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# EFFECT OF TILLAGE AND NUTRIENT MANAGEMENT ON FODDER YIELD, ECONOMICS AND ENERGETICS OF OAT (*AVENA SATIVA* L.)

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## SUMMARY

A field experiment was conducted at Ranchi (Jharkhand) to study the effect of tillage and nutrient management on fodder oat during **rabi** seasons of 2010-11 and 2011-12. Results showed that conventional tillage recorded higher green (354.6 q/ha) and dry fodder (78.7 q/ha) yield, higher gross returns (Rs. 79,689/ha), energy output (142985 MJ/ha) net energy returns (129471 MJ/ha) and energy use efficiency (11.7) over zero and minimal tillage. Zero tillage recorded higher B : C ratio (2.5) over minimal and conventional tillage, while net returns (Rs. 54,660/ha) and conventional tillage (Rs. 55,094/ha) were at par. Among the nutrient managements, 125 per cent RDF recorded significantly higher green fodder yield (375.1 q/ha) as well as gross returns (Rs. 83,904/ha), net returns (Rs. 59, 353/ha), B : C ratio (2.41), gross energy output (146069 MJ/ha), net energy output (132245 MJ/ha) and energy use efficiency (10.56). Application of biofertilizer at 75 per cent RDF was as good as 100 per cent RDF in terms of GFY, DFY, economics and energetics. Thus, in order to produce highest green herbage conventional tillage at 125 per cent RDF is most appropriate and application of biofertilizer (PSB+*Azotobacter*) saves the 25 per cent of inorganic fertilizer in fodder oat.

**Key words :** Tillage, RDF, biofertilizer, nutrients, energetics, economics, fodder yield

Apart from quality seed and soil, availability of moisture and nutrient is basic requirement for crop cultivation which is indirectly guided by tillage and nutrient management. Being a fast growing and high yielding crop, oat requires a large quantity of fertilizer nitrogen for enhancing production as well as quality of herbage (Singh and Dubey, 2007). However, low priority of fodder crops, increasing cost of nutrient and nitrate toxicity in early crop growth stage due to application of high dose of nitrogenous fertilizer caused soil and water pollution in long run. Tillage management is used in order to produce a good seed bed, root development, weed control and management of crop residue, levelling the surface for uniform irrigation and incorporation of fertilizers (Srivastav *et al*., 2006). Inappropriate tillage practice could inhabit not only crop growth and yield but also drain of energy and money. In Jharkhand, water is limiting factor and due to lack of moisture tillage operation is very difficult, thus in order to utilize the initial available soil moisture and high cost of inorganic inputs appropriate application of tillage and nutrient is essential. Further, green herbage production is directly related to higher dose of nitrogen. Thus, tillage and nutrient management in fodder oat is demand of the situation not only to green herbage production but also improves the physical, chemical and biological environment of soil and helps in maintaining yield levels in fodder oat crop under medium land condition.

## 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 (38.7%) with pH (6.2), organic carbon (3.8 g/kg), available nitrogen (232 kg/ha), available phosphorus (23.25 kg $P_2O_5$/ha) and available potassium (156.41 kg $K_2O$/ha). The experiment was conducted in

split-plot design by assigning three tillage managements viz., zero tillage, minimal tillage and conventional tillage assigned in main plot and four nutrient managements, 125, 100, 75 per cent of recommended dose of fertilizer (RDF of fodder oat i. e. 80 : 40 : 20=N : $P_2O_5$ : $K_2O$ kg/ha and 75% RDF+Biofertilizers (PSB+*Azotobacter*) in sub-plot treatment with three replications. The fodder oat cultivar 'Kent' was sown in the second week of November during both the years, keeping row to row distance of 25 cm with recommended seed rate of 100 kg/ha in 5 x 4 m plot area under medium land condition. Fertilizers were applied at the time of sowing through urea, DAP and MOP as basal application. Biofertilizers were applied as seed treatment in the form of PSB @ 500 g/ha and *Azotobacter* @ 500 g/ha and further top dressing was carried through urea. Full dose of $P_2O_5$, $K_2O$ and half dose of N were applied as basal and 25 per cent of N was top dressed at 30 DAS and rest 25 per cent of N was applied just after irrigation at first cut. Fodder oats were harvested at 60 and 120 DAS. Input and output in the form of energy were converted with standard values as given by Sriram *et al*. (1999).

## RESULTS AND DISCUSSION

### Tillage Management

Conventional tillage recorded significantly higher green (245.2 q/ha) and dry fodder yield (56.2 q/ha) at 2nd cut and total DFY (78.7 q/ha) over zero tillage and minimal tillage, while green and dry fodder yield at first cut along with total GFY under zero tillage was at par with conventional tillage (Table 1). Gross and net returns under conventional tillage (Rs.79,689 and 55,094/ha) were at par with zero tillage (Rs. 76,735 and 54,660/ha), while B : C ratio (2.47) was significantly higher under zero tillage. Conventionally sown forage oat had higher energy output (143.0 x $10^3$ MJ/ha), net energy return (129.4 x $10^3$ MJ/ha) and energy use efficiency (11.7) over minimal and zero tillage (Table 2). The probable reason could be favourable integrated effect of soil physical environment that enhanced root growth for better uptake of moisture and nutrients thereby maintaining high plant water status.

