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EFFECT OF TILLAGE PRACTICES AND NUTRIENT MANAGEMENT ON FODDER YIELD OF OAT, SOIL FERTILITY AND MICROBIAL POPULATION

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ABSTRACT
A field experiment was carried out during *rabi* 2011-12 to study the effect of tillage (zero tillage, minimal tillage and conventional tillage) and nutrient management (75 per cent RDF, 75 per cent RDF + biofertilizers (*Azotobacter* + PSB), 100 per cent RDF, 100per cent RDF + biofertilizers(*Azotobacter* + PSB) practices on fodder yield and quality of oat. Conventional tillage recorded maximum green fodder yield with 342.23 q ha^{-1}, dry fodder yield with 79.42 q ha^{-1} and maximum nutrient content with 238.22 kg N ha^{-1}, 20.30 kg P_2O_5 ha^{-1} and 295.19 kg K_2O ha^{-1} and organic carbon content 0.60 kg ha^{-1} and maximum bacteria with 2.37 x 10^{6}, fungi 1.86 x 10^{4} and actinomycetes 1.07 x 10^{5} after harvest of crop. Application of 100% RDF along with Bio-fertilizers like *Azotobacter* and PSB recorded maximum green fodder yield with 329.76 q ha^{-1}, dry fodder yield with 77.57 q ha^{-1} and maximum nutrient content with 236.30 kg N ha^{-1}, 19.96 kg P_2O_5 ha^{-1} and 292.60 kg K_2O ha^{-1} and organic carbon content 0.60 kg ha^{-1} and maximum bacteria with 2.50 x 10^{6}, fungi 1.92 x 10^{4} and actinomycetes 1.10 x 10^{5}after after harvest of crop.

INTRODUCTION

In order to make animal husbandry sector more viable and productive sector, there is a great need to maintain balanced feed and fodder supply. Feeding of livestock with concentrates increases the productivity but is not always possible for all the farmers to supply concentrates due to their poor economic condition. Green forage is one of the ways to replace the concentrates but it becomes limited during *rabi* season (Sharma *et al.*, 2004). Therefore, there is a need to boost the production of green and dry fodder yield.

Among the fodder crops, oat (*Avena sativa* L.) is one of the ideal fodder for milch and draft cattle. A major constraint in realizing fully the high genetic potential of fodder oat is the supply of inadequate nutrients (Rawat and Agrawal, 2010). The fodder oat needs copious fertilizers for succulent and quality herbage production (Hukkeri *et al.*, 1977). Nitrogen increases the vegetative growth of the plant, which is highly desirable for the forage production point of view. Oat being graminaceous species responds well to nitrogen fertilizer (Rana *et al.*, 2009) and requires heavy doses of nitrogen for producing succulent high quality herbage, phosphorus helps in synthesis of RNA and potassium activates enzymes involved in protein synthesis. Balanced nutrient supply ensures efficient use of all nutrients.

Although these inorganic fertilizers are supplying major plant nutrients, the application of heavy dose of inorganic fertilizers is not a sound management practice. The excessive use of chemicals in agriculture causes water pollution and human health hazards. (Damini Thawait *et al.*, 2014). Hence, emphasis is now being put on the use of nitrogenous fertilizers along with bio-inoculants as biofertilizers like *Azotobacter, Azospirillum* (Rawat and Agrawal, 2010). Biofertilizers have beneficial effect on yield. The beneficial effects were higher than the biofertilizer cost (Animesh pathak and Chakraborti, 2014).

Tillage plays an important role in the productivity of crop. Tillage is one of the forms of management practices of soil, water, nutrient and crop. Tillage helps to replace natural vegetation with useful crops and is necessary to provide a favourable edaphic environment for the establishment, growth and yield of crop plants (Chandre, 1989).

Considering the importance of fodder crops in animal husbandry with respect to nutrients and to study the impact of different types of tillage on fodder yield, the paper deals with the effect of tillage and nutrient management practices on growth, fodder yield and quality of Oat (*Avena sativa* L.)

