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Weed control in forage oat through conservation agriculture

Birendra Kumar*, S. Karmakar, D.K. Choudhary and P. Mahapatra
Department of Agronomy, Birsa Agricultural University, Kanke, Ranchi, Jharkhand 834 006

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ABSTRACT

A field experiment was conducted during *Rabi* season of two consecutive years of 2010-11and 2011-12 to evaluate the efficacy of different tillage practices in combination with various nutrient levels on productivity and quality along with weed control efficiency in forage oat under plateau region of Jharkhand. Variation in tillage and nutrient level significantly influenced the infestation of crop associated weeds, leaf area index, green forage yield, uptakes of calcium as well as, iron and contents of crude protein as well as crude fiber of forage oat. Population density of narrow, broad-leaved weeds and sedges and its biomass under zero tillage were lesser than conventional and minimal tillage. Application of biofertilizers with 75% recommended dose of fertilizer (RDF) remained at par with 100% RDF. However, maximum forage yield with improved quality was recorded under 125% RDF. Zero tillage practiced in forage oat was equally effective as conventional tillage with regards to productivity and quality of forage oat.

Key words: Biofertilizer, Green forage yield, Nutrient, Oat, Tillage, Weed infestation

Weeds are self germinating, nutrient extractor and competitor for light and space during crop growth. It is a major threat not only during rainy season but also during winter. Demand of food grains and fodder is being increased day by day to fulfill the need of human beings and also to bridge the challenge of fodder deficit for animals. India is rearing 15% of the world animal population with fodder production in 7.06% of net cropped area as well as on 3.7% of pasture/grazing land. Availability of fodder per animal is only 18.2 kg which is far below the requirement and keeping the animal half fed. During rainy season, some natural grasses help the farmers to mitigate the shortage of green herbage up to some extent but, its scarcity during lean period (winter) is very common in Jharkhand and other states. Due to shortage of irrigation, farmers are not inclined towards forage production over the field crops of human interest. Green forage oat is a basic fodder of winter.

Farmers are usually reluctant to chemical weed control because of ignorance and prevailing concepts regarding utilization of weeds as fodder, which may be harmful to the animals. Thus, suppression of weed is essential for improving the productivity and quality of herbage produced. Manual weed control is costly while, chemical control leave hazards to the environment. Better management of crop can be done through conservation agriculture. Among the different inputs, application of balanced nutrition in oat is essential for sustainable production. Keeping the facts in view an experiment was conducted to control the weed proliferation with improved productivity and quality of herbage produce through conservation agriculture.

***Corresponding author:** kbirendra1973@gmail.com

MATERIALS AND METHODS

A field experiment was carried out during *Rabi* 2010-11 and 2011-12 at the forage field situated at Ranchi Veterinary College campus under Birsa Agricultural University, Ranchi. The soil of field was sandy loam in texture having sand (56.8%), silt (28.0%), clay (15.2%) and water holding capacity 38.68%, pH 6.2, organic carbon 3.8 g/kg, available nitrogen 232 kg/ha, available phosphorus (P_2O_5) 23.25 kg P_2O_5/ha and available potassium (K_2O) 156.41 kg K_2O/ha. The experiment constituted in split plot design with three tillage management *viz.* zero tillage, minimal tillage and conventional tillage assigned in main plot and four nutrient levels, 125, 100, 75% of recommended dose of fertilizer (RDF) and 75% RDF + biofertilizers (PSB + *Azotobacter*) in sub-plot with three replications. The fodder oat cultivar *'Kent'* was sown in the second week of November during both the year by keeping row to row distance 20 cm with recommended seed rate 100 kg/ha under medium land situation. Fertilizers were applied at the time of sowing through urea, DAP and MOP as basal application. Biofertilizers were applied as seed treatment/inoculation in the form of PSB at 500 g/ha and *Azotobacter* at 500 g/ha and further top dressing were carried through urea. The data recorded on growth, yield, weed density and quality

of forage oat were tabulated and subjected to analysis by using analysis of variance (ANOVA) and treatment was tested by F-test. The data on weed density and weed biomass were subjected to square root transformation $\sqrt{x + 0.5}$ before carrying out analysis of variance and comparison was made on transformed value.

