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Soil health management under vermicompost based integrated nutrient management in wheat

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Summary

The yield of wheat ranged from 29.16 to 45.14 and 29.56 to 49.14 q ha^{-1} during 2005-06 and 2006-07, respectively was influenced significantly by different treatments. During 2005-06 maximum grain yield (45.14 q ha^{-1}) was recorded in case of treatment T_{10} (3 tonnes vermicompost + 100% NPK of RDF), where 100% NPK with vermicompost @ 3.0 t ha^{-1} was applied, was found statistically at par with treatment T_7 (3 tonnes vermicompost +75% NPK of RDF), where vermicompost @ 3.0 t ha^{-1} was applied with 75% NPK and significantly higher than the rest of the treatment. Similar trend of treatments effect on grain yield was also obtained during second year *i.e.* 2006-07. With exception of T_2 (one tonne vermicompost + 50% NPK of RDF), grain yield recorded in T_1 (150: 60: 40: as NPK, recommended dose of fertilizers), where 100% NPK was supplemented through inorganic source was found significantly lower than the rest of the treatments. Graded does of vermicompost with similar does of NPK influenced the grain yield of wheat significantly during both the years with exception of T_8 (one tonnes vermicompost +100% NPK of RDF) and T_9 (two tonnes vermicompost + 100% NPK of RDF). Results revealed that 50% NPK can be substituted by the application of @1.0 t ha^{-1} vermicompost as the grain yield recorded in T_1 (150: 60: 40: as NPK, recommended dose of fertilizers) and T_2 (one tonne vermicompost + 50% NPK of RDF), was statistically similar while grain yield increased significantly due to application of vermicompost @ 2.0 t ha^{-1} with 50% NPK. Application of different does of vermicompost with 75% NPK yielded significantly higher than the T_1 (150: 60: 40: as NPK, recommended dose of fertilizers), where only 100% NPK was applied during both the years. No significantly variation in grain yield of wheat was found between the treatments having application of 1 t ha^{-1} vermicompost with either 50% or 75% NPK but yield varied significantly between treatments having the application of 1 t ha^{-1} vermicompost with 50% or 100% NPK. Similarly no variation was also found between T_3 (two tonne vermicompost + 50% NPK of RDF) and T_6 (two tonne vermicompost + 75% NPK of RDF) and T_4 (three tonne vermicompost + 50% NPK of RDF) and T_7 (three tonnes vermicompost +75% NPK of RDF), while T_4 (three tonne vermicompost + 50% NPK of RDF) and T_{10} (three tonnes vermicompost + 100% NPK of RDF), varied significantly during both the years. This implies that application of 3.0 t ha^{-1} of vermicompost along with 75% NPK is a better combination for optimum crop yield. This combination also enhanced the physical, chemical properties of soil by improving the availability of different nutrients.

Key words : Earthworms, Vermicompost, Chemical fertilizers, Soil fertility, Plant productivity

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Introduction

During the last fifty years, global agricultural production has witnessed phenomenal growth averaging 2.3 per cent per year and ensured consistent availability of food for the increasing and wealthier global population. The modern agriculture based on intensive cropping system mainly depends on the use of agro-chemicals in the form of chemical fertilizers and pesticides. In general, the production of chemical fertilizers is leading to depletion of fossil fuels, causing environmental and ground water pollution (Senapati *et al.*,1984).To maintain good crop productivity along with maintenance of soil health, farmers are now showing inclination towards inclusion of organics with chemical fertilizers. Among various organic nutrient sources, vermicompost is gaining popularity now days. The average nutrient content of vermicompost is much higher than that in FYM (Kale and Krishnamoorthy, 1981 and Kale and Bano, 1986). The continued degradation of soil resources is considered an important factor in lowering the total and partial factor productivity of agriculture in the country. The future agricultural growth at higher rate cannot be sustained with deteriorating soil resource base (Sharma *et al.*, 2005) so there is an urgent need to monitor the quality of soil resources and appropriate management strategies for sustained productivity with least environmental degradation. In terms of agricultural production, the quality may refer to its ability to sustain productivity. The decline in soil quality over the time would, obviously lead to unsustainability. Soil quality is yard stick of good management.Soil productivity as integrated index of all these factors, fertilizers and manures are also the king pines of improved technology, contributing 50-60 per cent increase in productivity of food grain in India.

