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Integrated nutrient management in non-traditional crop oat (*Avena sativa* L.) under partially reclaimed soil

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Abstract
Oat (*Avena sativa* L.) is used as a green fodder, straw, hay or silage. A field experiment was carried out during 2014-15 and 2015-16 with the concept of integrated nutrient management under partially reclaimed sodic soil. Results indicated that maximum plant height at 120 days (157.7 cm), tillers plant^{-1} at 90 days (6.42), length of spike (38.7 cm) test weight (28.57 g), grain yield (34.92 q ha^{-1}), straw yield (82.77 q ha^{-1}) and maximum harvest index (29.64 %) was recorded with T_2- NPK (80:40:40 kg ha^{-1}) which was significantly higher than all the treatments followed by the treatment T_3- ½ NPK + 10t FYM showing the value of plant height at 120 days (152.5 cm), tillers plant^{-1} at 90 days (6.17), length of spike (37.2 cm) test weight (27.42 g), grain yield (34.22 q ha^{-1}), straw yield (81.68 q ha^{-1}) and maximum harvest index (29.52%). Seed treatment with *Trichoderma* or PSB with ½ doses of NPK also responded significantly over control in all the parameters. However, combined seed treatments with PSB + *Trichoderma* + ½ doses of NPK were much effective in comparison to single inoculation of *Trichoderma* or PSB.

Keywords: *Avena sativa*, NPK, FYM, Oat, *Trichoderma* and PSB

Introduction

Oat (*Avena sativa)* seeds are not only a rich source of carbohydrates and soluble fiber; they also have the highest content of iron, zinc and manganese. As a food, oat is known to be good for the heart because they keep blood fats under control. In addition they contain compounds which are selective and soothing to the brain and nervous system. Oat helps lower cholesterol level in the blood and also increases stamina. The seed is a mealy nutritive herb that is antispasmodic, cardiac, diuretic, emollient, nervine and stimulant. The seed contains the antitumor compound b-sitosterol and has been used as a folk remedy for tumors. Oat is the only cereals containing a globulin or legume like protein, avenaline, as the major (80%) storage protein. The more typical cereal proteins are gluten and zein and prolamines. The minor protein of oat is a prolamine: avenine. Avenin is a prolamine that is toxic to the intestinal submucosa and can trigger a reaction in some celiacs. Oat protein is nearly equivalent in quality to soy protein, which has been shown by the WHO to be equal to meat and egg protein. For Sustainable Agriculture and to control the hazards effect of chemical fertilizers, manure and bio-fertilizers are best option for our agriculture. FYM is the most commonly used organic manure of dung and urine of farm animals along with litter and left-over material from roughages or fodder fed to the cattle. Organics not only acts as a source of nutrients but also provides micro nutrient as well as modifies the soil physical behaviour and increases the efficiency of applied nutrient (Pandey *et al.* 2007). Bio-fertilizer is also a best alternate for the modern Agriculture with the objectives of increasing the number of such micro-organisms and accelerate certain microbial process to augments the extant of the availability of nutrients in a form which can assimilated by plant. In the experiment, an integrated approach of organic manure (F.Y.M.), inorganic and bio-fertilizers (P.S.B. and *Trichoderma*) are used for study. *Trichoderma* is capable of decomposing O.M. at the faster rate, hence can be used as a bio-fertilizer for quick release of nutrients. Like *Trichoderma*, P.S.B is also a bio-fertilizer (PO_4 solubilizer), which is used for seed treatment because unavailable form of phosphorus of soil is change in the available form of P_2O_5 and plants easily taken from the soil. Judicious use of organic and inorganic sources of plant nutrition is to be evaluated under existing climatic conditions. Therefore, to increase the production of oat seed, the productivity needs to be increased through integrated nutrients management under sodic soil condition.