RESULTS AND DISCUSSION

Tillage management

Tillage management significantly influenced the different types of weed population in forage oat. Zero tillage recorded significantly less narrow-weed (60.20/m^2) and broad weed (11.08/m^2) over minimal and conventional tillage, while less sedges under conventional tillage (50.79/m^2). Dry weight of weed (g/m^2) was significantly less under zero tillage (2.86 g/m^2) than minimal tillage (3.96 g/m^2) and conventional tillage (3.07 g/m^2). Total weed population and weed dry weight were in the order of zero tillage < conventional tillage < minimal tillage (Table 1). The difference in weed composition due to different tillage treatments might be due to variable environments, particularly soil physical condition created under different tillage systems (Singh 1992). Tillage not only favors the crops but also favors the germination, and growth of weeds but at deep ploughing with mould board plough or with increased level of tillage operation, weed seeds or its residue get damaged or go well within the soil thus, germination delayed or hampered in comparison to minimal tillage. While without tillage operation as under zero tillage, oat seeds were placed in between the two rows of paddy residue thus, got less congenial condition to germinate and to get less chance of nutrient utilization by weeds, resulted in poor performance of weed under zero tillage. Tillage operation received suitable environment which improved germination of weeds. The minimum population and dry weight of *Phalaris minor* were recorded under zero tillage and maximum under conventional tillage system in wheat cultivation (Sharma *et al*. 2002). The less weed problem under zero tillage may be due to less soil disturbance helping in keeping the weed seeds at deeper depth (Sharma *et al*. 2002). Due to less soil disturbance under zero tillage, weed germination usually remained less as compared to conventional tillage.

Tillage management had significant effect on growth, yield and quality of forage oat and also influenced the weed proliferation. Leaf area index (LAI) of forage oat at both the cuts under different tillage and nutrient management was influenced significantly. Maximum LAI at both the cuts was recorded under conventional tillage (4.49 and 5.70, respectively) which was significantly higher over zero and minimal tillage. Zero tillage recorded significantly higher LAI compared to minimal tillage (Table 2). Leaf area index (LAI), is best parameter to see the capacity of a crop producing dry matter. Leaf area index at first and second cut under conventional tillage were 8.71% and 16.32%, respectively higher over minimal tillage. This was due to increase in number of photosynthetic green area which led to improvement in photo synthetic efficiency. These findings were in close confirmatory with the result of Singh (1992). Leaf area index increased as growth progressed and achieved optimum at the time of second cut.

Tillage and nutrient management had significant effect on green forage yield at each cut. Green forage yield (GFY) under conventional tillage at first cut (10.95 t/ha) and total (35.46 t/ha) was at par with zero tillage while, at both the cuts and total GFY under

Table 1. Effect of tillage and nutrient management on weed flora in forage oat (pooled)

Treatment	Weed population/m^2				Weed dry Weight (g/m^2)
	Narrow-leaf	Broad-leaf	Sedges	Total	
Tillage management					
Zero tillage	7.82 (60.2)	3.46 (11.1)	8.44 (70.5)	11.9 (141.7)	2.86 (7.39)
Minimal tillage	10.34 (106.4)	6.01 (35.8)	10.73 (114.7)	16.1 (257.3)	3.96 (14.83)
Conventional tillage	10.12 (101.7)	4.33 (18.1)	7.17 (50.8)	13.1 (170.8)	3.07 (8.45)
LSD (P=0.05)	0.47	0.47	0.74	0.51	0.15
Nutrient management					
125% RDF	9.84 (98.8)	5.14 (27.3)	9.52 (92.6)	14.8 (213.7)	3.61 (12.2)
100% RDF	9.72 (95.1)	4.78 (22.7)	9.10 (76.3)	13.9 (194.2)	3.33 (10.3)
75% RDF	8.82 (77.6)	4.03 (16.1)	8.29 (69.4)	12.7 (163.1)	3.04 (8.3)
75% RDF + biofertilizer	9.53 (91.2)	4.46 (20.5)	8.65 (76.3)	13.6 (188.5)	3.29 (10.1)
LSD (P=0.05)	0.77	0.56	0.80	0.92	0.26

