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Effect of integrated nutrient management on productivity of oat (*Avena sativa L.*) and soil fertility

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ABSTRACT

A field experiment was conducted during rabi season (2014-16) at Research Farm, R.B.S. College, Bichpuri, Agra (U.P.) to study the effect of integrated nutrient management on productivity of oat (Avena sativa L.) and soil fertility. The experiment was laid out in randomized block design with ten treatments and three replications. The results revealed that the plant height, yields of oat crop increased significantly up to 100% NPK which were higher by 44.2 and 35.1% than the control. The maximum values of growth, quality and grain (6.38 t ha^{-1}) and straw (11.48 t ha^{-1}) yields were recorded with 75% NPK+2.5t VC+10kg Mn+20kg S ha^{-1}. Vermicompost alone was also found to be more beneficial in terms of growth and yield of oat crop over control. The maximum contents of protein in grain (9.50 %) and straw (3.38 %) were recorded with 100 % NPK but maximum value of protein yield (602 kg ha^{-1}) was recorded with 75% NPK+2.5t VC+10kg Mn+20kg S ha^{-1}. The uptake of N,K, S and Mn by oat crop was highest at 75% NPK+2.5t VC+10kg Mn+20kg S ha^{-1} and lowest in control. Phosphorus uptake by the crop was recorded maximum with 100% NPK alone. The amounts of organic carbon and available nutrients in post harvest soil were improved with 75% NPK+2.5t VC+10kg Mn+20kg S ha^{-1}. The available S and Mn increased with their application, respectively. The minimum amounts of available nutrients in post harvest soil were recorded under control.

Key words: - Oat, INM, quality, uptake of nutrients, soil fertility, yield

INTRODUCTION

Oats (*Avena sativa L.*)rank fourth in importance among cereals exceeded only by wheat, rice and maize. It is high in protein, fat, vitamin B, and minerals such as phosphorus and iron. Oat flour is used in the formulation of a skin care baby powder and as preservative. Oat is an important cereal mainly for fodder during rabi season. Oat provides a very nutritious fodder (protein 13- 15%) especially suited to milch animals. The ever-rising demand for fodder and feed for sustaining livestock production can be met through increasing productivity of fodder. The profitable production of oat crop may be affected by many factors, among these soil fertility to produce good fodder and grain, is of practical significance. The poor yield of oat crop in our country is mainly ascribed to low fertility of soil, inadequate manuring and cultural practices. Our soils have exhausted in respect of major and minor elements hampering the yield of crops. The new varieties of the crops require higher amounts of nutrients for realizing their inherent yield potential. Proper and optimum application of fertilizers not only increases the yield but also favourably affects the quality of the produce. To curb this trend of declining yield, there is need to adopt the concept of integrated nutrient management. Organic manure is an important component of an integrated nutrient management and may help to recover soil health. Besides, organic manures also supply the traces of micronutrients, which are not supplied by chemical fertilizers. Integrated system approach is not only a reliable way of obtaining high productivity with substantial fertilizer economy, but also a concept of ecological soundness leading to sustainable agriculture. The basic concept of integrated plant nutrient system is maintenance and improvement of soil fertility for sustaining crop productivity on long- term basis (Singh, 2017 and Pandey, 2018). The present experiment comprising of inorganic and organic fertilizers was undertaken to study their effects on oat crop.

MATERIALS AND METHODS

A field experiment was carriedout at Research Farm, Raja Balwant Singh College, Bichpuri (Agra) during rabi season of 2014-15 and 2015-16. The site of this experiment is