Materials and Methods

The present investigation was laid out at Aurawan Research Station of CSIR-National Botanical Research Institute, Lucknow (Uttar Pradesh). To study the integrated nutrient management in non-traditional crop Oat (*Avena sativa* L.) under partially reclaimed soil, a field experiment was conducted for two subsequent cropping years during *rabi* season in 2014-15 and 2015-16. The farm site is located between latitude 26^{0}43’03” N and longitudes 80^0 50’ 02” E at an altitude of 120 m above the mean sea level. The climate of this region is characterized by long and intensive hot summer low and irregular rainfall and long mild winter. The area receives an annual rainfall of 80 -100 cm, 70% of which is concentrated in the month of July-September. The initial properties of the soil were pH- 8.5, EC- 0.32, organic carbon- 4.4g kg^{-1}, available N- 154 kg ha^{-1}, available P- 14.8 kg ha^{-1}, Available K- 185 kg ha^{-}1. The experiment

comprising 6 treatment combinations *viz*., T_1- control, T_2- NPK (80:40:40), T_3- ½ NPK (40:20:20) + FYM 10t ha^{-1}, T_4- ½ NPK + FYM 10 t ha^{-1} + Seed Treatment with *Trichoderma*, T_5- ½ NPK + FYM 10t ha^{-1} + Seed Treatment with *PSB* and T_6- ½ NPK + FYM 10t ha^{-1} + Seed Treatment with PSB and *Trichoderma* with 4 replication under randomized block design. Decomposed FYM was applied in the field before sowing as per treatment. The fertilizer was given through Urea, D.A.P. and M.O.P. Full dose of D.A.P. and M.O.P. was applied at the time of sowing and nitrogen applied in three splits i.e. 1/3 at the time of sowing, 1/3 at the time of tillering and rest 1/3 at the time of panicle initiation. Seed treated by the bio-fertilizers like PSB and *Trichoderma* as per treatment at the time of sowing. Sowing was done in rows 25x10 cm apart followed by planking to lower the seed, the seed rate was 80 kgha-1. The data on growth characters *viz*., plant height and number of tillers/plant and yield attributes *viz*., length of spike, grains per spike and test weight of grains and yield of total grains, straw and harvest index at the time of harvest. After maturity, the crop harvested and grain and straw yield was recorded. At the time of before preparation of field soil sampling should be done for the initial soil properties and after harvesting also soil sampling should be done for soil analysis. The pooled data of two years (2014-15 and 2015-16) on the growth yield and economics was statistically analysed for interpreting the results.

Results and Discussion

Growth characters

Plant height

The results regarding plant height as presented in Table 1 showed significant effect of organic and inorganic fertilizer application. The mean of two years indicated that varying doses of organic, inorganic and their combinations of plant nutrients significantly influenced growth of oat (Table 1). Result showed that all the treatment showed significant response over control (T_1). Maximum plant height (54.8cm) was recorded with treatment T_2- NPK (80:40:40) which was at par with treatment T_6- ½ NPK +10 t FYM + PSB+ *Trichoderma* showing the value of 53.8 cm at 30 DAS (days after sowing) (5). Single inoculation of seed with Trichoderma and PSB was not effective in treatment T_4 and T_5 at 30 and 60 DAS. However, at 90 DAS treatment T_5- ½ NPK + 10 t FYM + PSB responded significantly over T_3- ½ NPK (40:20:20) + 10 t FYM showing the value of 136.2 cm over 129.5 cm. Similar trend was also recorded at 120 DAS of plant growth. (1) reported that the combine application of biofertilizer together with 75% of recommended NP increase plant height compare with 100% NP alone.

Table 1: Effects of treatments on plant height (mean of two years)

Treatments	Plant Height (cm)			
	30 DAS	60 DAS	90 DAS	120 DAS
T_1- Control	43.2	58.2	87.5	101.3
T_2- NPK (80:40:40)	54.8	82.7	141.3	157.7
T_3- ½ NPK (40:20:20) + 10 t FYM	50.9	74.0	129.5	143.5
T_4- ½ NPK + 10 t FYM + *Tricho*.	51.7	76.3	133.8	147.6
T_5- ½ NPK + 10 t FYM + PSB	52.2	78.2	136.2	150.9
T_6- ½ NPK +10 t FYM + PSB+ *Tricho*.	53.8	80.6	138.9	154.8
SE(m)±	1.09	1.89	2.62	3.31
$CD_{(P=0.05)}$	2.33	4.03	5.58	7.06

