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Effect of Integrated Nutrient Management on Quality of Fodder Oats (*Avena sativa* (L.))

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ABSTRACT

A field experiment was conducted at Instructional Farm College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* 2019- 2020 entitled the "Effect of integrated nutrient management on growth, yield and quality of fodder oats (*Avena sativa* L.)". Fourteen INM treatment viz.,100 % RDF, 100% RDF + FYM @ 20.0 t ha^{-1}, 100 % RDF + PSB, 100% RDF + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1}, 75% RDF, 75% RDF + Vermicompost @ 5.0 t ha^{-1}, 75% RDF + Vermicompost @ 2.5 t ha^{-1}, 75% RDF + Vermicompost @ 2.5 t ha^{-1} + PSB, 75% RDF +Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$ @12.5 kg ha^{-1}, 75% RDF + FYM @ 20.0 t ha^{-1}, 75% RDF + FYM @ 10.0 t ha^{-1}, 75% RDF + FYM @ 10.0 t ha^{-1} + PSB, 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg/ha, Control (untreated) were laid out in Randomized Block Design with three replications. The results revealed that application of all treatments were significant increased N, P and Zn content and uptake and crude protein in fodder oats also enhanced with application of 75% RDF + FYM @ 10 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1}. But significantly highest crude fiber content was recorded under control and lowest with application of 75% RDF + FYM @ 10 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1}.

Keywords Fodder quality, INM, PSB, Vermicompost.

INTRODUCTION

Oats (*Avena sativa* L.) is locally known as "Jai". It is an annual cereal, which is mainly used as fodder for livestock. It is a good source of fiber, protein and minerals. Green fodder supply abundant quantity of vitamin A and contains about 10-12% protein and important minerals like Ca and Fe in addition to energy for the animals. Oats, content 30–35% dry matter (Singh *et al*. 2015). Production of livestock is backbone of Indian agriculture. Total number of cattle 192.49 million, buffaloes 109.85 million, goat 148.88 million, Sheep 74.26 million in the population of animals (Livestock Census 2019). Fodder requirement of India is 530 million tones dry matter and 851 million tones green fodder but present supply is 467 million tones and 590 million tones dry and green fodder respectively. So, there is a huge gap in demand and supply. Deficiency of fodder in country 35.6% in green fodder and 10.95% dry crop residue. (IGFRI vision 2050). In oats production, the main constraint is over uses of N and P fertilizers results

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in micronutrients deficiency combined application of inorganic fertilizers with different sources of organic manures in different proportions has significant role to boost forage productivity, improve nutrient uptake by plants and maintain soil nutrient status. Judicious use of manures and fertilizers in integrated manner is best alternat for maintaining crop productivity while maintaining soil fertility status in forage crops. INM improves crop productivity and soil fertility status rather than mineral fertilizers alone. Use of organic manures has been found to be promising the productivity through correction of deficiency of secondary and micronutrients and improving the physical and biological properties of soil. It improves the quality by increasing the protein content of fodder crops and governs to a considerable utilization of potassium, phosphorus and other nutrients. Therefore, the use of PSB would not only offset the high cost of manufacturing but would also mobilize insoluble P in the fertilizers and soils to which they are applied. The fixed phosphorus in the soil can be solubilized by PSB, which have the capacity to convert inorganic unavailable phosphorus form to soluble forms HPO_4^{-2} and H_2PO_4- through the process of organic acid production chelating and ion exchange reactions and make them available to plants. Application of micronutrients like Zn is also essential in addition to other macronutrients so there is no deficiency in animal fodder. The deficiency of Zn under semi-arid climate has emerged a serious limitation to crop production. The light textured soils Zn deficiency is being widely expressed. Application of nitrogen after cutting will ensure better regrowth and canopy there by accumulated more stem carbohydrate. Recent researches indicate that a judicious combination of fertilizer and organic manures can better increase the production of fodder crops. Besides, organic manures also supply the traces of micronutrients, which are not supplied by chemical fertilizers. Application of different organic-inorganic sources was found very effective in realizing high yield, improved residual fertility and better economy of the soil. Therefore, the present study was undertaken to assess the effect of INM on yield and quality of oats.