Resource and Research Methods

A field experiment was conducted at Sardar Vallabh Bhai Patel University of Agriculture and Technology, Meerut U.P. during 2005– 07 to study the impact of different levels of vermicompost in various combinations with chemical fertilizers on physico-chemical properties of soil and yield of wheat crop. Different raw materials like wheat straw, paddy straw, moong straw, pressmud mixed with buffalo dung in the ratio of 2:1 and also only buffalo dung were used to prepare the vermicompost. *Eseniafoetida*, an *Epigeic* spp. of earthworm was used for composting. The macro and micro nutrient were estimated after preparation of vermicompost. Along with these nutrient status pH, EC, OC and bulk density were also estimated.Samples from all above types of vermicompost were collected and analysed for nutrient content in the laboratory. The sample of vermicompost having highest nutrient status in comparison to that of other selected for further study was the mixture of presmud + buffalo dung. Soil samples were collected before and after the harvest of crop. These were subjected to physico-chemical analysis of soil such as pH, EC and OC etc. The ten combination of various treatments as different doses of vermicompost with chemical fertilizers applied on soil and wheat crop were as T_1 (150: 60: 40: as NPK, recommended dose of fertilizers), T_2 (1tonne vermicompost + 50% NPK of RDF), T_3 (2 tonne vermicompost + 50% NPK of RDF), T_4 (3 tonne vermicompost + 50% NPK of RDF), T_5 (1 tonne vermicompost + 75% NPK of RDF), T_6 (2 tonne vermicompost + 75% NPK of RDF), T_7 (3 tonnes vermicompost +75% NPK of RDF), T_8 (1 tonnes vermicompost +100% NPK of RDF), T_9 (2 tonnes vermicompost + 100% NPK of RDF) and T_{10} (3 tonnes vermicompost + 100% NPK of RDF). Experimental soil was used for the purpose consisted of top 15 cm soil of crop research centre farm. The Randomized Block Design (RBD) was used for statistical analysis. 10 treatments with 3 replications were used for the study.

Research Findings and Discussion

The data revealed that grain, straw and biological yield of wheat crop were influenced significantly by different treatments. The grain yield of wheat which ranged from 29.16 to 45.14 and 29.56 to 49.14 q ha^{-1} during 2005-06 and 2006-07, respectively was influenced significantly by different treatments (Table 1). During 2005-06 maximum grain yield (45.14 q ha^{-1}) was recorded in case of treatment T_{10} where 100% NPK with vermicompost@ 3.0 t ha^{-1} was applied, was found statistically at par with treatment T_7 where vermicompost @ 3.0 t ha^{-1} was applied with 75% NPK and significantly higher than the rest of the treatment. While minimum yield of wheat (29.16 qha^{-1}) was recorded from the treatment T_1 (150: 60: 40: as NPK, recommended dose of fertilizers), where only inorganic source were applied to supply 100 % N P K. Similar trend of treatments effect on grain yield was also obtained during second year. With exception of T_2 (one tonne vermicompost + 50% NPK of RDF), grain yield recorded in T_1 (150: 60: 40: as NPK, recommended dose of fertilizers), where 100% NPK was supplemented through inorganic source was found significantly lower than the rest of the treatments. Graded dose of vermicompost with similar dose of NPK influenced the grain yield of wheat significantly during both the years with exception of T_8 (one tonnes vermicompost +100% NPK of RDF) and T_9 (two tonnes vermicompost + 100% NPK of RDF). Results revealed that 50% NPK can be substituted by the application of @1.0 t ha^{-1} vermicompost as the grain yield recorded in T_1 (150: 60: 40: as NPK, recommended dose of fertilizers) and T_2 (one tonne vermicompost + 50% NPK of RDF), was statistically similar while grain yield increased significantly due to application of vermicompost @ 2.0 t ha^{-1} with 50% NPK. Application of different dose of

