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RESEARCH PAPER

Yield of fodder oat and balance sheet of nutrients influenced by tillage practices and nutrient management

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Abstract : A field experiment was conducted during *Rabi*, 2011-12 to study the effect of tillage practices and nutrient management on growth, fodder yield and quality of oat (*Avena sativa* L.). The treatments comprised of zero tillage, minimal tillage and conventional tillage in main plots and 75 per cent RDF, 75 per cent RDF + bio-fertilizers, 100 per cent RDF, 100 per cent RDF + bio-fertilizers in sub plots. Biofertilizers are *Azotobacter* and phosphorus solubilizing bacteria. Highest green and dry fodder yields were recorded in the plots treated with conventional tillage. Highest net available soil nutrients were recorded under plots treated with conventional tillage. In case of nutrient management highest green fodder and dry fodder yields and highest net available soil nutrients were recorded in the plots treated with 100 per cent RDF + bio-fertilizers (*Azotobacter* and PSB).

Key Words : Oat, Tillage, Nutrient management, Biofertilizers, Yield, Balance sheet

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INTRODUCTION

Agriculture and Animal husbandry in India are interwoven with the intricate fabric of the society in cultural, religious and economical ways as mixed farming and livestock rearing forms an integral part of rural living. The productivity of animals in India especially of milch animals is very low as compared to developed countries, primarily due to less availability of nutritive feed and fodder to animals (Patel *et al*., 2011).

The analysis of this situation reveals that one of the main reasons for the low productivity of our livestock is malnutrition, under nutrition or both, besides low genetic potential of the animals. There is no scope to increase the area for fodder production because of heavy pressure on land for growing grain and cash crops. 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. Oat is an important fodder crop of *Rabi* season and requires a greater attention on the part of growers to increase fodder production as well as its quality. Oat is grown in an area of 1,00,000 hectare and productivity of green fodder is 35-50 tonnes per hectare in India. It is highly nutritive fodder which is rich in soluble carbohydrates, energy, proteins, vitamin B, phosphorus and iron (Gupta *et al.*, 2002). Being more energizing, it forms a good feed for horses, draft as well as milch animals. 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).

Although these inorganic fertilizers are supplying major plant nutrients, the application of heavy dose of inorganic fertilizers is not a sound management practice and creates many problems like declining trend in productivity, water pollution and soil degradation etc. 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).

Tillage plays an important role in the productivity of crop. Tillage is the tilling of land for the cultivation of crop plants. 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). Conventional tillage is more beneficial when compared to no tillage and yield will get increased with conventional tillage as conventional tillage can increase porosity and loosen soil, allowing for good air exchange and root growth. Minimal tillage and zero tillage are also beneficial as it conserves moisture by minimizing the loss of organic matter and also minimizes the loss of crop residues by reducing the level of tillage. Keeping these points in view, an experiment entitled effect of tillage and nutrient management practices on growth, fodder yield and quality of oats was conducted.

MATERIAL AND METHODS

The present investigation was carried out at research cum instructional farm, Indira Gandhi Agricultural University, Raipur, Chhattisgarh during *Rabi* season of 2011-12 in an elevation of 298.56 m above mean sea level, 21^0 16' North latitude and 81^0 36' East longitude. Soil of the experimental field was clayey in texture and belonged to vertisol which was low in available nitrogen with 200.70 kg/ha, medium in available phosphorus with 12.99 kg/ha and medium in available potassium with 256.01 kg/ha, low in organic carbon with 0.44 per cent, neutral in pH and EC. The treatments consisting of three tillage practices (zero, minimal and conventional tillage) assigned to main plot and four levels of nutrient management (75% RDF (60-45-30 kg NPK/ha), 75 per cent RDF + bio-fertilizers (*Azotobacter* + PSB), 100 per cent RDF (80-60-40 kg NPK/ha), 100 per cent RDF + bio-fertilizers) were allotted to sub plot in Split Plot Design with 3 replications. Oat cv. KENT was sown on 24 November, 2011 in 30 cm apart from row and harvested at 50 per cent flowering stage. The field was ploughed thrice in criss - cross direction by tractor drawn implement followed by harrowing and levelling in conventional tillage. In minimal tillage field was ploughed once in criss - cross direction by tractor drawn implement followed by levelling. In zero tillage field was not ploughed. Full dose of phosphorus and potassium (45 kg P_2O_5 and 30 kg K_2O in plots treated with 75 % RDF and 60 kg P_2O_5 and 40 kg K_2O in plots treated with 100% RDF) were applied as basal and nitrogen was applied through urea in three splits (40:30:30) *i.e.* basal, 20 and 40 DAS. Bio-fertilizers *viz., Azotobacter* and phosphorus solubilizing bacteria (PSB) were used as seed treatment. All the growth parameters like plant height, plant population, leaf stem ratio, number of tillers per m row length, number of leaves plant^{-1} were taken and fresh weight of fodder from each plot was recorded and dry matter estimation and chemical analysis like N, P and K content and uptake by fodder oat were done. Data were recorded on green and dry fodder yield and balance sheet was calculated and economical and statistical analysis were done.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