MATERIALS AND METHODS

The field experiment was conducted during the winter seasons of 2019-20 at the Instructional Farm, S. K. Rajasthan Agricultural University, Bikaner (28°38' N, 77°11' E, 228.6 m above mean sea-level). The soil of the experimental site was loamy sand, with bulk density of 1.55 g cm^{-1}. It had 0.15% organic carbon, 120.4 kg $KMnO_4$ oxidizable N ha^{-1}, 14.68 kg 0.5 N $NaHCO_3$ extractable P ha^{-1}, 175.5 kg 1.0 N NH_4OAC exchangeable K ha^{-1}, 8.5 pH and 0.22 dSm^{-1} electrical conductivity at the start of the experiment. The experiment effect of integrated nutrient management on growth, yield and quality of forage oat was carried out at the Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* 2019-2020. The experiment was laid out in Randomized Block Design with three replications. Total fourteen treatments viz, 100% RDF (T_1), 100% RDF+ FYM @ 20.0 t ha^{-1} (T_2), 100% RDF+PSB (T_3), 100% RDF + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1} (T_4), 75% RDF (T_5), 75% RDF + Vermicompost @ 5.0 t ha^{-1} (T_6), 75% RDF + Vermicompost @ 2.5 t ha^{-1} (T_7), 75% RDF + Vermicompost @ 2.5 t ha^{-1} +PSB (T_8), 75% RDF + Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1} (T_9), 75% RDF + FYM @ 20.0 t ha^{-1} (T_{10}), 75% RDF + FYM @ 10.0 t ha^{-1} (T_{11}), 75% RDF + FYM @ 20.0 t ha^{-1} + PSB (T_{12}), 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1} (T_{13}), Control (T_{14}) were comprised in oat crop. The crop was sown at 20 cm apart rows with utilizing 100 kg of seed ha^{-1}. As per treatments well-rotted FYM and vermicompost were applied before sowing and exhaustively mixed in the plots. PSB, Full dose of phosphorus and half dose of nitrogen were applied at the time of sowing and the remaining half nitrogen at the time of first irrigation. All other agronomic practices were kept normal and uniform for all the treatments.

Analysis of nutrient content

The fodder nitrogen content was estimated using colorimetric method (Snell and Snell 1949), phosphorus content by Vanadomolybdo phosphate yellow color method (Jackson 1973) and zinc by Atomic absorption spectrophotometer. The uptake of nitrogen, phosphorus and zinc after harvest in seed was estimated by using the following relationship :

$$\text{Nutrient uptake (kg/ha}^{-1}\text{)} = \frac{\text{Nutrient content in straw (per cent)} \times \text{Straw yield (kg ha}^{-1}\text{)}}{100}$$

Crude protein content

Crude protein percent in straw was calculated by multiplying nitrogen content percentage in straw by the factor of 6.25 (AOAC 1990).

Crude protein yield

Crude protein yield was worked out by using the following formula:

$$\text{Crude protein yield (kg ha}^{-1}\text{)} = \frac{\text{Crude protein content (\%)} \times \text{Fodder yield (kg ha}^{-1}\text{)}}{100}$$

Crude fiber content

Crude fiber content in whole plant was estimated by acid-alkali digestion method and was expressed in percentage (AOAC 1990).

$$\text{Crude fiber (per cent)} = \frac{\text{Weight of residue} - \text{Weight of ash}}{\text{Weight of sample taken}} \times 100$$

