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Short Note

Effect of rainfed application of vermicompost, FYM and NPK on yield, nutrient uptake and soil fertility under maize-wheat cropping sequence

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Indiscriminate use of chemicals without adequate organic recycling of crop residues has not only aggravated multinutritional deficiencies in soil-plant system but also deteriorated soil-health. Excessive reliance on the input of chemical fertilizers without replenishment of organic matter has now been considered unsound system of farming in recent years. Since good quality vermicompost and FYM found to be environment-friendly and cost effective and the same can be produced by farmers at their own farms, therefore, the present investigation was undertaken to study the effect of Vermicompost and FYM applied alone and in combination with NPK fertilizers on yield, nutrient uptake and soil fertility under maize-wheat cropping sequence.

Field experiment was conducted under rainfed conditions for two consecutive years during *kharif* 1999 and 2000 with maize (var. Navin) at research farm of CSKHPKV, HAREC, Dhaulakuan. To see the residual effect of different treatments, wheat (var. PBW-343) was taken after maize during *rabi* 1999-2000 and 2000-2001. The soil of the experimental farm was sandy loam having pH 5.9, organic carbon (0.40%) and medium in available nitrogen (376 kg ha^{-1}), high in available P (29 kg ha^{-1}) and medium in K (240 kg ha^{-1}) status. During *kharif*, the treatments consisted of five levels of NPK (0, 25, 50, 75 and 100% of the recommended) with and without organic manure. The organic manures used were vermicompost and FYM @ 10 t/ha. There were 11 treatments replicated thrice in a randomized block design. N was applied in two equal splits through urea while full dose of P and K were applied at the time of sowing through single super phosphate and muriate of potash. Recommended doses of NPK were 120:60:40 for maize and 80:40:40 for wheat. During *rabi* season, the residual effect of manures and fertilizer treatments applied to maize crop was studied by taking wheat crop to which no organic manure was applied. The soil and plant samples taken before and harvest of each crop were analyzed for physico-chemical properties as per the methods outlined by Jackson (1967)

The data (Table 1) revealed significant increase in grain and stover yield of maize with graded doses of NPK fertilizers applied along with vermicompost or farm yard manure (FYM) in comparison to vermicompost or FYM applied alone. This is because vermicompost or FYM organic manures applied @ 10 t ha^{-1} cannot meet out the full nutritional requirements of the plant. However, vermicompost or FYM along with 50 % NPK fertilizer was found to be at par with 100 % fertilizer

NPK applied alone in increasing grain and stover yield of maize. The combination of chemical fertilizers and compost has a tremendous promise of providing higher yields. These findings are in agreement with the findings of Das *et al.* (2002), who reported significant increase in grain and straw yield of paddy with 50 % vermicompost + 50 % chemical fertilizer. Without disturbing soil fertility, 100 kg N ha^{-1} along with vermicompost @10 t ha^{-1} was also reported to be at par with recommended doses of NPK fertilizer alone in increasing grain, straw and biological yield of wheat (Ranwa and Singh, 1999). Increase in rice yield with the application of vermicompost @ 5 t ha^{-1} along with recommended NPK was also reported by Vasanthi and Kumarswamy (1999). Maximum values of all the growth parameters of wheat were observed with vermicompost @ 15 t ha^{-1} and was significantly superior to other organic manures, viz., FYM, press mud (Nehra *et al.*, 2001)

Table 1. Effect of Vermicompost and FYM on yield and nutrient uptake of maize

Treatments	Grain Yield (q ha^{-1})		Straw Yield (q ha^{-1})		N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	Year		Year		Year		Year		Year	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Vermicompost	23.93	20.19	43.76	36.21	58.50	44.74	9.30	9.34	17.20	14.79
FYM only	22.59	19.50	44.24	37.21	61.90	69.50	10.90	8.84	16.80	15.01
25% NPK + VC	31.75	23.61	43.58	62.05	75.10	96.78	13.30	11.92	20.60	23.12
50% NPK + VC	40.32	26.36	59.21	61.19	88.40	110.16	17.70	14.16	27.70	27.48
75% NPK + VC	40.61	27.79	42.99	55.67	85.40	103.62	16.30	12.88	27.10	26.12
100% NPK + VC	38.71	27.89	55.20	58.24	93.70	105.14	16.50	17.61	25.50	27.30
25% NPK + FYM	31.95	21.85	48.24	51.58	73.40	71.74	12.20	10.59	23.00	21.06
50% NPK + FYM	38.65	26.23	48.62	55.29	85.60	83.45	16.80	13.49	27.10	25.80
75% NPK + FYM	37.99	27.70	50.22	57.25	93.40	89.74	14.20	14.32	27.60	23.94
100% NPK + FYM	40.61	26.94	54.34	63.86	95.40	99.41	17.40	15.47	27.10	26.03
100% NPK	39.37	27.89	59.87	58.62	84.00	103.03	17.30	15.28	27.10	26.28
CD (P=0.05)	5.68	3.49	11.23	7.02	11.40	16.80	3.40	3.96	4.40	4.29