*****Un parentheses data are square root transformed $(x \pm 0.5)^{-2}$ value.

Table 2. Effect of tillage and nutrient management on leaf area index, green forage yield of forage oat (pooled)

Treatment	Leaf area index		Green forage yield (t/ha)		
	1st cut	2nd cut	1st cut	2nd cut	Total
Tillage management					
Zero tillage	4.29	5.25	10.6	23.5	34.2
Minimal tillage	4.13	4.90	7.74	21.6	29.3
Conventional tillage	4.49	5.70	10.9	24.5	35.4
LSD (P=0.05)	0.07	0.07	0.62	0.88	2.92
Nutrient management					
125% RDF	4.82	5.93	11.5	25.9	37.5
100% RDF	4.33	5.29	10.1	23.6	33.7
75% RDF	3.85	4.65	7.80	20.3	28.1
75% RDF + biofertilizer	4.24	5.27	9.73	22.9	32.7
LSD (P=0.05)	0.44	0.62	1.40	2.65	3.95

conventional tillage was significantly higher to minimal tillage (Table 2). Similarly, zero tillage was also significantly superior over minimal tillage at both the cuts and total.

Under conventional tillage, soil was pulverized well and created congenial conditions for proper root establishment which helped to utilize ample nutrients by crop in presence of sufficient moisture and sun shine hour throughout the growth period resulted in higher production of photosynthates. In other words, green forage yield under minimal tillage were less as compared to both zero and conventional tillage. Minimal tillage neither recorded the benefit of zero tillage in terms of soil health improvement nor the intensification or activities of roots facilitated due to deep ploughing resulted in inefficient utilization of moisture, nutrient and thereby growth and development and finally the crop yield. These finding was also in symmetry with the finding of Kumar *et al.* (2001). Mohammad *et al.* (2006) also reported more GFY and DFY under conventional tillage in oat over zero tillage. Further, more GFY and DFY were recorded at second cut which was due to more photo-synthetically active area *i.e.*, higher LAI resulting in greater production of dry matter per unit area (Patel *et al.* 2010). The photosynthesis effectiveness depends upon favorable environmental condition as the low temperature prevailing immediately after cutting affected the re-growth of crop and increased temperature at later stages decreased the plant height and other yield attributes (Bali *et al.* 1998).

Leaf: stem (LS) ratio under conventional tillage and zero tillage were at par and were significantly superior over minimal tillage. More uptake of iron and calcium were recorded under conventional tillage.

Table 3. Interaction effects of tillage and nutrient management on total green forage yield (t/ha) of fodder oat under medium land condition (pooled)

Tillage management (T)	Nutrient management(N)				Mean
	125% RDF	100% RDF	75% RDF	75% RDF + biofertilizer	
Zero tillage	39.1	35.9	28.3	33.1	34.2
Minimal tillage	32.6	28.4	26.1	30.1	29.3
Conventional	40.8	36.2	29.7	34.8	35.4
Mean	37.5	33.7	28.1	32.7	
		SEm ±		LSD (P=0.05)	
Between N at same T		0.77		2.28	
Between T at same or different N		0.72		3.15	

Crude protein and crude fiber under conventional and zero tillage were at par however, higher crude protein (10.26% at first cut) and crude fiber (27.98 and 29.56%) at both the cuts under conventional tillage were recorded (Table 3). The decrease in L:S ratio might be due to crop age factor and lodging induced leaf senescence. Joshi *et al.* (1997) reported that in general, specific leaf weight increased with age of the crop except a short fall just after first cut. The response of nutrient up to 125% RDF was also observed on leaf: stem ratio at both the cuts. Higher L:S ratio at first cut was recorded at each levels of nutrient management compared to second cut. This was due to more translocation of photosynthates in leafy portion during early stage of growth *i.e.*, from germination to first cut and decreased with the age of crop. Singh *et al.* (1998) and Sharma *et al.* (2001) also noticed the similar results.