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

Significantly higher green fodder yield was recorded with conventional tillage (342.23 q ha^{-1}) followed by minimal tillage (288.86 q ha^{-1}). The lowest green fodder yield was recorded with zero tillage (252.92 q ha^{-1}). Green fodder yield increased with increase in dose of fertilizers along with and without application of biofertilizers. Among various nutrient management, significantly higher green fodder yield was recorded with application of 100 per cent RDF + biofertilizers (329.76 q ha^{-1}) which was statistically at par with application of 100 per cent RDF (310.55 q ha^{-1}). The lowest green fodder yield was recorded with 75 per cent RDF (259.55 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}) which was at par with the treatment combinations conventional tillage x 100 per cent RDF (351.14 q ha^{-1}), conventional tillage x 75 per cent RDF + biofertilizers (351.12 q ha^{-1}), minimal tillage × 100 per cent RDF + bio fertilizers (336.90 q ha^{-1}) and with minimal tillage x 100 per cent RDF (333.22 q ha^{-1}). The lowest green fodder yield was recorded in the treatment combination of zero tillage x 75 per cent RDF (227.19 q ha^{-1}).

Conventional tillage improves all properties of soil and make better availability of nutrients from soil as well as supplied nutrients 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 on yield attributes might be due to increased plant height, plant population, number of tillers, dry matter accumulation and leaf thickness occurred due to supply of 100 per cent nitrogen through chemical fertilizers along with biofertilizers. Furthermore, nitrogen is known to increase the chlorophyll content of the plants which is site of manufacture of food during photosynthesis. Nitrogen has also specific role on the metabolism in plant through RNA synthesis in vegetative growth stage. Phosphorus helps in synthesis of RNA and potassium activates enzymes involved in protein synthesis. The results are similar to the findings of 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}) :

Among different tillage practices, conventional tillage recorded significantly higher dry fodder yield (79.42 q ha^{-1}) as compared to other tillage practices followed by minimal tillage (69.86 q ha^{-1}). The lowest dry fodder yield was recorded under zero tillage (59.08 q ha^{-1}).

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}) which was at par with 100 per cent RDF (73.46 q ha^{-1}). The lowest dry fodder yield was recorded with application of 75 per cent RDF (58.95 q ha^{-1}).

The interaction effect of tillage practices and nutrient management on dry fodder yield was significant. 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. However, it was at par with the treatment combination of conventional tillage x 100 per cent RDF (79.67 q ha^{-1}). The lowest dry fodder yield was recorded under the treatment combination of zero tillage x 75 per cent RDF (40.43 q ha^{-1}).

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. The findings are similar to 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

Table 1 : Effect of tillage practices and nutrient management on yield of fodder oat

Treatments	Green fodder yield (q ha^{-1})					Dry fodder yield (q ha^{-1})				
	Nutrient management									
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
Zero tillage	227.19	241.60	247.28	295.59	252.92	40.43	61.83	66.03	68.02	59.08
Minimal tillage	241.60	243.72	333.22	336.90	288.86	63.52	65.12	74.70	76.11	69.86
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	278.81	310.55	329.76		58.95	67.82	73.46	77.57	
	C.D. (P=0.05)					C.D. (P=0.05)				
Comparison of two main plots	32.10					7.36				
Comparison of two sub plots	25.90					5.40				

N_1: 75% RDF, N_2: 75% RDF + biofertilizers (*Azotobacter* and PSB), N_3: 100% RDF, N_4: 100% RDF + biofertilizers (*Azotobacter* and PSB)
75 % RDF : 60-45-30 kg NPK/ha, 100% RDF: 80-60-40 kg NPK/ha