Number of tillers

Number of tillers is one of the important yield contributing factors which was significantly affected by the application of different nutrient sources as shown in Table 1. Maximum 4.02 tillers $plant^{-1}$ was recorded in T_2- NPK (80:40:40) followed by 3.95 tillers $plant^{-1}$ in T_6- ½ NPK +10 t FYM + PSB+ *Trichoderma* which was produced significantly higher tillers $plant^{-1}$ in comparison to 3.96 tillers $plant^{-1}$ in the treatment T_3- ½ NPK (40:20:20) + 10 t FYM at 30 DAS (9). Similar trend was also recorded at 60 DAS. However, at 90 DAS, maximum 6.42 tillers $plant^{-1}$ was recorded in T_2- NPK (80:40:40) which was at par with T_6- ½ NPK +10 t FYM + PSB+ *Trichoderma* showing the value of 6.32 tillers $plant^{-1}$. Seed treatment with PSB in treatment T_5- ½ NPK + 10 t FYM + PSB responded significantly in comparison to without inoculation in T_3- ½ NPK (40:20:20) + 10 t FYM showing the value of 5.85 tillers $plant^{-1}$ over 5.14 tillers $plant^{-1}$. However, dual inoculation of PSB and *Trichoderma* in treatment T_6- ½ NPK + seed treatment (PSB+ *Tricho*.) was much effective in comparison to single inoculation (PSB or *Trichoderma*) with ½ dose of NPK + 10 t FYM (Table-2). Similarly (2) also revealed that the application of combined source of organic and inorganic fertilizers recorded higher number of tillers m^{-2} in oat.

Yield characters

Length of spike (cm)

In case of length of spike, all the treatment showed significant response over control. Treatment T_2- NPK (80:40:40) achieve the result of 38.7 cm which was higher than all the treatment followed by 37.6 cm in T_6- ½ NPK +10 t FYM + PSB + *Trichoderma*. Single inoculation of seed with *Trichoderma* (T_4) was not responded significantly in comparison to without inoculation. However, seed treatment with PSB in T_5- ½ NPK + 10 t FYM + PSB was showed significant response over T_3- ½ NPK (40:20:20) + 10 t FYM showing the value of 34.2 cm and 31.7 cm respectively (Table-3).

Number of grains (per spike):

Number of grains per spike is one of the most important parameters affecting the yield of crops. It was evident from the data that number of grains (per spike) was affected significantly by different source of nutrient. Statistically the maximum Number of grains per spike (67.12) was recorded in treatment T_2 fertilized with inorganic sources (NPK 80:40:40 kg ha^{-1}) followed by T_6 (64.67) treatments where combination of inorganic and organic sources of fertilizer were used ½ NPK +10 t FYM + PSB+ *Trichoderma*. Single inoculation of seed with *Trichoderma* (T_4) was not responded significantly in comparison to without

inoculation. However, seed treatment with PSB in T_5- ½ NPK + 10 t FYM + PSB was showed significant response over T_3- ½ NPK (40:20:20) + 10 t FYM showing the value of 54.20 and 46.58 respectively (Table-3).

Test Weight (g)

Maximum test weight 28.57 g was recorded in the treatment T_2- NPK (80:40:40) and minimum 21.36 g in the treatment T_1- Control. Seed treatment with PSB + *Trichoderma* in the treatment T_6 (½ NPK +10 t FYM + PSB + *Trichoderma*) was much effective (28.32 g) (Singh and Singh, 2005) [9] in comparison to single inoculation of PSB and *Trichoderma in the treatment* T_4 and T_5 and significantly higher than T_3 (½ NPK (40:20:20) + 10 t FYM) showing the value of 25.22 g (Table-3).