MATERIALS AND METHODS

The experiment on effect of tillage practices and nutrient management on growth, fodder yield and quality of oats was conducted in research cum instructional farm in an elevation of 298.56 m above mean sea level, 21°16′ North latitude and 81°36′ East longitude. Soil of the experimental field was clayey in texture. Three tillage practices zero, minimal and conventional tillage were tested in split plot design with three replications under 4 levels of nutrient management 75 % RDF, 75% RDF + Bio-fertilizers *viz. Azotobacter* and PSB, 100% RDF, 100% RDF + Bio-fertilizers. Sowing was done on November 24, 2011 with 100 kg seed per hectare. Full dose of phosphorus and potassium along with 1/3 dose of nitrogen were applied as basal and remaining dose of nitrogen was applied equally in two splits as top dressing at 20 and 40 DAS. Biofertilizers *viz. Azotobacter* and phosphorus solubilizing bacteria (PSB) were used as seed treatment. Before sowing, seeds of oat crop were inoculated with *Azotobacter* and PSB culture as per the treatments. For inoculation, 10% jaggery solution was prepared to serve as sticker. This solution was sprinkled on seeds and mixed properly and then it was spread on polythene sheet. The content of inoculant packet were sprinkled uniformly over the sticker coated seeds and mixed simultaneously. The seeds were spread uniformly for drying on a gunny bag in shade avoiding direct sunlight. The seeds were sown immediately.

Field preparation was done according to treatments. No ploughing was done in zero tillage, one ploughing followed by leveling in case of minimal tillage and three ploughings followed by harrowing and leveling in case of conventional tillage. All observations on growth and yield were taken and analysis was done for quality. Harvesting of oat for fodder purpose was done at 50 per cent flowering (74 DAS). The crop from border area of each plot was harvested first and removed from the experimental area. The remaining crop in the net plot area was cut close to the ground. The green fodder from individual net plot in each replication was weighed separately. Then the average of the three plots of three replications was considered as an average yield of respective treatment and finally converted into quintal per hectare. After taking of green fodder yield, fresh weight of one kilogram sample was collected from each net plot and was cut into small pieces, sun dried for two days and finally oven dried at 60°C temperature until the constant weight was obtained. These oven dried plant samples were weighed and dry fodder yield was calculated by multiplying them with their respective green fodder yield in kilogram from each net plot and converted into quintal per hectare. Soil samples were analyzed for available nitrogen, phosphorus, potassium, organic carbon, and microbial population. Five soil samples are collected from 30 cm depth from each plot after harvesting of oat. Soil samples were dried, grinded and passed through 2 mm sieve and then available N, P_2O_5, K_2O, organic carbon, and microbial population (bacteria, fungi and actinomycetes) were determined by following the prescribed standard methods. Available N by Modified Kjeldahl method (Jackson, 1967), Available P_2O_5 by Olsen's method (Olsen, 1954), Available K_2O by Flame photometric method (Jackson, 1967), Organic carbon by Walkley and black's method (Jackson, 1967) and Bacteria, fungi and actinomycetes by dilution method (Subbarao, 1988). Statistical analysis by procedure given by Panseb and Sukhatme (1967).

RESULTS AND DISCUSSION

Fodder yield

Green fodder yield (q ha^{-1})

Significantly higher green fodder yield was recorded with conventional tillage (342.23 q ha^{-1}) (Table 1). Green fodder yield increased with increase in dose of fertilizers along with and without application of biofertilizers. Table 1 show that application of 100 per cent RDF + Biofertilizers recorded higher green fodder yield (329.76 q ha^{-1}).

The interaction effect of tillage practices and nutrient management on green fodder yield was found significant. The highest green fodder yield was recorded with the treatment combination of conventional tillage x 100 per cent RDF + biofertilizers (356.79 q ha^{-1}) as shown in Table 2.

Conventional tillage improves physical, chemical and biological properties of soil which improves the availability of nutrients from soil which may leads to increase in fodder yield. Green fodder yield of oat crop was significantly affected by fertilization especially nitrogen along with and without biofertilizers and the response was linear from 75 per cent RDF to 100 per cent RDF and biofertilizers. One of the possible reasons for favourable influence on increasing fertilizer dose

Table 1: Fodder yield of oat and soil fertility and microbial population as influenced by tillage practices and nutrient management

