆	19.29	18.79	16.75	16.86	14.61	14.29	40.28	38.44
S ₇	18.07	17.29	15.79	15.71	13.06	13.12	38.03	35.68
SEd ±	0.25	0.31	0.20	0.27	0.23	0.21	0.38	0.41
C.D. (P=0.05)	0.51	0.63	0.41	0.56	0.47	0.43	0.77	0.85
Interaction	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

N.S. = Non significant

Yield attributes :

Among the organic sources, vermicompost application (M_3) recorded significantly higher cob length, cob girth, number of grain rows cob^{-1} , number of grains row^{-1} , cob weight, test grain weight and shelling percentage followed by FYM (M_1) during both the years of study and were at par with each other (Table 1a and 1b). The increase in yield attributing characters with the application of vermicompost is attributed to higher amount of available major nutrient present in vermicompost treated plots. Besides, vermicompost also contains higher number of N fixers and other beneficial microbes which would have helped the crop to absorb more nutrients for its development (Kale and Bono, 1996).

Application of 100 RDF with as 2 per cent poly feed as foliar spray (S_6) significantly increased the cob length, cob girth, and number of grain rows cob^{-1} , number of grains row^{-1} , cob weight and test weight. 100 per cent RDF with foliar spray of 2 and 1 per cent polyfeed treatments (S_6 and S_4 , respectively) recorded higher yield components *viz.*, cob length, cob girth, and number of grain rows cob^{-1} , number of grains row^{-1} , cob weight, shelling percentage and test weight compared to 75 per cent RDF with foliar spray treatments (S_3 , S_5 and S_7). Sankhayan and Sharma (1997) also recorded increase in yield attributes due to higher level of fertilizers due to adequate availability of nutrients leading to higher DMP. This probably facilitated greater partitioning of dry matter of ears, leading to

Table 1b : Effect of organic source, fertilizer levels and foliar spray on cob weight (g), hundred grain weight (g) and shelling percentage of hybrid maize

Treatments	Cob weight (g)		Hundred grain weight (g)		Shelling percentage	
	2011-12	2011-12	2012-13	2011-12	2011-12	2012-13
M_1	228.59	221.51	35.92	35.19	68.11	68.37
M_2	215.41	209.71	34.50	33.72	66.19	66.35
M_3	231.40	226.77	36.79	35.50	68.88	68.88
SEd \pm	4.43	3.30	0.49	0.50	0.45	0.64
C.D. (P=0.05)	12.31	9.17	1.38	1.41	1.25	1.77
S_1	208.96	201.33	34.14	32.77	66.34	66.45
S_2	215.07	208.26	35.10	33.31	66.70	67.88
S_3	203.95	194.83	33.21	31.60	66.54	66.08
S_4	239.34	237.22	37.16	36.80	68.77	69.10
S_5	224.85	218.34	35.49	35.06	67.51	67.40
S_6	252.81	247.50	38.46	38.03	70.68	70.41
S_7	230.97	227.84	36.59	36.05	67.53	67.75
SEd \pm	3.46	4.41	0.61	0.52	0.51	0.56
C.D. (P=0.05)	7.02	8.96	1.23	1.07	1.04	1.14
Interaction	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

N.S. = Non significant

Table 2 : Effect of organic source, fertilizer levels and foliar spray on grain yield (kg ha^{-1}) of hybrid maize

Treatments	2011-2012			Mean	2012-2013			Mean
	Organic sources				Organic sources			
	M_1	M_2	M_3		M_1	M_2	M_3	
S_1	7776	7198	8403	7793	7483	7012	8005	7500
S_2	7856	7295	8432	7861	7558	7092	8044	7565
S_3	7736	7279	7095	7370	7243	6893	6541	6892
S_4	8564	7873	8937	8458	8118	7511	8350	7993
S_5	7907	7360	8521	7929	7604	7237	8117	7653
S_6	8859	8234	9293	8795	8468	7882	8830	8393
S_7	8115	7531	8626	8091	7828	7421	8233	7827
Mean	8116	7539	8473	8042	7757	7292	8017	7689
	SEd \pm		C.D. (P=0.05)		SEd \pm		C.D. (P=0.05)	
M	199		552		172		476	
S	153		310		149		301	
M at S	316		734		294		670	
S at M	265		537		257		522	

increase in cob length, cob girth, number of grain rows per cob and test weight. The higher yield attributes recorded in combined soil and foliar application of nutrients when compared to soil application of NPK alone (S_1) could be due to the following reason. The P use efficiency of soil applied fertilizers is very low, because more than 80 per cent of the applied P becomes immobile and unusable by the plant because of adsorption, precipitation or conversion to organic form. The foliar application increased P concentration and its uptake suggesting that phosphorus was absorbed poorly by the roots, but was well absorbed by the leaves (Thao and Yamakawa, 2009).