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located at 27^o 2' N latitude and 77^o 9' E longitude at an altitude of 168 meter above the mean sea level. The experimental site is characterized by semi-arid climate with hot dry summers (46 to 48° C) and very low temperature during winter (as low as 2° C). The average rainfall is about 650 mm, of which a major portion of 546 mm (84 per cent) is received from July to September and only 104 mm (16 per cent) is received in the remaining part of the year. The experimental soil was sandy loam in texture having pH 8.0, organic carbon 3.7 g kg^{-1}, available N 165 g kg^{-1}, available P 10.2 g kg^{-1}, available K 130 g kg^{-1}, available S 16.5 g kg^{-1}, DTPA – Mn 2.2 mg kg^{-1}and Zn 0.57 mg kg^{-1}. The experiment was laid out in randomized block design with three replications. The experiment included ten treatments, viz. T_1 Control, T_2 2.5 t Vermicompost ha^{-1}, $T_3$75% NPK, $T_4$75% NPK + 2.5 t Vermicompost ha^{-1}, $T_5$75% NPK + 10 kg Mn ha^{-1}, $T_6$75% NPK + 20 kg S ha^{-1} , $T_7$75% NPK + 2.5 t VC + 10 kg Mn ha^{-1} , $T_8$75% NPK + 2.5 t VC + 20 kg S ha^{-1} , $T_9$75% NPK + 2.5 t VC + 10 kg Mn + 20 kg S ha^{-1} and T_{10}100% NPK. Nitrogen was supplied in the form of urea as per treatments. Triple superphosphate and muriate of potash were used as sources for P_2O_5 and K_2O, respectively. Recommended dose of NPK for oat was 100:60:40 kg NPK ha^{-1}, respectively. Full quantities of P and K fertilizers were given at the time of sowing. Nitrogen was applied as basal and two splits at first and second irrigation. Sulphur and Mn were applied at sowing as elemental sulphur and manganese chloride, respectively. Well-decomposed vermicompost was added to the plots as per treatment one week before sowing. The oat (variety Kant) was sown at the rate of 80 kg ha^{-1} in first week of November in both the years. The grain and straw yield was recorded at harvest Processed samples of grain and straw were digested using di-acid mixture of HNO_3: $HClO_4$ (10:4). Phosphorus, K and S contents in acid extract were determined by vanadomolybdo phosphoric yellow colour method, flame photometer (Jackson 1973), turbidimetric method (Chesnin and Yien, 1951) and Mn by AAS. Nitrogen content was estimated by modified Kjeldahl method and crude protein content was calculated by multiplying with a factor of 6.25.The uptake of nutrients by oat crop was worked out by multiplying their content values with corresponding yield data. After harvest of the crop, soil samples were collected and analyzed for available N (Subbiah and Asija, 1956), P (Olsen *et al.*1954), K (1 N neutral ammonium acetate extractable), S (0.15% $CaCl_2$ extractable) and DTPA Mn (Lindsay and Norvell, 1978). The trend of results was similar during both the years hence; data were subjected to pooled analysis for results and discussion.

RESULTS AND DISCUSSION

Yield

Application of organic and inorganic sources of nutrients increased the plant height of oat crop over control and tallest plants were recorded with75% NPK+2.5t VC+10 kg Mn + 20kg S ha^{-1} followed by 100% NPK. The increase in plant height may be attributed to increased availability of nutrients in soil. These results are in accordance with those reported by Pandey and Rana (2016).The grain and straw yields of oat ranged from 4.36 and 8.21 t ha^{-1} at control to 6.20 and 11.10 t ha^{-1} with 100% NPK (Table 1). This treatment significantly increased the grain and straw yield by 44.2 and 35.1, respectively over control owing to greater availability of nutrients to plants (Singh, 2019). Application of 75% NPK + 2.5 t VC+10 kg Mn+20kg S ha^{-1} recorded significantly highest yield of grain (6.38 t ha^{-1}) and straw (11.48 t ha^{-1}).The beneficial effect of vermicompost on yields might be due to additional supply of nutrients as well as improvement in physical and biological properties of soil. Singh and Patra (2017) reported similar results. Application of 10 kg Mn ha^{-1} along with 75% NPK increased the grain and straw yields by 29.3 and 22.0 % over control, respectively. But this treatment failed to improve the yields significantly of oat over 75% NPK alone (Singh and Patra 2017). Application of 20 kg S ha^{-1} along with 75% NPK (T6) increased the yields significantly over control. Pandey and Chauhan (2016) reported similar results. The results clearly indicated that the highest yield was obtained with balanced use of nutrients (Hussain *et al.* 2013).