VC = vermicompost applied during maize crop

FYM = farm yard manure applied during maize crop

The two years data (Table 2) revealed that the N uptake by maize crop with 25 % NPK along with vermicompost was significantly higher as compared to control but was at par with 100 % NPK alone. Further, N uptake with 50 % NPK along with FYM was at par with 100 % NPK alone. Regarding P uptake, it was observed that there was a significant increase at 50 % NPK along with vermicompost as compared to vermicompost or FYM alone as well as along with 25 % NPK, though found to be at par with 100 % NPK alone. Similar trend was observed in case of K uptake. Results of Antil *et al.* (1995) were also on the same line, who opined that the positive effect of organic manure on uptake of phosphorus may be attributed to the chelation of Fe, Al, Mn, Zn, Ca and Mg preventing from fixing phosphorus into insoluble. compounds. Total NPK uptake increased significantly with the application of organic manures over the control. It might be due to the positive effect of organic manures, which on decomposition releases macro and micro nutrients, avoid volatilization losses of nitrogen, less fixation of applied phosphorus, thereby increasing the availability of nutrients in soil and their uptake by plants. Logbina and Bugaeskii (1992); Minhas and Sood (1994); Bhandari *et al.* (1992) and Rathore *et al.* (1995) have also reported similar findings elsewhere.

The data (Table 3) revealed increasing tendency of organic carbon of soil with the application of organic manure (FYM or vermicompost) though statistically, increase was non-significant. The increase in the organic carbon with the application of organic manure (FYM or vermicompost) was also reported by Maheshrappa *et al.* (1999).

Increase in fertilizer doses along with vermicompost or FYM resulted in increased level of available soil N (Table 3). This may be attributed to the fact that with higher fertilizer dose, higher amount of fertilizer nitrogen could be converted into available form by the bio-chemical reaction of fertilizer N with soil organic matter.

The available N status of the soil at different fertilizer doses along with vermicompost or FYM was at par with 100 % NPK fertilizers during first year but in the second year, significant increase in available N status was observed being highest at 100 % NPK + vermicompost dose. It may be due to the formation of organic chelates of higher stability with organic legends, which have lower susceptibility to adsorption, fixation and precipitation in the soil (Lee, 1985). In case of FYM application, significant increase in available soil N was observed at 100 % NPK when compared to rest of the levels studied. Dinesh and Dubey (1999) have reported that mineralization of net nitrogen was significantly higher in the soil amended with organic matter as compared to the unamended soil. Similar results with the application of vermicompost were also observed by Nehra *et al.* (1999).

Available phosphorus status of the soil increased with increasing levels of fertilizer NPK along with organic manure (FYM/vermicompost) and a significant increase was observed at 100 % NPK compared to lower levels of NPK and vermicompost or FYM applied alone (Table 3). Similar trend was observed in case of available potassium in soil. Vasanthi and Kumarswamy (1999) also reported similar results with the application of vermicompost or FYM.

To see the residual effect of different treatments, wheat crop was taken after maize.The grain yield (Table 4) of wheat in a maize-wheat cropping sequence increased significantly with graded doses of NPK fertilizer. The treatments, i.e. no NPK and 25 % NPK to wheat crop where organic manure (vermicompost or FYM) was applied to maize crop, were found at par, may be because of the residual effect of organic manure. 50 % NPK, where organic manure (vermicompost/FYM) was applied to maize crop was found to be at par with 75 and 100 % NPK dose in increasing grain yield of wheat. Similarly, in case of straw yield of wheat, application of organic manures to maize crop has beneficial residual effect on wheat.

Graded doses of NPK to wheat resulted in increased uptake of nutrients (Table 4) by wheat crop. Application of organic manure during *kharif* increased nutrient uptake with graded doses of NPK and 50 to 100 % NPK doses were found to be at par with 100 % NPK where no NPK was applied to maize crop. Similar trend was observed with P uptake by wheat crop. But K uptake was found to be minimum at 75 and 100 % NPK doses in which organic manure was applied to maize crop and was at par with 100 % NPK without organic manure applied to maize crop . This clearly shows the beneficial residual effect of organic manure in wheat in a maize-wheat cropping sequence. Organic carbon status of the soil after wheat harvest was medium but the effect of different treatments was found to be non-significant (Table 4.).

In case of available nitrogen and phosphorus

Table 2. Effect of Vermicompost and FYM on physico-chemical properties of soil

Treatments	pH		Organic carbon (O.C. %)		N (kg ha^{-1})		P_2O_5 (kg ha^{-1})		K_2O (kg ha^{-1})	
	Year		Year		Year		Year		Year	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Vermicompost	5.9	5.8	0.47	0.48	397.0	361.00	30.00	22.27	250.00	233.33
FYM only	5.9	5.9	0.46	0.48	366.0	390.80	27.00	22.70	253.00	317.33
25% NPK + VC	5.8	5.8	0.53	0.54	445.0	438.67	31.00	22.30	267.00	317.30
50% NPK + VC	5.9	5.8	0.41	0.61	462.0	445.0	40.00	31.97	267.00	289.30
75% NPK + VC	5.8	5.8	0.52	0.54	456.0	480.67	47.00	32.73	313.00	336.00
100% NPK + VC	5.6	5.7	0.47	0.68	498.0	511.67	50.00	36.73	276.00	290.67
25% NPK + FYM	5.9	5.9	0.52	0.49	418.0	417.67	30.00	23.43	260.00	298.67
50% NPK + FYM	5.9	5.9	0.53	0.52	485.0	430.33	49.00	33.83	270.00	317.33
75% NPK + FYM	5.9	5.8	0.53	0.53	485.0	451.33	49.00	32.27	270.00	354.67
100% NPK + FYM	5.7	5.7	0.52	0.54	491.0	490.17	48.00	31.67	287.00	373.33
100% NPK	5.7	5.7	0.44	0.48	477.0	505.67	49.00	36.40	283.00	336.00
CD (P=0.05)	NS	NS	NS	NS	62.2	32.26	7.02	3.89	NS	NS