The interaction effect due to organic source and fertilizer levels along with foliar spray was not significant on yield attributes of maize.

Grain and stover yield :

Grain and stover yield of maize was significantly influenced by organic sources and combined application of different levels of fertilizers with foliar sprays and data are presented in the Table 2 and 3.

Among the organic sources, vermicompost @ 5t ha⁻¹ (M_3) recorded significantly higher grain yield of 8473 and 8017 kg ha⁻¹ and stover yield of 12068 and 11521 kg ha⁻¹ during 2011-2012 and 2012-2013, respectively followed by FYM @ 12.5 t ha⁻¹ which recorded grain yield of 8116 and 7757 kg ha⁻¹ and stover yield of 11546 and 11106 kg ha⁻¹ during 2011-2012 and 2012-2013, respectively and were at par with each other. The cumulative effect of microbial stimulation through gradual mineralization reflected in increased vigour of the crop, resulting in increased yield attributes and yield in maize crop (Christopher Lourduraj, 2006).

Among the different fertilizer level with foliar spray treatments, 100 per cent RDF with 2 per cent poly feed as foliar spray (S_6) registered higher grain yield of 8795 and 8393

kg ha⁻¹ and stover yield of 12575 and 12064 kg ha⁻¹ during 2011-12 and 2012-13, respectively and followed by 100 per cent RDF with 1 per cent poly feed as foliar spray (S_4) which registered grain yield of 8458 and 7993 kg ha⁻¹ and stover yield of 12054 and 11561 kg ha⁻¹ during 2011-12 and 2012-13, respectively. The increased yield recorded in the above treatments might be due the positive and significant improvement in growth and higher nutrient uptake in the above treatments. These results are in conformity with the findings of Mokidul Islam and Munda (2012).

The interaction effect between organics and fertilizer levels with foliar spray on maize grain yield was significant. In both the years of study, vermicompost application along with 100 per cent RDF with 2 per cent poly feed as foliar spray (M_3S_6) recorded the highest yield of 9293 and 8830 kg ha⁻¹, during 2011-12 and 2012-13, respectively and stover yield of 13403 and 12802 kg ha⁻¹, during 2011-12 and 2012-13, respectively and followed by vermicompost application along with 100 per cent RDF and foliar spray of 1 per cent polyfeed (M_3S_4). This is due to increase in growth, nutrient uptake and enhanced the yield attributes in the above treatments. These results are in conformity with the findings of Afifi *et al.* (2011) in maize crop.

Conclusion :

Among the organic sources, vermicompost application 5 t ha⁻¹ followed by FYM @ 12.5 t ha⁻¹ recorded higher values of yield attributes, grain and stover yield in hybrid maize. Among fertilizer levels with foliar spray treatments, increased yield attributes and yield was recorded in 100 per cent RDF with 2 per cent polyfeed foliar spray at 30th and 45th DAS. Considering the different combination of organics fertilizer levels with foliar spray treatments tried, the treatment combination of vermicompost 5 t ha⁻¹ with 100 per cent RDF along with foliar spray of 2 per cent poly feed on 30th and 45th

Table 3 : Effect of organic sources, fertilizer levels and foliar spray on stover yield (kg ha⁻¹) of hybrid maize

Treatments	2011-2012			Mean	2012-2013			Mean
	Organic sources				Organic sources			
	M ₁	M ₂	M ₃		M ₁	M ₂	M ₃	
S ₁	11062	10000	12029	11030	10603	9713	11411	10576
S ₂	11172	10151	12071	11131	10715	9831	11478	10674
S ₃	10979	9799	9706	10161	10493	9803	9432	9909
S ₄	12259	11035	12867	12054	11801	10705	12178	11561
S ₅	11249	10280	12223	11251	10779	10057	11584	10807
S ₆	12727	11595	13403	12575	12221	11169	12802	12064
S ₇	11374	10467	12174	11338	11133	10333	11765	11077
Mean	11546	10475	12068	11363	11106	10230	11521	10953
	SEd ±				SEd ±			
	C.D. (P=0.05)				C.D. (P=0.05)			
M	312				276			
S	246				232			
M at S	504				463			
S at M	447				401			

DAS (M_3S_6) and followed by vermicompost 5 t ha^{-1} with 100 per cent RDF along with foliar spray of 1 per cent poly feed on 30^{th} and 45^{th} DAS (M_3S_4) proved to be the best in enhancing the yield attributes and yield of maize.

In conclusion, application of vermicompost 5 t ha^{-1} with 100 per cent RDF ($150:75:75 \text{ kg NPK ha}^{-1}$) along with foliar spray of 2 per cent poly feed on 30^{th} and 45^{th} DAS can be recommended for enhancing the yield attributes, grain and stover yield of hybrid maize.

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