Table 1: Effect of integrated nutrient management on growth, yields and quality of oat (mean of two years)

Treatments	Plant height (cm)	Yield (t ha^{-1})		Protein content (%)		Protein yield (kg ha^{-1})
		Grain	Straw	Grain	Straw	
T_1	100.4	4.30	8.21	8.63	2.88	371
T_2	104.0	4.73	8.48	8.75	2.94	414
T_3	106.5	5.39	9.81	9.06	3.13	488
T_4	111.5	5.87	10.58	9.25	3.19	543
T_5	108.0	5.56	10.02	9.13	3.06	508
T_6	109.8	5.68	10.22	9.19	3.13	522
T_7	112.2	6.01	10.87	9.31	3.19	559
T_8	114.6	6.12	11.03	9.38	3.25	575
T_9	116.1	6.38	11.48	9.44	3.31	602
T_{10}	115.0	6.20	11.10	9.50	3.38	589
SEm±	0.75	0.78	0.87	012	0.03	0.75
CD (P= 0.05)	2.20	2.29	2.56	0.35	0.08	2.20

T_1 Control, T_2 2.5 t Vermicompost ha^{-1}, $T_3$75% NPK, $T_4$75% NPK + 2.5 t Vermicompost ha^{-1}, $T_5$75% NPK + 10 kg Mn ha^{-1}, $T_6$75% NPK + 20 kg S ha^{-1} , $T_7$75% NPK + 2.5 t VC + 10 kg Mn ha^{-1} , $T_8$75% NPK + 2.5 t VC + 20 kg S ha^{-1} , $T_9$75% NPK + 2.5 t VC + 10 kg Mn + 20 kg S ha^{-1}, T_{10}100% NPK

Quality

There was significantly higher percentage of protein in grain and straw under all the treatments as compared to control. The protein content in grain and straw of oat plants ranged from 8.63 to 9.50 and 2.88 to 3.38 per cent, respectively. Application of 75% NPK + 2.5 t VC ha^{-1} +10 kg Mn + 20 kg S ha^{-1} being at par with 100% NPK and 75% NPK + 2.5t VC + 10 kg Mn ha^{-1} proved significantly superior to other treatments in respect of protein content. This may be due to accumulation of more nitrogen with these treatments and ultimately showing more protein content (Pandey and Kumar, 2017 and Pandey and Chauhan, 2016). Application of VC alone (2.5t ha^{-1}) also improved the protein content over control. The protein yield ranged from 371 kg ha^{-1} at control to 602 kg ha^{-1} with 75% NPK + 2.5 t VC + 10 kg Mn + 20 kg S ha^{-1}. The minimum protein yield was noted under control, which may be attributed to lower protein content and yield of oat crop. Addition of 100% NPK enhanced the protein production over 75% NPK alone. Application of S and Mn coupled with 75% NPK and 2.5t VC ha^{-1} also improved the protein yield and maximum value of protein yield (889.0 kgha^{-1}) was recorded with 75%NPK+2.5t VC+20 kg S ha^{-1} showing the beneficial effect of combined application of chemical fertilizers and vermicompost (Pandey and Singh, 2017).

Table 2: Effect of integrated nutrient management on uptake of N, P, S (kg ha^{-1}) and Mn (g ha^{-1}) by oat crop (mean of two years)

Treatment	Nitrogen		Phosphorus		Potassium		Sulphur		Manganese	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	59.3	37.8	7.7	6.6	22.4	162.7	7.3	8.2	202.1	304.0
T_2	66.3	39.9	9.0	6.8	25.6	169.7	9.0	11.0	248.6	364.9
T_3	78.2	49.1	11.3	8.8	30.7	201.1	9.7	10.8	264.1	390.4
T_4	87.0	53.9	12.9	10.6	34.7	220.0	11.8	13.8	294.9	423.1
T_5	81.2	49.1	11.1	9.0	31.2	204.3	10.6	12.0	337.8	502.9
T_6	83.5	51.1	11.9	10.2	32.4	210.6	12.5	14.3	292.5	429.5
T_7	89.5	55.5	12.6	10.9	34.8	224.0	12.6	14.1	381.3	560.1
T_8	91.9	57.4	13.5	11.0	36.8	231.7	14.7	17.6	322.2	476.5
T_9	96.3	60.9	14.0	11.5	38.47	240.0	16.0	18.4	414.7	616.7
T_{10}	94.2	59.9	14.3	12.2	38.4	235.3	11.8	14.4	317.4	468.4
SEm±	1.98	1.26	0.17	0.37	0.97	1.65	0.18	0.22	2.63	3.91
CD (P= 0.05)	5.82	3.70	4.50	1.09	2.85	4.85	0.53	0.65	7.73	11.49