Grain and Straw yield (q ha^{-1})

Seed treatment with PSB (T_5) or *Trichoderma* (T_4) *increased* the grain yield showing the value of 31.46 q ha^{-1} and 32.64 q ha^{-1} respectively over 30.22 q ha^{-1} in without treatment (T_3) but significant response was recorded through PSB treatment only in T_5 (½ NPK + 10 t FYM + PSB) (8). However, Seed treatment with PSB + *Trichoderma* + ½ dose of NPK+10 t FYM (T_6) was much effective (33.12 q ha^{-1}) than single inoculation of PSB and *Trichoderma* with similar dose of manure and fertilizer. Maximum grains grain yield (34.92 q ha^{-1}) was recorded with full dose of NPK (80:40:40) in T_2 treatment (10) which was at par with T_6- ½ NPK +10 t FYM + PSB+ *Trichoderma* showing the value of 33.12 q ha^{-1} (4, 11). Similar to grain yield, maximum straw yield was also recorded (82.77 q ha^{-1}) in T_2- NPK (80:40:40) which was closely at par with T_6- ½ NPK +10 t FYM + PSB+ *Trichoderma* (81.10 q ha^{-1}) (Table-3). (2) also reported yield advantage in oat with the application of inorganic and organic source of nutrients together.

Harvest index is depending on grain and straw yield of oat. Maximum harvest index was recorded (29.67%) in T_2- NPK (80:40:40) followed by 29.10% and 29.00% respectively in T_5- ½ NPK + 10 t FYM + PSB and T_6- ½ NPK +10 t FYM + PSB+ *Trichoderma*. Seed treatment with *Trichoderma* (T_4) and PSB (T_5) only numerically increased the harvest index but did not reach up to the levels of significant over without treatment (T_3) (Table-3).

Soil fertility after harvest of oat

In case of soil properties, organic carbon status slightly increased by the application of 10 t FYM in the treatment T_3 and T_5 (Sharma *et al.*, 2007) [6]. Available N was not affected by the treatments however available P and available K improved through different treatments (Table-4).

After two years of experimentation, data on soil analysis indicated that integration of organic and inorganic to oat showed variation in organic carbon (%), available N and K in soil as compared to initial level. Application of 20 t FYM slightly decreased the pH (8.4) from its initial pH value of 8.6 and electrical conductivity was also decreased from 0.37 dS/m to 0.24, 0.25 by the application of 20 t FYM. Application of 20 t FYM was also found effective for increasing the organic carbon status from 4.1 g/kg to 4.3 g/kg. Available NPK was also increased through 20 t FYM application. Available P was further increased through PSB and PSB + *Trichoderma* inoculation in the treatments T_4 and T_5. (7) have also the improvement in organic carbon and available N in fodder sorghum due to addition of organic source of nutrient.

Table 2: Effects of treatments on number of tillers/plant (mean of two years)

Treatments	Tillers/Plant		
	30 DAS	60 DAS	90 DAS
T_1- Control	2.32	2.68	3.35
T_2- NPK (80:40:40)	4.02	5.56	6.42
T_3- ½ NPK (40:20:20) + 10 t FYM	3.62	4.85	5.14
T_4- ½ NPK + 10 t FYM + *Tricho.*	3.72	5.06	5.42
T_5- ½ NPK + 10 t FYM + PSB	3.87	5.22	5.85
T_6- ½ NPK +10 t FYM + PSB+ *Tricho.*	3.95	5.43	6.32
SE(m)±	0.15	0.25	0.31
$CD_{(P=0.05)}$	0.33	0.53	0.66

Table 3: Effects of treatments on length of spike, test weight, grain and straw yield and harvest index (mean of two years)