Table 1: Effect of different treatments on grain, straw and biological yields (q ha^{-1}) of wheat (pooled of two years 2005– 07)

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
T_1	29.4	50.3	79.6
T_2	32.6	59.3	91.9
T_3	37.2	64.7	102.1
T_4	42.4	75.6	118.1
T_5	34.8	61.5	96.3
T_6	39.2	66.8	105.9
T_7	45.9	76.1	121.8
T_8	37.8	66.1	103.9
T_9	40.0	70.0	110.0
T_{10}	47.1	77.7	124.8
C.D. (P=0.05)	3.8	5.1	8.4
S.E.±	1.3	1.7	2.8

T_1 (150: 60: 40: as NPK, Recommended dose of fertilizers), T_2 (1tonne vermicompost + 50% NPK of RDF), T_3(2 tonne vermicompost +50% NPK of RDF), T_4 (3 tonne vermicompost + 50% NPK of RDF), T_5 (1 tonne vermicompost + 75% NPK of RDF), T_6 (2 tonne vermicompost + 75% NPK of RDF), T_7 (3 tonnes vermicompost +75% NPK of RDF), T_8 (1 tonnes vermicompost +100% NPK of RDF), T_9 (2 tonnes vermicompost + 100% NPK of RDF) and T_{10} (3 tonnes vermicompost + 100% NPK of RDF)

Table 2: Effect of different treatments of vermi-compost on organic carbon (%), pH, EC (dSm^{-1}) and bulk density (g/cc) of soil at different days interval (pooled of two years 2005– 07)

Treatments	Organic carbon (%)		pH		EC (dSm^{-1})		Bulk density (g/cc)	
	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest
T_1	0.32	0.31	8.50	8.56	0.43	0.43	1.63	1.67
T_2	0.42	0.32	8.14	8.21	0.34	0.42	1.56	1.64
T_3	0.57	0.34	7.88	8.13	0.24	0.39	1.43	1.56
T_4	0.61	0.38	7.70	7.86	0.22	0.35	1.38	1.45
T_5	0.42	0.32	8.28	8.14	0.34	0.42	1.56	1.63
T_6	0.57	0.34	8.06	8.10	0.24	0.38	1.44	1.56
T_7	0.62	0.38	7.70	7.80	0.21	0.34	1.37	1.45
T_8	0.44	0.32	8.24	8.18	0.34	0.40	1.58	1.64
T_9	0.57	0.34	8.07	7.86	0.24	0.38	1.45	1.55
T_{10}	0.62	0.38	7.71	7.80	0.21	0.34	1.36	1.45
C.D. (P=0.05)	0.02	0.01	0.26	0.05	0.00	0.02	0.03	0.02
S.E.±	0.01	0.00	0.09	0.02	0.00	0.01	0.01	0.01
	Initial value- 0.32 (%)		Initial value – 8.67		Initial value – 0.435 (dSm^{-1})		Initial value- 1.7 g/cc	

