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Effect of nitrogen and vermicompost on growth, yield and quality of Oat (Avena sativa L.)

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Abstract

A field experiment was conducted during rabi season of 2013-14 at the research farm of R.B.S College, Bichpuri, Agra.(U.P.) to evaluate the effect of nitrogen and vermicompost on growth, yield and quality of oat. The plant height and number of tillers plant^{-1} increased significantly with N and vermicompost levels over control. The ear length and test weight of oat increased significantly with nitrogen levels over control. Vermicompost levels also improved these characters significantly over control. Application of nitrogen and vermicompost increased significantly the grain and straw yield of oat. The increases in grain yield due to 50, 100 and 150 kg N ha^{-1} over control were 15.9, 28.8 and 35.7% respectively. Application of 5 t vermicompost ha^{-1} increased the grain yield by 16.2% over control. Application of N enhanced the percentage of protein in oat grain and straw significantly. Vermicompost levels also increased the protein percentage significantly over control. Protein yield increased significantly with N and vermicompost application.

Keywords: Nitrogen, vermicompost, growth parameters, and quality of oat

Introduction

Oats rank fourth in importance in world production of cereals exceeded only by wheat's, rice and maize. A greater proportion of the oat crop is fed directly to live stock than any other cereal. In India, oat is chiefly grown as a rabi fodder crop and provides nutrition's fodder especially suited to horse and mulch animals, poultry and young breeding animals of all kinds. Oat forage can be fed either green of as silage. It is high in protein, fat, vitamin B and minerals such as phosphorous and iron. Oat flour is used in the formulation of a skin care baby powder and as preservative. In medicine, oat is given as nerve stimulant tonic and soporific, emollient, refrigerant and laxative. It is useful in diphtheria paralysis, dysentery and acts as an antidote in morphine's and alcoholism. Oat forms an important restorative in exhaustion after febrile disease. It exerts a very beneficial action upon the heart muscles and on urinary organs. Oat exerts powerful effect against dental decay. The chemical, physical and biological properties of the soils are influenced by the application of the vermicompost. This manure has to be used to prevent the decline in the content of organic matter and nitrogen by continuous cropping. Vermicompost is the excreta of earthworms, which is rich in humus and nutrients. Vermicompost is rich in all essential plant nutrients and provides excellent effect on overall plant growth encourages the growth of new shoots/leaves and improves the quality and shelf life of the produce. It improves soil structure, texture, aeration and water holding capacity and prevents soil erosion. Vermicompost is rich in beneficial micro flora such as N fixers, P-solubilizers, cellulose decomposing micro flora etc in addition to improve soil environment. It prevents nutrient losses and increases the use efficiency of chemical fertilizers. It contains nitrogen 1.5-2.5%, phosphorus 0.9-1.7%, potash 1.5-2.4%, calcium 0.5-1.0%, magnesium 0.2-0.3% and sulphur 0.5-0.5%. Besides the major nutrients, vermicompost also contains traces of micro-nutrients.

Materials and Methods

A field experiment was conducted on a sandy loam soil having pH 8.0, EC 0.2 dSm^{-1}, organic carbon 3.1g kg^{-1}, available nitrogen 140.0 kg^{-1}, available P 9.2 kg^{-1}, and available K 110.0 kg^{-1} and Mn 3.25 mgkg^{-1}. The four levels of nitrogen (0, 50, 100 and 150 kg ha^{-}

^{1}) and three levels of vermicompost (0, 2.5 and 5.0 t ha^{-1}) were evaluated in Randomized Block Design with three replications. The sowing of the oats was done on 29th November 2013 with the variety name Kent. Recommended doses of 60 kg P_2O_5 and 40 kg K_2O ha^{-1} were applied to oat in the form of single superphosphate and muriate of potash, respectively. Nitrogen as per treatments was applied through urea. Vermicompost (1.52% N, 1.10% P and 1.65% K) was applied to plots 15 days before sowing. At harvest the plant height, number of tillers $plant^{-1}$, ear length, test weight, grain and straw yields of the crop were recorded.