Table 2 : Balance sheet of nutrients (kg/ha) as influenced by tillage practices and nutrient management

Treatments	Balance sheet of nitrogen (kg/ha)			Balance sheet of phosphorus (kg/ha)			Balance sheet of potassium (kg/ha)		
	Total available N	Removal of N by crop	Net available soil N	Total available P_2O_5	Removal of P_2O_5 by crop	Net available soil P_2O_5	Total available K_2O	Removal of K_2O by crop	Net available soil K_2O
Tillage practices									
Zero tillage	270.7	101.52	6.77	65.49	45.41	1.48	291.01	83.13	9.4
Minimal tillage	270.7	118.80	13.40	65.49	57.58	3.12	291.01	100.54	18.29
Conventional tillage	270.7	142.77	37.52	65.49	70.74	7.31	291.01	119.79	39.18
Nutrient management									
75% RDF	260.7	99.52	6.34	57.99	46.06	1.37	286.01	83.65	9.79
75% RDF + BF	260.7	115.24	13.22	57.99	55.27	2.34	286.01	97.50	17.07
100% RDF	280.7	132.94	21.73	72.99	62.15	5.21	296.01	107.92	26.29
100% RDF + BF	280.7	136.44	35.60	72.99	68.17	6.97	296.01	115.54	36.59
Grand mean	270.7	121.03	19.22	65.49	57.91	3.97	291.01	101.15	22.44

BF - Biofertilizers

inoculation of *Azotobacter* and vermicompost.

Balance sheet of soil available nutrients :

Balance sheet of soil available nitrogen (kg ha^{-1}) :

The net soil available nitrogen was affected with various tillage practices. The net (37.5 kg ha^{-1}) soil available nitrogen was recorded under conventional tillage followed by minimal tillage (13.40 kg ha^{-1}, respectively). The lowest calculated net (6.77 kg ha^{-1}) soil available nitrogen was recorded under zero tillage.

The net soil available nitrogen was increased with increase in dose of fertilizers irrespective of biofertilizers inoculation. The highest net (35.60 kg ha^{-1}) soil available nitrogen was recorded with application of 100 per cent RDF + biofertilizers followed by 100 per cent RDF (21.73 kg ha^{-1}, respectively). The lowest net (6.34 kg ha^{-1}) soil available nitrogen was recorded with the application of 75 per cent RDF.

Balance sheet of soil available phosphorus (kg ha^{-1}) :

The net soil available phosphorus was affected with various tillage practices. The net (7.31 kg ha^{-1}) soil available phosphorus were highest under conventional tillage followed by minimal tillage (8.20 and 3.12 kg ha^{-1}, respectively). The lowest net (1.48 kg ha^{-1}) soil available phosphorus was recorded under zero tillage.

The net (6.97 kg ha^{-1}) soil available phosphorus was highest with application of 100 per cent RDF + biofertilizers followed by application of 100 per cent RDF (7.36 and 5.21 kg ha^{-1}, respectively). The lowest net soil available phosphorus was recorded with the application of 75 per cent RDF.

Balance sheet of soil available potassium (kg ha^{-1}) :

The net available soil potassium was affected with various tillage practices. The net (39.18 kg ha^{-1}) available soil potassium was highest under conventional tillage followed by minimal tillage (83.83 and 18.29 kg ha^{-1}, respectively). The lowest net (9.4 kg ha^{-1}) available soil potassium was recorded under zero tillage.

The net available soil potassium was increased with increase in dose of fertilizers irrespective of biofertilizers inoculation. The highest net (36.59 kg ha^{-1}) soil available potassium was recorded with application of 100 per cent RDF + biofertilizers followed by 100 per cent RDF (94.21 and 26.29 kg ha^{-1}, respectively). The lowest net (9.79 kg ha^{-1}) available soil potassium was recorded with the application of 75 per cent RDF.

The positive balance of nutrients could be attributed to the addition of nutrients through inorganic fertilizers and also through biofertilizers like *Azotobacter* which is a N- fixer and PSB which is a phosphorus solubilizer. Conventional tillage made soil loose and friable and well pulverised so that nutrients from deeper layers will reach upper layer of soil so that chemical properties of soil was increased.

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