Treatment	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})	Soil available N(kg ha^{-1})	Soil available P(kg ha^{-1})	Soil available K(kg ha^{-1})	Organic carbon (%)	Microbial population in 1 g soil		
							Bacteria	Fungi	Actinomycetes
Tillage practices									
Zero tillage	252.92	59.08	207.47	14.47	265.85	0.55	2.24×10^6	1.72×10^4	0.96×10^5
Minimal tillage	288.86	69.86	214.10	16.11	274.30	0.58	2.27×10^6	1.82×10^4	1.02×10^5
Conventional tillage	342.23	79.42	238.22	20.30	295.19	0.60	2.37×10^6	1.86×10^4	1.07×10^5
CD (p=0.05)	32.10	7.36	13.70	1.11	21.60	0.04	0.09×10^6	0.06×10^4	0.06×10^5
Nutrient management									
75 % RDF	259.55	58.95	207.04	14.36	265.80	0.55	2.12×10^6	1.70×10^4	0.95×10^5
75% RDF + Biofertilizers	278.81	67.82	213.92	15.33	273.08	0.57	2.40×10^6	1.83×10^4	1.05×10^5
100% RDF	310.55	73.46	222.43	18.20	282.30	0.59	2.17×10^6	1.77×10^4	0.98×10^5
100% RDF + Biofertilizers	329.76	77.57	236.30	19.96	292.60	0.60	2.50×10^6	1.92×10^4	1.10×10^5
CD (p=0.05)	25.90	5.40	10.02	0.99	11.23	0.02	0.10×10^6	0.10×10^4	0.10×10^5

Table 2: Green and dry fodder yields (q ha^{-1}) of fodder oat as influenced by interaction of tillage practices and nutrient management

	Green fodder yield (q ha^{-1})					Dry fodder yield (q ha^{-1}) Nutrient management				
Treatments	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
Tillage practices										
T_1- Zero tillage	227.19	241.60	247.28	295.59	252.92	40.43	61.83	66.03	68.02	59.08
T_2- Minimal tillage	241.60	243.72	333.22	336.90	288.86	63.52	65.12	74.70	76.11	69.86
T_3- Conventional tillage	309.86	351.12	351.14	356.79	342.23	72.91	76.50	79.67	88.59	79.42
Mean			259.55	78.81	310.55	329.76	58.95	67.82	73.46	77.57
					$SE_{m\pm}$	CD(P=0.05)	CV (%)	$SE_{m\pm}$	CD (P=0.05)	CV (%)
Comparison of two main plots					8.17	32.10	10.00	1.87	7.36	10.00
Comparison of two sub plots					8.72	25.90	9.00	1.82	5.40	8.00
Comparison of two sub plots at same level of main plots					15.10	44.86	3.15	9.35		
Comparison of two main plots at same or different level of sub plots					15.42	50.78	3.31	11.04		

N_1 - 75% RDF, N_2 -75% RDF + BF, N_3 - 100% RDF, N_4 - 100% RDF + BF

on yield attributes might be due to increased plant height, plant population, number of tillers, dry matter accumulatuion and leaf thickness occurred due to supply of 100 per cent nitrogen through chemical fertilizers along with biofertilizers. This results are similar to the findings of Sheoran *et al*. (2002) found that the inoculation of oats seed with *Azotobacter* was found beneficial in terms of increased forage yield over un-inoculated treatments. Kumar and Ramawat (2006) reported that application of 100 per cent recommended NPK (80-60-30 kg ha^{-1}) resulted in highest green fodder yield of oat than 75 per cent recommended dose Rawat and Agrawal (2010) who reported that maximum green fodder (361.5 q ha^{-1}) yield was recorded under 100 kg N ha^{-1} and inoculation of *Azotobacter* along with vermicompost.

Dry fodder yield (q ha^{-1})

Data (Table 1) shows that conventional tillage recorded significantly higher dry fodder yield (79.42 q ha^{-1}) as compared to other tillage practices.

Dry fodder yield increased with increase in dose of fertilizers along with and without biofertilizers. Application of 100 per cent RDF + Biofertilizers recorded significantly higher dry fodder yield (77.57 q ha^{-1}) (Table 1).

The interaction effect of tillage practices and nutrient management on dry fodder yield was significant. Table 2 shows that significantly the higher dry fodder yield was recorded under the treatment combination of conventional tillage x 100 per cent RDF + biofertilizers (88.59 q ha^{-1}) as compared to other treatment combinations.