Results and Discussion

Plant height

The data on the effect of nitrogen and vermicompost levels on plant height of oat crop are summarized in Table1. The results indicate that the plant height increased significantly with nitrogen application over control and the tallest plants were noted with 150 kg N ha^{-1}. Plant height increased from 129.6 cm at control to 136.2 cm at 150 kg N ha^{-1} level. Application of N resulted in improved nutrient availability and had the beneficial effect on plant height. These results are in close conformity with the findings of Kumar et al. (2001) and Meena et al. (2012). Plant height of oat plants also increased significantly with vermicompost application over control. Plant height increased from 131.7 cm at control to 134.0 cm at 5 t vermicompost ha^{-1}. Both the levels of vermicompost proved significantly superior to control in respect of plant height. The beneficial effect of vermicompost may be. attributed to its contribution in supplying additional plant nutrients, improvement in soil physical condition and biological process in soil (Dahiya et al. 1987). Similar results have been reported by Kumar et al. (2010). The interaction effect of N and vermicompost on plant height was found to be significant (Table1). When the levels of N and vermicompost were applied together in various combinations, the increases in plant height were significantly more than those with their individual application. The tallest plants (137.3 cm) were recorded under 150 kg N + 5 t vermicompost ha^{-1} treatment but it was at par with 100 kg N + 5 t vermicompost ha^{-1} and 150 kg N + 12.5 t vermicompost ha^{-1}.

Tillers $plant^{-1}$

A study of Table 1 reveals that the number of tillers $plant^{-1}$ increased significantly with N application over control and maximum value was recorded with 150 kg N ha^{-1}. The number of tillers $plant^{-1}$ increased from 5.5 to 6.2 with 150 kg N ha^{-1}.This increase in number of tillers may be attributed to increased availability of N in oat which resulted in vigorous growth of plants. Similar results were reported by Singh et al. (2013). Application of vermicompost also improved the number of tillers $plant^{-1}$ over control and maximum number was recorded with 5 t vermicompost ha-^{1}. The number of tillers increased from 5.7 to 6.1 / plant with 5 t vermicompost ha-^{1} which may be attributed to increased availability of nutrients and improvement in physic-chemical properties of the soil. Kumar et al. (2010) also reported similar results. The interaction effect was also significant maximum number of tillers were recorded with N1so + VCs treatment.

Table 1: Effect of nitrogen and vermicompost levels on plant height of oat crop

N levels (kg ha^{-1})	Vermicompost levels (t ha-^{1}) 0	2.5	5.0	Mean
Plant height (cm)				
0	128.5	129.6	130.7	129.6
50	130.0	131.5	133.0	131.5
100	133.4	134.0	135.0	134.1
150	135.0	136.2	137.3	136.2
Mean	131. 7	132.8	134.0	
	N	VC	N X VC	
SEm±	0.48	0.39	1.33	
CD (P=0.05)	1.41	1.13	2.44	
Number of tillers/plant				
0	5.3	5.5	5.8	5.5
50	5.6	5.8	6.0	5.8
100	5.8	6.0	6.2	6.0
150	6.0	6.2	6.4	6.2
Mean	5.7	5.9	6.1	
	N	VC	N X VC	
SEm±	0.049	0.043	0.085	
CD (P=0.05)	0.0143	0.125	0.249	

Yield attributing character

Data on yield attributing character (ear length and test weight) were recorded at harvest and presented in Table 2. It is evident that lower values of ear length and test weight were recorded in control treatment. Application of nitrogen levels enhanced the values of these characters significantly over control. The maximum values of these attribute were recorded at 150 kg N ha^{-1}. The increase in yield attributing characters may be ascribed to increased availability of nutrients with nitrogen application. Similar results

Table 2: Effect of nitrogen and vermicompost on ear length and test weight of oat crop