T_1 (150: 60: 40: as NPK, Recommended Dose of Fertilizers), T_2(1tonne vermicompost +50% NPK of RDF), T_3(2 tonne vermicompost +50% NPK of RDF), T_4 (3 tonne vermicompost + 50% NPK of RDF), T_5(1 tonne vermicompost + 75% NPK of RDF), T_6(2 tonne vermicompost + 75% NPK of RDF), T_7 (3 tonnes vermicompost +75% NPK of RDF), T_8(1 tonnes vermicompost +100% NPK of RDF), T_9(2 tonnes vermicompost + 100% NPK of RDF) and T_{10}(3 tonnes vermicompost + 100% NPK of RDF) vermicompost with 75% NPK yielded significantly higher than the treatment T_1 (150: 60: 40: as NPK, recommended dose of fertilizers) where only 100% NPK was applied during both the years. No significantly variation in grain yield of wheat was found between the treatments having application of 1 t ha^{-1} vermicompost with either 50% or 75% NPK but yield varied significantly between treatments having the application of 1 t ha^{-1} vermicompost with 50% or 100% NPK. Similarly no variation was also found between T_3 (two tonne vermicompost + 50% NPK of RDF) and T_6 (two tonne vermicompost + 75% NPK of RDF) and T_4 (three tonne vermicompost + 50% NPK of RDF) and T_7 (three tonnes vermicompost +75% NPK of RDF), while T_4 (three tonne vermicompost + 50% NPK of RDF) and T_{10} (three tonnes vermicompost + 100% NPK of RDF), varied significantly during both the years. Effect of graded dose of vermicompost on soil properties like bulk density of soil, pH, EC, are significantly reduced and increases the per cent organic carbon and also available NPK, due to addition of graded dose of vermicompost with chemical fertilizers at different days of interval during both the years. Bulk density of soil (g/cc) as affected by different treatments is during both the year is given in Table 2. The initial value of bulk density was 1.71 and 1.69 (g/cc) during first and second year, respectively. As seen from the table that the bulk density decline from its initial value in all the treatments during both the years. Significantly higher bulk density in comparison to other treatments was found in T_1 (one tonne vermicompost + 50% NPK of RDF) where only inorganic sources of plant nutrients were applied. Bulk density decline appreciably with the higher dose of vermicompost as compared to lower dose. Reduction of about 13 per cent in bulk density was found due to application of vermicompost @ 3.0 t ha^{-1} over 100% NPK during both the years.

Organic carbon content of soil after wheat harvest as affected by different treatments is given in Table 2. The initial values of organic carbon content were 0.321 and 0.323 during 2005-06 and 2006-07, respectively. As evident from the table that the organic carbon content of soil was affected significantly by different treatments. In the treatments where NPK through inorganic was applied organic carbon declined from its initial value during both the years, while in the rest of the treatments organic carbon buildup although extent was variable. Organic carbon content of soil increased significantly with increasing levels of vermicompost at similar NPK level during both the year. Organic carbon content decline by 6 and 3 per cent from its initial value due to application of 100% NPK only during first and second year, respectively while gain of 19 and 19.5 per cent was recorded due to application of vermicompost @ 3.0 t ha^{-1} with 100% NPK. Results clearly indicates that level of vermicompost is most important factor for organic carbon variation while levels of NPK are less important. Soil pH measured after wheat harvesting in different treatments during both the years is given in Table 2. The

Table 3: Effect of different treatments of vermicompost on available nitrogen, phosphorus and potassium (kg ha^{-1}) in soil at different day's interval (pooled of two years 2005– 07)

Treatments	Available nitrogen (kg/ha)				Available phosphorus (kg/ha)				Available potassium (kg/ha)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	163.0	150.6	140.2	139.7	10.7	8.9	7.7	7.2	170.3	165.0	160.3	156.8
T_2	180.9	168.1	156.9	154.4	12.1	11.0	10.1	9.4	195.5	174.3	167.5	162.0
T_3	206.0	194.5	181.9	180.8	14.1	11.9	10.8	10.2	221.2	205.5	194.8	186.3
T_4	218.3	200.1	189.2	185.8	15.8	14.2	12.8	12.2	239.2	221.7	201.0	199.5
T_5	184.4	170.6	159.5	157.0	13.2	11.4	10.3	9.6	196.8	175.5	167.3	162.0
T_6	209.8	189.5	179.4	177.0	14.9	12.4	11.0	10.4	230.2	208.8	197.3	187.5
T_7	222.3	208.5	195.3	194.2	17.4	15.7	14.4	13.4	243.2	225.7	203.7	202.5
T_8	188.4	178.8	165.7	163.1	13.4	12.0	10.6	9.9	199.7	184.2	172.7	168.8
T_9	213.4	199.6	190.8	188.4	15.2	12.8	11.1	10.7	234.5	213.3	199.2	193.7
T_{10}	226.1	211.2	199.5	196.7	18.3	16.2	14.6	13.9	249.2	228.2	209.2	204.2
C.D. (P=0.05)	1.8	2.0	2.7	1.9	2.7	2.8	2.7	2.5	2.4	2.2	3.2	3.3
S.E.±	0.6	0.4	0.9	0.6	0.9	0.9	0.9	0.8	0.8	0.7	1.1	1.1
	Initial value- 156.825 kg/ha				Initial value- 11.375 kg/ha				Initial value- 176.48 kg/ha			