Adequate availability of water to plants resulted in cell turgidity and eventually higher merismatic activity leading to more foliage development, greater photosynthetic rate and consequently better plant growth (Dalal and Chan, 2001). Besides water and nutrient uptake, root directly or indirectly influences the activity of shoot (Sharma and Acharya,1994). The beneficial effect of tillage was also observed by Painuli *et al*. (2000), who reported that soil tillage significantly increased the growth and development and finally economic yield of crops. Comparatively low value of cost of cultivation and energy input under zero tillage

TABLE 1
Effect of tillage and nutrient management on forage yield (q/ha) of fodder oat (Pooled data for 2010-11and 2011-12)

| Treatment | Green fodder yield (q/ha) | | | Dry fodder yield (q/ha) | | |
|---|---|---|---|---|---|---|
| | 1st cut | 2nd cut | Total | 1st cut | 2nd cut | Total |
| **Tillage management (T)** | | | | | | |
| Zero tillage | 106.2 | 235.3 | 341.5 | 19.8 | 50.4 | 70.2 |
| Minimal tillage | 77.4 | 215.9 | 293.3 | 16.3 | 47.7 | 64.0 |
| Conventional tillage | 109.4 | 245.2 | 354.6 | 22.5 | 56.2 | 78.7 |
| S. Em± | 1.6 | 2.2 | 7.4 | 0.7 | 0.73 | 1.7 |
| LSD (P=0.05) | 6.3 | 8.8 | 29.2 | 3.05 | 2.86 | 6.27 |
| **Nutrient management (N)** | | | | | | |
| 125% RDF | 115.4 | 259.6 | 375.0 | 23.3 | 57.8 | 81.1 |
| 100% RDF | 100.2 | 236.5 | 336.7 | 19.3 | 52.4 | 71.7 |
| 75% RDF | 77.9 | 202.6 | 280.5 | 16.6 | 46.2 | 62.8 |
| 75% RDF+Biofertilizer | 97.3 | 229.8 | 327.1 | 18.8 | 49.4 | 68.2 |
| S. Em± | 4.7 | 8.9 | 13.2 | 0.7 | 1.6 | 2.7 |
| LSD (P=0.05) | 13.9 | 26.5 | 39.5 | 2.1 | 4.8 | 8.1 |
| C. V. (%) | 14.4 | 11.5 | 12.1 | 11.0 | 9.4 | 11.6 |
| Interaction (T x N) | Sig. | Sig. | Sig. | NS | NS | NS |

RDF : 80 : 40 : 20 (N : $P_2O_5$ : $K_2O$ kg/ha). Sig.–Significant, NS–Not Significant.

TABLE 2
Effect of tillage and nutrient management on economics and energetics of fodder oat under oat- rice croppings system under medium land condition (Pooled data for 2010-11and 2011-12)

| Treatment | Gross returns (Rs./ha) | Economics Net returns (Rs./ha) | B : C ratio | Energy output (MJ/ha) | Energetic net energy (MJ/ha) | Energy use efficiency |
|---|---|---|---|---|---|---|
| **Tillage management (T)** | | | | | | |
| Zero tillage | 76735 | 54660 | 2.47 | 123.5 | 114.5 | 10.5 |
| Minimal tillage | 65881 | 42546 | 1.82 | 116.5 | 103.3 | 9.7 |
| Conventional tillage | 79689 | 55094 | 2.24 | 143.0 | 129.4 | 11.7 |
| S. Em± | 785 | 785 | 0.02 | 1.9 | 1.9 | 0.1 |
| C. D. (P=0.05) | 3077 | 3077 | 0.08 | 7.4 | 7.4 | 0.5 |
| **Nutrient management (N)** | | | | | | |
| 125% RDF | 83904 | 59353 | 2.41 | 14.6 | 132.2 | 10.56 |
| 100% RDF | 76876 | 53329 | 2.26 | 128.4 | 116.2 | 10.46 |
| 75% RDF | 63141 | 40598 | 1.80 | 113.0 | 102.2 | 10.43 |
| 75% RDF+Bio-fertilizer | 72486 | 49785 | 2.19 | 123.1 | 112.5 | 11.24 |
| S. Em± | 1980 | 1980 | 0.05 | 3.0 | 3.0 | 0.3 |
| C. D. (P=0.05) | 5880 | 5880 | 0.14 | 9.0 | 9.0 | 0.9 |
| C. V. (%) | 8.01 | 11.70 | 8.08 | 7.1 | 7.8 | 8.43 |
| Interaction (T x N) | Sig | NS | NS | NS | NS | NS |

Sig.–Significant, NS–Not Significant.

resulted into higher B : C ratio under zero tillage. The conservation of energy was assessed and compared in various tillage systems viz., conventional, reduced and no-tillage. Akbarnia *et al*. (2010) indicated that the cost of tillage practices had a vital role in selecting a particular tillage system as the tillage operations were energy-intensive and also formed a major portion of production cost. Energy requirement varied with tillage systems used and thus, an energy efficient system could strengthen a farm economy considerably.