N levels (kg ha^{-1})	Vermicompost levels (t ha-^{1}) 0	2.5	5.0	Mean
Ear length (cm)				
0	22.2	22.4	22.5	22.4
50	22.5	22.8	23.0	22.8
100	23.0	23.2	23.4	23.2
150	23.1	23.4	23.5	23.3
Mean	22.7	22.9	23.1	
	N	VC	N XVC	
SEm±	0.144	0.126	0.24	
CD (P=0.05)	0.422	0.369	NS	
Test weight (g)				
0	43.6	44.0	44.4	44.0
50	44.2	44.5	44.8	44.5
100	44.7	45.0	45.4	45.0
150	45.0	45.4	46.0	45.4
Mean	44.4	44.7	45.1	
	N	VC	N XVC	
SEm±	0.134	0.117	0.230	
CD (P=O.05)	0.393	0.343	NS	

were reported by Kumar et al. (2001) and Singh et al. (2013). Application of vermicompost also enhanced these characters significantly over control. The maximum values of these attributes were recorded at 5 t vermicompost ha^{-1}. The increase in yield attributing characters may be attributed to increased availability of nutrients due to application of vermicompost. Kumar et al. (2010) also reported similar results. The interaction effect between Nand vermicompost levels on ear length and test weight was non- significant (Table 2). The greater length of the ear and higher test weight was recorded with 150 kg N + 5 t vermicompost ha^{-1} treatment and lower at control.

Yield Studies

Grain

A study of Table 3 reveals that the grain yield of oat increased significantly with nitrogen application over control. The increase in yield at each level of nitrogen addition was found to be significant as compared to control. The maximum grain yield of oat (63.24 q ha^{-1}) was recorded with 150 kg N ha^{-1}. The percent increases in grain yield over control were 15.9, 28.8 and 35.7, respectively with 50, 100 and 150 kg N ha^{-1}. The increases in the levels of nitrogen have profound effect on the yield of grain. The increases in the level of nitrogen was responsible for the increased number of leaves and leaf area index causing higher photosynthesis and assimilation rates, metabolic activity and cell division, which were responsible for significant increase in the growth characters and grain yield of oat. Similar results were also reported by Singh et al. (1995), Kumar et al. (2001), Sahay et al. (2009) and Meena et al. (2012) and Kumar et al. (2013). The green foliage and dry matter yield of oats increased significantly with N2 @ 80 kg^{-1} and N3 @ 120 kg^{-1} levels of nitrogen as compared to control during both the cuttings (Lal et al 2012).

The results (Table 3) indicate that the grain yield of oat increased significantly with vermicompost application. This increase in grain yield was significant for each level of vermicompost as compared to control. The higher level of vermicompost (5 t ha^{-1}) improved the grain yield of oat by 5.37 q ha^{-1} over 2.5 t vermicompost ha-^{1} level. Increases in average grain yield due to 2.5 and 5.0 t vermicompost ha^{-1} were 10.4 and 16.2 percent, respectively over control. Similar results have ,been reported by Singh et al. (1994), Kumar et al. (2010), Meena et al. (2012) and Kumar et al. (2013). The beneficial effect of vermicompost may be due to its contribution in supplying additional plant nutrients, improvement of soil physical conditions and biological process in soil.

Straw yield

Table 3: Effect of nitrogen and vermicompost on grain yield of oat

N levels (kg ha^{-1})	Vermicompost levels (t ha-^{1}) 0	2.5	5.0	Mean
Grain yield (q ha^{-1})				
0	41.00	46.95	51. 76	46.57
50	48.80	55.11	58.00	53.97
100	56.17	60.87	62.92	59.98
150	59.55	64.08	66.11	63.24
Mean	51.38	56.75	59.70	
	N	VC	N X VC	
SEm±	1.25	1.10	2.19	
CD (P=0.05)	3.64	3.19	6.39	
Stover yield (q ha^{-1})				
0	66.07	74.18	82.82	74.36
50	78.11	88.75	92.88	86.58
100	88.98	97.00	100.00	95.33
150	96.22	103.16	105.67	101.68
Mean	83.34	90.77	95.34	
	N	VC	N X VC	
SEm±	2.00	1.75	3.51	
CD (P=0.05)	5.83	5.10	10.22	