Uptake of nutrients

Nitrogen uptake by oat grain and straw increased from 59.3 and 37.8 kg ha^{-1} at control to 94.2 and 59.9 $kgha^{-1}$ with 100% NPK. This increase in N update by the crop may be attributed to increased grain and straw yield (Singh, 2019). The highest N update by grain and straw was recorded with 75%NPK+2.5tVC+10kgMn+20kgS ha^{-1} which may be attributed to increased grain and straw yield and N content in the crop. Incorporation of Mn and S with 75% NPK also improved the uptake of N by the crop (Singh and Patra 2017). The P uptake by oat grain and straw ranged from 7.7 to 14.3 kg ha^{-1} and 6.6 to 12.2 kg ha^{-1}, respectively with 100% NPK alone. This increase in P uptake may be ascribed to increased grain and straw production and improvement in P content in the crop (Singh 2017). Combined application of 75% NPK + 2.5 t VC + 10 kg Mn + 20 kg S ha^{-1} also improved the P uptake by the crop over control and other treatments. Sulphur and Mn addition along with 75% NPK proved more beneficial than 75% NPK alone. The uptake of K by oat crop was lowest in control and highest in75% NPK+2.5t VC +10kg Mn+20 kg S ha^{-1}. The mean uptake of K by oat crop and straw varied from 22.4 to 38.4 kg ha^{-1} and 162.7 to 240.0 kg ha^{-1}, respectively. However, 100% NPK was statistically at par with T9 treatment. The higher yield of grain and straw under these treatments absorbed large quantities of K from the soil, thus depleting the soil more K consequently showing higher uptake in plants (Sharma *et al.* 2016). All the treatments proved beneficial in increasing the uptake of sulphur by oat crop over control (Table 2). The minimum (7.3 and 8.2 kg ha^{-1}) and maximum (16.4 and 18.4 kg ha^{-1}) uptake of S by grain and straw were recorded under control and 75% NPK+2.5t VC +10kg Mn+20 kg S ha^{-1}, respectively. Inclusion of S significantly increased its uptake by oat grain and straw over 75% NPK. This increase in S uptake may be attributed to increased grain and straw yield and improvement in S content in crop. Pandey and Kumar (2017) also reported similar results. The uptake of Mn by oat grain and straw ranged from 202.1 to 414.7 g ha^{-1} and 304.0 to 616.7 g ha^{-1}, respectively. The combined application of fertilizers and manure including Mn application increased the Mn uptake by grain and straw (Singh and Patra, 2017)

Table 3: Effect of integrated nutrient management on status of organic carbon and available nutrients in post harvest soil (mean of two years)

Treatments	Organic Carbon ($g\ kg^{-1}$)	Nitrogen ($kgha^{-1}$)	Phosphorus ($kgha^{-1}$)	Potassium ($kgha^{-1}$)	Sulphur ($kgha^{-1}$)	Manganese ($mg\ kg^{-1}$)
T_1	3.4	147.0	8.6	118.0	16.0	1.8
T_2	3.9	158.5	10.0	122.0	16.8	2.1
T_3	3.7	166.0	12.5	126.0	16.6	1.9
T_4	4.0	177.5	15.0	130.0	18.0	2.1
T_5	3.7	170.0	10.6	125.0	16.7	2.5
T_6	3.8	172.5	11.0	126.2	22.0	2.2
T_7	4.3	179.6	14.5	128.5	17.0	2.6
T_8	4.3	181.5	15.6	131.6	22.4	2.2
T_9	4.4	184.5	16.0	134.5	22.0	2.2
T_{10}	0.39	185.6	16.5	133.0	17.0	2.0
SEm±	0.07	1.29	0.17	1.32	0.33	0.04
CD (P= 0.05)	0.20	3.79	0.50	3.88	0.97	0.11

Soil fertility

Use of different nutrient management practices caused a marked change in the organic carbon content and maximum amount of soil organic carbon (4.4 g kg^{-1}) in post harvest soil was noted with 75% NPK+2.5t VC +10kg Mn+20 kg S ha^{-1} (Table 3). This increase in organic carbon content may be attributed to addition of vermicompost. The available N status exhibited marked difference due to various nutrient management practices and highest value (185.6 $kgha^{-1}$) was obtained under 100% NPK ha^{-1} followed by 75% NPK+2.5t VC +10kg Mn+20 kg S ha^{-1}.The lowest available nitrogen content was recorded in control.