Treatments	Length of Spike (cm)	Grains per Spike	1000 grain wt. (g)	Grain and Straw yield (qha^{-1})		Harvest index (%)
				Grain	Straw	
T_1- Control	22.0	23.02	21.36	12.70	36.56	25.78
T_2- NPK (80:40:40)	38.7	67.12	28.57	34.92	82.77	29.67
T_3- ½ NPK (40:20:20) + 10 t FYM	29.2	46.58	25.22	30.22	77.68	28.00
T_4- ½ NPK + 10 t FYM + *Tricho.*	31.7	49.79	26.67	31.46	78.38	28.64
T_5- ½ NPK + 10 t FYM + PSB	34.2	54.20	27.31	32.64	79.52	29.10
T_6- ½ NPK +10 t FYM + PSB+ *Tricho.*	37.6	64.67	28.32	33.12	81.10	29.00
SE(m)±	1.65	1.57	1.12	1.12	1.56	0.55
$CD_{(P=0.05)}$	3.53	3.36	2.38	2.38	3.33	1.17

Table 4: Changes in Soil properties after harvest of Oat Crop (mean of two years)

Treatments	Soil pH_2	EC_2 (dSm^{-1})	O.C. (gkg^{-1})	Avail. N (kgha^{-1})	Avail. P (kgha^{-1})	Avail. K (kgha^{-1})
T_1- Control	8.5	0.29	3.5	143	13.6	182
T_2- NPK (80:40:40)	8.5	0.24	3.4	151	16.7	192
T_3- ½ NPK (40:20:20) + 10 t FYM	8.4	0.22	3.8	153	16.5	196
T_4- ½ NPK + 10 t FYM + *Tricho.*	8.4	0.24	3.7	152	16.0	186

T_5- ½ NPK + 10 t FYM + PSB	8.4	0.23	3.8	154	16.2	187
T_6- ½ NPK +10 t FYM + PSB+ *Tricho*.	8.4	0.25	3.7	156	16.8	190
Initial	8.5	0.32	3.7	154	14.8	185

Conclusion

It is concluded from this experimentation that maximum grain yield and other parameters was recorded in balance fertilization. However, ½ dose of NPK (40:20:20) + 10 t FYM + PSB + *Trichoderma* was the cost effective agri-package for the cultivation of oat.

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References

1. Chellamuthu V, Khan AKF, Malarvizhi P. Studies on effect of inorganic and biofertilizer on bajranapier hybrid grass. Range Manag Agrofor,2000:21(2):135-137. (CAB Absts. 71(8):375).
2. Jayanthi C, Malarvizhi AK, Khan AK, Chinnusamy C. Integrated nutrient management in forage oat (*Avena sativa* L.). Indian J Agron,2002:47(1):130-133.
3. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium carbonate. United States Department of Agriculture, Circular 939, 1954.
4. Patel DM, Patel SK, Karelia GN. Integrated nutrient management in pearl-millet-wheat cropping system. Indian J Agron,1995:40(2):266-268.
5. Patidar M, Mali AL. Effect of farm yard manure, fertility levels and bio-fertilizer on growth yield and quality of Sorghum bicolor. Indian J Agron,2004:49(2):117-120.
6. Sharma A, Singh H, Agrawal RK. Integrated nutrient management on productivity of wheat (Triticum aestivum) under limited and adequate irrigation supplies. Indian J Agron,2007:52(2):120-120.
7. Sharma KC, Agarwal RK. Effect of chemical fertilizers and vermicompost on the productivity and economics of forage sorghum and their residual effects on oat. Range Manag Agrofor,2003:24(2):127-131.
8. Sharma KC, Verma RS. Effect of chemical and biofertilizers on growth behavior of multicut fodder oats (*Avena sativa* L.). Range Manag Agrofor,2004:25(1):57-60.
9. Singh J, Singh KP. Effect of organic manures and herbicides on yield and yield attributing characters of wheat. Indian J Agron,2005:50(4):289.
10. Singh M, Gupta GR, Singh MP. Response of wheat to nitrogen, phosphorus and potassium. Indian J Agron,1987:32(1):52-55.
11. Singh R. Effect of INM with vermi-compost on productivity of wheat. Indian J Agron,1999:44(3):554-559.
12. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr Sci,1956:25:259-260.
13. Walkley A, Black CA. Estimation of organic carbon by chromic acid and titration method. Soil Sci,1934:37:28-29.