A study of Table 3 reveals that the significantly increase in the straw yield of oat with nitrogen application. The maximum yield of straw (101.68 q ha^{-1}) was recorded at 150 kg N ha^{1} treatment. The straw yield of oat increased from 74.36 q ha^{-1} at control to 101.68 q ha^{-1} with 150 kg N ha^{-1}. The increases in straw yield due to 50, 100 and 150 kg N ha-^{1} levels over control were 16.4, 28.2 and 36.7 percent, respectively. Such spectacular response to nitrogen application was obviously attributable to low available nitrogen content of the soil and relatively high nitrogen requirement of the crop. Similar results were also reported by Singh et al. (1995) and Meena et al. (2012). A further study of Table 4.3 revealed that the vermicompost levels had a positive effect on straw yield over control. The application of 2.5 and 5 t vermicompost ha^{-1} increased the straw yield by 8.9 and 14.4% over control, respectively. The higher availability of nutrients with vermicompost helped to acquire a definite advantage over control in respect of plant height. Better availability of nutrients has led to higher growth characters which finally resulted in higher straw yield of oat. Similar results were reported by Meena et al. (2012).

The effect of N and vermicompost interaction on straw yield was significant (Table 3). The vermicompost application under all the levels of nitrogen increased the grain and straw yield. The rate of increase in yield due to the application of vermicompost was more conspicuous when it was applied in conjunction with nitrogen than its absence. The results thus, demonstrated that the application of vermicompost along with nitrogen was superior in terms of grain and straw yield of oat to the application of vermicompost without nitrogen. The maximum yield was recorded under 150 kg N + 5 t vermicompost ha-^{1} treatment. Singh and Agarwal (2001) and Chauhan et al. (2011) reported similar results.

Table 4: Effect of nitrogen and vermicompost levels on content and yield of protein in oat

N levels (kg ha^{-1})	Vermicompost levels (t ha-^{1}) 0	2.5	5.0	Mean
Protein content in grain (%)				
0	8.1	8.3	8.5	8.3
50	8.5	8.7	8.8	8.6
100	9.0	9.2	9.4	9.2
150	9.2	9.5	9.7	9.4
Mean	8.7	8.9	9.1	
	N	VC	N X VC	
SEm±	0.09	0.06	0.12	
CD (P=0.05)	0.26	0.17	NS	
Protein content in straw (%)				
0	2.6	2.8	3.0	2.8
50	2.8	3.0	3.3	3.0
100	3.1	3.3	3.5	3.3
150	3.3	3.5	3.8	3.5
Mean	2.3	3.1	3.4	
	N	VC	N X VC	
SEm±	0.065	0.055	0.11	
CD (P=0.05)	0.188	0.159	NS	

Protein content

The data on protein content in oat grain and straw as affected by'. N and vermicompost levels are presented in Table 4. A reference to data given in Table 4.4 reveals that the lowest content of protein in grain and straw was noted at no N treatment. The protein showed an increasing trend under N fertilized plots than no nitrogen application. The protein content in oat grain increased from 8.3 % at control to 9.4 % with 150 kg N ha-^{1} treatment. The corresponding increase in protein content in .straw was from 2.8 to 3.5 percent. This increase may be attributed to the fact that the protein content is directly related to nitrogen content in the plants. Patel (1998), Ram and Singh (2001) and Kumar et al. (2013) also reported similar results. Protein content in oat with both the vermicompost levels was significantly higher than in control. The protein content ingrain increased from 8.7 % at control to 9.1 % at 5.0 t vermicompost ha^{-1}. Thus, the results showed synergistic effect of applied vermicompost on protein content in grain and straw of oat. Kumar et al. (2010) also reported similar results. Interaction effect (N x vermicompost) had a non-significant effect on protein content in oat crop. However, the maximum value of protein content in oat was recorded under 150 kg N + 5.0 t vermicompost ha^{-1} treatment.