The positive response of fertilizers under various tillage practices tended might be due to higher green fodder yield and dry matter content in plant, ultimately leading to higher dry fodder yield of oat. Our findings are similar to Mahale *et al*. (2003) found that the application at 80 kg N ha^{-1} produced significantly higher dry fodder yield for all three years and in pooled data. Kumar and Ramawat (2006) reported that application of 100 per cent recommended NPK (80-60-30 kg ha^{-1}) resulted in highest dry fodder yield of oat than 75 per cent recommended dose of fertilizers. Rawat and Agrawal (2010) who observed the maximum dry matter (100.2 q ha^{-1}) yield with application of 100 kg N ha^{-1} along with inoculation of *Azotobacter* and vermicompost. Ma YueCun *et al*. (2008) reported that the oat yield under minimum tillage was observed 15.8 per cent and 10.0 per cent as low as that under conservation tillage in 2005 and 2006, respectively.

Soil fertility

Organic carbon (%)

Organic carbon per cent in soil was significantly influenced by various treatments after harvest of crop. Organic carbon per cent in soil was increased after harvest of fodder oat when compared to initial organic carbon per cent.

Data in Table 1 shows that organic carbon content in soil was significantly higher in plots where conventional tillage (0.60%) was done.

The organic carbon per cent in soil increased with increasing levels of recommended dose of fertilizers irrespective of biofertilizers inoculation. Application of 100 per cent RDF + Biofertilizers recorded significantly higher organic carbon content (0.60%) in soil (Table 1).

Each increment of fertilizers level increased residual organic carbon content in soil after harvest of the crop. This might be due to residual effect of fertilizers. Conventional tillage improves the chemical properties of the soil so that organic carbon content in the soil was more where conventional tillage was done. Our findings are similar to the findings of Singh and Dubey (2007) who reported that application of 80 kg N ha-^{1} and addition of FYM @ 5 t ha-1 improved the organic carbon (0.61%) content in soil.

Soil available nutrients (N, P_2O_5, K_2O) (kg ha^{-1})

Available nutrient content in soil was significantly influenced by various treatments after harvest of crop. Available nutrients in soil were more after harvest of fodder oat when compared to initial available nutrients.

Table 1 shows that available nutrients in soil was significantly higher in plot where conventional tillage (238.22 kg N ha^{-1}, 20.30 kg P_2O_5 ha^{-1} and 295.19 kg K_2O ha^{-1}) was done.

In general the soil available nutrients increased with increased recommended dose of fertilizers irrespective of biofertilizers inoculation. Significantly the highest available nutrients content in soil was recorded in plots treated with 100 per cent RDF + Biofertilizers as shown in Table 1. (236.30 kg N ha^{-1}, 19.96 kg P_2O_5 ha^{-1} and 292.60 kg K_2O ha^{-1}).

Conventional tillage produces granular structure and improves the chemical properties of the soil as the nutrients from deeper layers reach upper layers as the soil will get pulverized by tillage practices. Application of 100 per cent RDF along with biofertilizers increased available nutrient content in soil after harvest of the crop because of residual effect of fertilizers applied and biofertilizers like *Azotobacter* which fixes the nitrogen and improved the available nitrogen in soil and PSB improved the available phosphorus content in soil. These findings are similar to findings of Umadevi *et al.* (2010) who reported that inoculation of oat seed with *Azotobacter* influenced nutrient content in soil. Singh *et al.* (1996) reported that the application of 80 kg N increased phosphorus and potassium content in oats. Agrawal (2005) reported that the concentration of N in oat at various stages of crop growth significantly increased with increased levels of N up to 80 kg ha^{-1}.

Microbial population

Microbial population in one gram of soil after harvest of crop was affected by tillage practices and nutrient management. The population of bacteria, fungi and actinomycetes were increased after harvest of fodder oat from their initial value. Among different tillage practices, conventional tillage recorded highest bacterial (2.37×10^6) fungal (1.86×10^4) and Actinomycetes (1.07×10^5) population (Table 1).

Among nutrient management, application of 100 per cent RDF + Biofertilizers recorded significantly higher bacteria, fungi and actinomycetes population with 2.5×10^6, 1.92×10^4 and 1.10×10^5, respectively as in Table 1.

This might be due to inoculation of oat seed with bacteria like *Azotobacter* (N-fixer) and PSB (P solubilizer) and conventional tillage which improves the biological properties of the soil.

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