Available phosphorus status recorded significant variation due to treatments (Table 3). Highest available P content of 16.5 kgha^{-1} was recorded in 100% NPK ha^{-1} treatment followed by 75% NPK+2.5t VC +10kg Mn+20 kg S ha^{-1} The lowest available P content (8.6kg ha^{-1}) was observed under control. Application of 75% NPK+2.5t VC +10kg Mn+20 kg S ha^{-1} showed significantly higher amount of available potassium in post harvest soil and lowest (118.0 kg ha^{-1}) in control. Available S content in post harvest soil ranged from 16.0 to 22.0 kg ha^{-1}. Inclusion of S with 75% NPK and vermicompost also increased the amount of available S in post harvest soil. Lowest (1.8 mgkg^{-1}) and highest (2.6 mgkg^{-1}) contents of DTPA-Mn in post harvest soil were recorded under control and 75% NPK + 2.5 t VC + 10 kg Mn ha^{-1}, respectively. This increase in available Mn in post harvest soil may be attributed to applied Mn and vermicompost to the soil.

It may be concluded from the present investigation that application of 75% NPK + 2.5 t VC + 10 kg Mn + 20 kg S ha^{-1} proved beneficial under semi-arid condition of Agra region of Uttar Pradesh for achieving higher productivity of oat, besidesimproving quality of produce and maintaining soil fertility. Inclusion of S and Mn also enhanced their uptake by oat crop.

REFERENCES

Chesnin, L. and Yien, C.H. (1951) Turbidimetric determination of available sulphates.Proceeding of Soil Science Society of America **15**: 149-151.

Hossain, A., Kumar, D., Rana, D.S., Gangaiah, B., Dwivedi, B.S. and Sahoo, R.N. (2013) Productivity and profitability of Bt cotton (*Gossypium hirsutum*)-wheat (*Triticum aestivum*) cropping system as affected by nutrient omissions. *Indian Journal of Agronomy* **58** (2): 175-18

Jackson M.L. (1973) *Soil chemical Analysis*. Pentice Hall of India Pvt. Ltd., NewDelhi.

Lindsay, W.L. and Norvell, W.A. (1978) Development of a DTPA test for Zn, Fe, Mn and Cu. Soil Science Society America Journal **42**:421-28.

Olsen, S.R, Cole, C.V., Watanable, F.S. and Dean, L.A. (1954) Estimation of available phosphorus in soils extraction with sodium bicarbonate. *Cire.*U.S. *Dept. Agric.* 939.

Pandey, M. and Chauhan, M. (2016) Effect of sulphur and zinc on yield, quality and uptake of nutrients in barley.*Annals of Plant and Soil Research* **18** (1): 74-78.

Pandey, M. and Kumar, M. (2017) Effect of sulphur, manganese and zinc on yield, quality and uptake of nutrients by wheat (*Triticum aestivum*), *Annals of Plant and Soil Research* **19**(4): 403-407.

Pandey, M. and Rana, N. (2016) Response of wheat to sulphur and zinc nutrition in alluvial soil.*Annals of Plant and Soil Research* **18** (4): 418-422.

Pandey, M. and Singh, O.P. (2017) Effect of balanced use of nutrients on yield, quality and uptake of nutrients by wheat (*Triticum aestivum*).*Annals of Plant and Soil Research* **19**(4):426-429.

Sharma, V.K. and Singhal, S.K. (2016) Maximizing rice (*Oryza sativa*) and wheat (*Triticum aestivum*) productivity and profitability using improved nutrient management practices.*Indian Journal of Agriculteral Sciences* **86**(9): 1179-82.

Singh, S.P. (2017) Productivity, quality and uptake of nutrient in wheat (*Triticum aestivum*) as influenced by integrated nutrient management.*Annals of Plant and Soil Research* **19** (1): 12-16.

Singh, V. (2017) Effect of balanced use of nutrients on productivity and economics of wheat (*Triticum aestivum*).*Annals of Plant and Soil Research* **19**(1): 105-109.

Singh, V. and Patra, A. (2017) Effect of FYM and manganese on yield and uptake of nutrients in wheat (*Triticum aestivum*).*Annals of Plant and Soil Research* **19** (4): 381-384.

Singh,V. (2019) Effect of nutrient management on yield, uptake of nutrients and soil fertility under pearl mellet (*Pennisetum glaucum*) – wheat (*Triticum aestivum*) crop sequence. *Annals of Plant and Soil Research* **21** (2): 149-153.

Subbiah, B.V. and Asija, G.L. (1956) Aapid method for the estimation of available nitrogen in soils *current Science* **25**: 259-260.