Protein yield

A study of Table 5 indicates that the application of nitrogen significantly increased the protein yield of oat grain over control. All the levels of N tried in the present study were significantly superior over control in respect of protein production. The maximum value of protein yield was noted under 150 kg N ha^{-1}. Nitrogen application increased the protein content in oat grain therefore protein yield also increased. Similar results were also reported by Patel (1998), Ram and

Table 5: Effect of nitrogen and vermicompost levels on protein yield in oat

N levels (kg ha-1)	Vermicompost levels (t ha-1) 0	2.5	5.0	Mean
Protein yield (kg ha-1)				
0	332.1	389.6	439.9	387.2
50	414.8	479.4	510.4	468.2
100	505.3	560.0	591.4	552.3
150	547.8	608.7	641.2	559.2
Mean	450.0	509.4	545.7	
	N	VC	N X VC	
SEm±	14.0	12.5	24.5	
CD (P=0.05)	40.7	35.6	71.3	

Singh (2001) and Kumar et al. (2013). The addition of vermicompost also enhanced the protein yield of grain significantly over control. As compared to control, both the levels of vermicompost were found to be significantly superior in respect of protein yield of oat grain. The maximum average value of protein yield was recorded with 5.0 t vermicompost ha-1. The interaction effect of N and vermicompost had a significant beneficial effect on the protein yield of oat grain. The maximum value of protein yield was recorded under 150 kg N + 5.0 t vermicompost ha-1.

References

Chauhan, S.S., Kumar, V. Bhadauria, U.P.S., and Dwivedi, A.K. (2011). Effect of conjoint of organic and inorganic fertilizer on soil fertility and productivity of soybean- wheat crop sequence. Ann. PI. Soil Res: 13: 47-50.

Kumar, A, Singh, B. and Singh J. (2001). Response of macoroni wheat (Triticum aestivum) to nitrogen phosphorous and sodic water on loamy sand soils of south-west Haryana. Indian J. Agron. 46 (1): 118-121.

Kumar, P., Singh, A. and Singh, A.K. (2010). Effect of biofertilizers, farmyard manure and nitrogen levels on growth yield and uptake of nutrients in wheat. Ann. PI. Soil Res. 12(2): 92-94.

Kumar, R., Pandey, D.S., Singh, V.P., Singh, J.P. and Pandey, D. (2013). Growth yield and quality of wheat (Trihcum aestivum) as influenced by organic sources of nitrogen nutrition. Indian. J. Agron. 88(3): 334-339.

Lal, Munna, Nataraja, K.C., Kherawat, B.S. Brajendra and Kumar, Arvind (2012).. Effect of nitrogen and manganese on yield and uptake of nutrients by oats (Avena sativa L.). Asian J. Soil Sci., **7**(1): 127-13

Meena, L.R., Mann, J.S and Meena, S.L. (2012). Effect of levels and mode of nitrogen application on dual purpose barley (Hordeum vulgare)' under semi-arid condition. Indian J. Agron. 57(2): 168-170.

Patel, J.R. (1998). Response of forage sorghum (Sorghum bicolor) to nitrogen and cutting management. Forage Res. 24(1): 55-56.

Ram, S.N. and Singh, B. (2001). Effect of nitrogen and harvesting time on yield and quality of sorghum (Sorghum bicolor) inter cropped with legumes. Indian J. Agron. 46 (1): 32-37.

Sahay, Neha., Kumar, Ajay and Verma, Dharmesh (2009). Effect of nitrogen and zinc on herbage yield, nutrient uptake and quality of fodder oat. Ann. PI. Soil Res. 11(2): 162-163.

Singh, R., and Agarwal, S.K. (2001). Growth and yield of wheat (Triticum aestivum) as influenced by levels of farmyard manure and nitrogen. Indian J. Agron. 46 (3): 462-467

Singh, T.; Singh, K.N; Bali, A.S. and Bhatt, G.N. (1995) Response of wheat (Triticum aestivum) genotypes to nitrogen and phosphorous. Indian J. Agron. 40; 90-101.

Singh, V., Singh, S.P., Singh, S. and Shivay, Y.S. (2013). Growth yield and nutrient uptake by wheat (Triticum aestivum) as affected by bio fertilizers, FYM and nitrogen. Indian J. Agric. Sci. 83(3): 331-334.

Singh, Vinay, Kumar, R and Ram Lakhan (1994). Effect of applied farmyard manure and molybdenum on yield and nutrient uptake by Egyptian clover. Indian J. Agron. 39 (3): 307-309.