Nutrient management

Leaf area index, green forage yield, leaf: stem ratio, uptake of calcium, iron, contents of crude protein, crude fiber and weed proliferation in terms of weed density and its biomass were recorded higher at 125% RDF. The 100% RDF and 75% RDF + biofertilizer remained at par with each other at both the cuts. Different nutrient levels with or without application of biofertilizers significantly affected the yield attributing characters and yield of forage oat. Green forage yield (GFY) at each cuts were significantly enhanced up to higher dose of nutrients and this might be due to improvement in growth and yield attributing characters which were more at 125% RDF. Similarly 75% RDF + biofertilizers was comparable to 100% RDF due to extra benefit of availability of nutrients through microbial activity specially phosphorus as well as nitrogen availability which leads to better yield attributing parameters (Table 4).

Table 4. Effect of tillage and nutrient management on nutrient uptake and crude protein and fiber content in forage oat (pooled)

Treatment	Leaf : stem ratio		Total uptake (kg/ha)		Protein content (%)		Crude fiber content (%)	
	1st cut	2nd cut	Ca	Fe	1st cut	2nd cut	1st cut	2nd cut
Tillage management								
Zero tillage	2.97	1.96	33.4	0.63	10.1	9.54	26.1	27.6
Minimal tillage	2.92	1.82	30.5	0.55	9.69	9.37	24.5	26.1
Conventional tillage	2.99	2.01	35.1	0.68	10.3	9.44	27.9	29.5
LSD (P=0.05)	0.04	0.07	NS	0.32	0.27	0.15	1.92	1.92
Nutrient management								
125% RDF	3.48	2.51	38.2	0.71	10.3	9.86	26.6	28.2
100% RDF	2.83	1.94	33.7	0.61	10.1	9.44	26.3	27.8
75% RDF	2.75	1.35	28.7	0.54	9.54	9.10	25.8	27.4
75% RDF + biofertilizer	2.78	1.93	31.3	0.60	10.1	9.39	26.0	27.5
LSD (P=0.05)	0.35	0.26	2.23	0.03	0.44	0.38	0.15	0.15

Crude protein and crude fiber increased with increased level of nutrients. During second cutting, proportion of leaf and stem decreased and fodder became harder than that of first cut which reduced the protein content. Similar results for quality parameter in forage oat were also reported by Aklilu (2005). Increased nutrient level also improved the growth of weeds and increased weed density and dry weight per unit area. *Azotobactor* and PSB improved the availability of nitrogen and phosphorus in soil. Thus, 75% RDF along with biofertilizers also remained comparable with 100% RDF (Devi *et al.* 2009).

Interaction

Interaction between tillage and nutrient management had significant effect on green forage yield at both the cuts and on total. Total green forage yield under zero, minimal and conventional tillage managements increased with increased level of nitrogen up to 125% RDF. Total GFY under conventional tillage was at par with zero tillage at RDF, while both the treatments were significantly higher over minimal tillage in similar nutrient level. Green forage yield under conventional tillage at 125% RDF (40.8 t/ha) was significantly higher over all the treatment combinations except zero tillage at the same level of nutrient which was 56.42 per cent more than the minimum under minimal tillage at 75% RDF (Table 2). This might be due to congenial condition for growth and development resulted into higher yield.

Based on the findings, it be concluded that zero tillage is as good as conventional tillage with regards to productivity, quality and suppression of weeds.

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