## Nutrient Management

Green and dry fodder yield, economics and energetics increased with increased levels of nutrient up to 125 per cent RDF. The maximum GFY (375.11 q/ha), DFY (81.15 q/ha), gross returns (Rs. 83,904/ha), net returns (Rs. 59,353/ha), B : C ratio (2.41), gross energy output (146.07 x $10^3$ MJ/ha) and net energy output (132.24 x $10^3$ MJ/ha) with energy use efficiency (10.56). Application of 75% RDF+*Azotobacter*+PSB produced at par results with 100% RDF in terms of GFY, DFY, gross and net returns, B : C ratio, gross output and net energy return and energy use efficiency. An advantage of Rs. 9,187 and energy 10.277 x $10^3$ MJ/ha were observed at 75 per cent RDF on inoculation of biofertilizer (*Azotobacter*+PSB). This was due to better availability of nutrient at higher dose which resulted in better growth and development led to better GFY, DFY and finally reflected in terms of economics and energetics. Increased nutrient uptake was also observed by Sharma (2009) when seed was treated with single or mixed culture of *Azotobacter* and phosphate solubilizing bacteria (PSB) compared with no inoculated treatments. Patel *et al*. (2010) also reported the similar results. Nandi and Sen (1985) reported in maize that the green fodder yield (22.0 t/ha) was the highest with a combination of 75 kg N/ha and seed inoculation with biofertilizer. The lowest yield was in control (7.6 t/ha). They also observed that 25 kg N/ha+seed inoculation gave similar fodder yield with application of 50 kg N/ha alone.

## Interaction

The data (Table 3) showed that green fodder oat under conventional tillage performed significantly superior results over minimal tillage at all levels of nutrient, while same was significant over zero tillage at 125% RDF only. Maximum green fodder yield was under conventional tillage at 125% RDF (408.14 q/ha) which was 55.42 per cent more than minimal under minimal tillage at 75 per cent RDF. Interaction effect (Table 4) also showed that gross returns under zero and conventional tillage at any nutrient management level were at par with each other and were higher than minimal tillage. Further, maximum gross returns (Rs. 91,383/

TABLE 3
Interaction effect of tillage and nutrient management on total green forage yield (q/ha) of fodder oat (Pooled data 2010-11 and 2011-12)

| Treatment | Nutrient management (N) | | | |
|---|---|---|---|---|
| | 125% RDF | 100% RDF | 75% RDF | 75% RDF+ Biofertilizer |
| **Tillage management (T)** | | | | |
| Zero tillage | 391.5 | 359.6 | 283.7 | 331.3 |
| Minimal tillage | 326.4 | 284.5 | 260.9 | 301.2 |
| Conventional tillage | 408.1 | 362.0 | 297.3 | 348.9 |
| Interaction (T x N) | S. Em± | LSD (P=0.05) | | |
| Between N at same T | 7.6 | 22.8 | | |
| Between T at same or different N | 7.1 | 31.5 | | |

TABLE 4
Effect of tillage and nutrient management on gross returns (Rs./ha) of fodder oat (Pooled data for 2010-11 and 2011-12)

| Treatment | Nutrient management (N) | | | |
|---|---|---|---|---|
| | 125% RDF | 100% RDF | 75% RDF | 75% RDF+ Biofertilizers |
| **Tillage management (T)** | | | | |
| Zero tillage | 87808 | 81876 | 63828 | 73429 |
| Minimal tillage | 72520 | 65655 | 58705 | 66645 |
| Conventional tillage | 91383 | 83096 | 66890 | 77385 |
| Interaction (T x N) | | S. Em± | C. D. (P=0.05) | |
| Between N at same T | | 1229 | 2494 | |
| Between T at same or different N | | 880 | 3017 | |

ha) were recorded under conventional tillage with 125 per cent RDF which was significantly superior over all the treatment combinations except under zero tillage at the same level of nutrient (125% RDF i. e. Rs. 87,808/ ha) and it was also observed that maximum gross returns under conventional tillage at 125 per cent RDF were 55.66 per cent more than minimum under minimal tillage at 75 per cent RDF (Rs. 58,705/ha).

## CONCLUSION

Fodder oat sown under conventional tillage at 100 : 50 : 25 ($N : P_2O_5 : K_2O$ kg/ha) significantly produced higher GFY (408.1 q/ha) and gross returns (Rs. 91383/ ha) besides, inoculation of PSB along with *Azotobacter* with seed saved the one-fourth recommended dose of fertilizer.

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