VC = vermicompost applied during maize crop, FYM = farm yard manure applied during maize

Table 3. Residual effect of vermicompost and FYM on yield and nutrient uptake of wheat

Treatments	Grain Yield (q ha^{-1})		Straw Yield (q ha^{-1})		N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})	
	Year		Year		Year		Year		Year	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Vermicompost	30.24	31.74	60.23	62.33	78.25	81.78	16.96	16.97	65.43	62.50
FYM only	31.47	30.46	61.80	76.13	88.02	80.98	16.55	16.20	72.32	63.27
25% NPK + VC	31.66	32.91	60.30	69.95	92.10	83.70	16.60	16.95	69.89	61.84
50% NPK + VC	32.92	36.35	63.13	67.57	89.70	86.12	18.00	17.17	71.17	61.89
75% NPK + VC	34.44	37.53	62.26	77.09	96.81	92.01	20.11	17.87	81.46	68.93
100% NPK + VC	36.73	37.77	68.51	67.38	94.67	94.53	20.23	19.01	75.46	79.69
25% NPK + FYM	32.11	31.03	61.33	58.43	78.82	82.70	14.42	15.45	60.82	62.37
50% NPK + FYM	33.89	33.12	62.33	59.19	92.83	88.17	15.55	16.31	63.43	67.54
75% NPK + FYM	34.37	37.54	62.33	64.24	92.45	89.97	18.29	17.68	65.86	67.81
100% NPK + FYM	35.33	36.92	64.33	69.83	100.63	94.02	19.18	19.06	77.88	68.81
100% NPK	36.61	36.98	66.00	67.76	107.40	99.56	18.13	18.54	64.92	66.86
CD (P=0.05)	5.68	2.82	4.08	7.70	11.43	10.89	2.77	2.39	6.74	5.58

VC= vermicompost applied during maize crop, FYM = farm yard manure applied during maize

Table 4. Residual effect of vermicompost and FYM on physico-chemical properties of soil after harvest of wheat crop

Treatments	Organic carbon (O.C. %) Year		N (kg ha^{-1}) Year		P_2O_5 (kg ha^{-1}) Year		K_2O (kg ha^{-1}) Year	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001
Vermicompost	0.71	0.68	355.41	293.02	23.10	22.37	221.00	217.73
FYM only	0.70	0.74	338.69	307.18	22.10	21.47	201.60	211.00
25% NPK + VC	0.78	0.71	393.00	344.74	28.30	25.40	201.60	227.07
50% NPK + VC	0.72	0.67	418.13	361.06	29.80	28.80	225.50	223.10
75% NPK + VC	0.79	0.75	411.86	380.08	33.00	31.16	213.07	190.33
100% NPK + VC	0.75	0.72	384.68	475.09	33.00	32.61	206.07	224.60
25% NPK + FYM	0.61	0.73	409.73	300.80	23.20	23.40	193.60	189.83
50% NPK + FYM	0.79	0.75	372.14	361.26	27.50	24.01	213.53	189.83
75% NPK + FYM	0.73	0.74	441.13	415.29	32.50	31.60	213.53	190.67
100%NPK + FYM	0.70	0.74	432.77	489.50	33.00	33.03	209.07	199.53
100% NPK	0.75	0.77	393.00	315.90	28.20	25.08	206.07	192.47
CD (P=0.05)	NS	NS	37.13	18.62	5.44	3.26	NS	NS

VC = vermicompost applied during maize crop, FYM = farm yard manure applied during maize

in soil after harvest, graded doses of NPK to wheat crop increased the available nitrogen and phosphorus of soil over no NPK treatment where organic manure (vermicompost or FYM) was applied to maize crop and was found to be at par with that of 100 % NPK without applying organic manure to maize crop (Table 4.). But in case of available K status in soil after wheat crop harvest, the effect of different treatments was found to be non-significant.

The study revealed that grain yield of maize obtained with the application of 50 % NPK fertilizer along with vermicompost (40.32 and 26.36 q ha^{-1}) or FYM @ 10 t/ha (38.65 and 26.63 q ha^{-1}) was at par with 100 % NPK fertilizer applied alone (39.37 and 27.89 q ha^{-1}). Vermicompost and FYM were found equally effective in increasing yield, nutrient uptake and soil fertility status in maize and have beneficial residual effect on wheat crop.

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