T_1 (150: 60: 40: as NPK, Recommended dose of fertilizers), T_2 (1tonne vermicompost + 50% NPK of RDF), T_3 (2 tonne vermicompost + 50% NPK of RDF), T_4 (3 tonne vermicompost + 50% NPK of RDF), T_5 (1 tonne vermicompost + 75% NPK of RDF), T_6 (2 tonne vermicompost+75% NPK of RDF), T_7 (3 tonnes vermicompost +75% NPK of RDF), T_8 (1 tonnes vermicompost +100% NPK of RDF), T_9 (2 tonnes vermicompost + 100% NPK of RDF) and T_{10} (3 tonnes vermicompost + 100% NPK of RDF) initial value of soil pH was 8.73 and 8.61 during both the year. From the table it was found that soil pH was affected significantly by different treatments during both the years. Significant reduction in soil pH was noticed due to application of increasing levels of vermicompost at similar NPK level during first year while no clear effect was noticed during second and some treatments were found statistically similar. Soil pH drop by 0.79 to 0.41 and 0.74 to 0.36 unit due to application of 1 to 3.0 tonnes of vermicomposting over 100% NPK during the both year. EC (dSm^{-1}) of soil as affected by different treatments of different day's interval sampling are presented in Table 2. At 30 DAS sampling interval the EC ranged from 0.214 to 0.427 and 0.209 to 0.429 (dSm^{-1}) during the first and second, respectively. Electrical conductivity (dSm^{-1}) of soil extract after wheat harvest in different treatments during both the years. It is evident from the table that with exception of T_1 (150: 60: 40: as NPK, recommended dose of fertilizers) in the rest of the treatments electrical conductivity of soil extract declined from its initial value during both the years. Available nitrogen (kg ha^{-1}) in soil affected by significantly different treatments at different day's interval. Available nitrogen, phosphorus and potassium (Table 3) in soil declined gradually with the advancement of crop growth at different DAS interval. The highest available nitrogen, phosphorus and potassium were found in treatment T_{10} (three tonnes vermicompost+ 100% NPK of RDF), which was found statistically at par with treatment T_7 (three tonnes vermicompost +75% NPK of RDF), lowest available NPK were recorded in T_1 (150: 60: 40: as NPK, recommended dose of fertilizers), during both the years.Similar work relating to the present investigation was also carried out by Lui *et al.* (1992); Ramesh and Gunathilagaraj (1996); Sreenivas *et al*. (2000) and Vasanthi and Kumaraswamy (1999).

Conclusion:

Application of organic amendments like vermicompost with chemical fertilizers, increased yield of wheat crop, the available nutrients in soil, declining pH, EC and bulk density of soil and increased the organic carbon as well as promotes microbial activity. Biological, grain and straw yields of wheat were influenced significantly by the application of graded doses of vermicompost with chemical fertilizers. Application of higher dose of NPK (100% NPK of RDF) with vermicompost @ 3.0 t ha^{-1}, treatment T_{10} (three tonnes vermicompost + 100% NPK of RDF), was found statistically at par with lower dose of NPK (75% NPK of RDF) with equal dose of vermicompost *i.e*. 3.0 t ha^{-1} in treatment T_7 (three tonnes vermicompost +75% NPK of RDF), These treatment were found also significantly higher than the rest of the treatments during both the years. The treatment T_7 (75% NPK with vermicompost @ 3.0 t ha^{-1}) was found statistically similar to T_{10} (100% NPK with vermicompost @ 3.0 t ha^{-1}) was applied during both the years. This application also enhanced the soil physico-chemical properties of soil by improving availability of different nutrients.

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