RESULTS AND DISCUSSION

Nutrient content and uptake

In the present investigation, nitrogen, phosphorus and zinc content and uptake of fodder oat were influenced significantly by integrated nutrient management (Table 1). Maximum nitrogen, phosphorus and zinc content was recorded under application of 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1} (1.183 and 1.292%), (0.101 and 0.105 %) and (597 and 592.3 ppm) at 1st cut and harvest and it was significantly increased as compared to application of other remaining combination of nutrient management, but which was at par with 100% RDF + FYM @ 20.0 t ha^{-1}, 100% RDF + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1}, 75% RDF + Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$@ 12.5 kg ha^{-1}, 75% RDF + FYM @ 20.0 t ha^{-1}, 75% RDF + FYM @ 10.0 t ha^{-1} and 75% RDF + FYM @ 10.0 t ha^{-1} + PSB. It might be concluded from the above findings that nitrogen content in oat at different cuttings enhanced by the application of organic with inorganic fertilizer in this investigation, it may be due to gradual mineralization formation of more humus colloidal complex coupled with higher nutrient contents along with increased moisture. The gradual release and steady supply of nutrients from humus/organics throughout the growth and development of oat crop, similar observations were also reported by Singh and Pathak (2003). This might be since increasing N level in soil increase availability of nitrogen to plants (rhizosphere) which resulted vigorus vegetative as well as profuse root growth, leading to improved absorption of N and other nutrients from soil and hence, more N content in fodder increased. Thus, phosphorus content in oat enhanced by the applying of organic with inorganic fertilizer combination. It may be as certain by the beneficial effect of FYM is due to its contribution in supplying additional plant nutrients, improvement of soil physical condition and biological process in soil. similar results were also found Pandey (2018). Similar findings were reported by Pandey and Kumar (2017) and Pandey and Chauhan (2016) Singh *et al.* (2008). Yadav and Singh (2018) who reported that application of FYM had additive effect on available nutrients besides it use of micro-organism in the presence of FYM had exerted maximum positive effect on the soil biological productivity.

Significant increase in nitrogen, phosphorus and zinc uptake by fodder oat under application of 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$@ 12.5 kg ha^{-1} as compared to rest of treatments (Table 1). It may be concluded that nitrogen, phosphorus and zinc uptake increased due to richer content of N, P and Zn as well as by higher yield of dry fodder of oat collectively in all cuttings due to applying various integrated nutrient management treatments. It is one of the valid reasons for higher zinc uptake. Our findings agree with Sharma and Singhal (2016) Singh and Pathak (2003), Singh *et al.* (2008) and Swaroop (2003).

Crude protein content and yield

It is seen from the data given in Table 2 that various

Table 1. Effect of integrated nutrient management on nitrogen, phosphorus and zinc content and uptake in fodder oat.

Sl. No.	Treatments	N content (%) 1st cut	N content (%) at harvest	N uptake (kg ha^{-1})	P content (%) 1st cut	P content (%) at harvest	P uptake (kg ha^{-1})	Zn content (%)1st cut	Zn content (%) at harvest	Zn uptake (kg ha^{-1})
T_1	100% RDF (120.0 kg ha^{-1} N and 40 kg ha^{-1} P_2O_5)	0.993	1.223	72.69	0.086	0.090	5.896	340.3	333.7	2260.0
T_2	100% RDF+FYM @ 20.0 t ha^{-1}	1.098	1.287	94.64	0.100	100.4	8.312	350.0	340.0	2825.5
T_3	100% RDF + PSB	0.996	1.221	77.74	0.087	0.091	6.324	302.3	297.0	2140.4
T_4	100% RDF+PSB+$ZnSO_4$ @ 12.5 kg ha^{-1}	1.053	1.260	87.27	0.093	0.098	7.323	591.7	581.7	4464.6
T_5	75% RDF	0.954	1.175	59.08	0.075	0.080	4.373	318.3	311.7	1789.4
T_6	75% RDF+Vermicompost @ 5.0 t ha^{-1}	0.983	1.212	70.62	0.084	0.088	5.604	346.0	338.3	2242.6
T_7	75% RDF+Vermicompost @ 2. 5 t ha^{-1}	0.899	1.179	63.12	0.077	0.082	4.766	310.3	305.7	1859.8
T_8	75% RDF+Vermicompost @ 2.5 t ha^{-1} + PSB	0.973	1.183	65.68	0.081	0.085	5.110	329.7	322.3	2023.7
T_9	75% RDF+Vermicompost @ 2. 5 t ha^{-1}+ $ZnSO_4$ @ 12.5 kg ha^{-1}	1.092	1.183	75.39	0.083	0.086	5.365	596.0	588.0	3763.1
T_{10}	75% RDF+FYM @ 20.0 t ha^{-1}	1.079	1.266	93.07	0.097	0.101	8.090	330.7	324.0	2675.5
T_{11}	75% RDF+FYM @ 10.0 t ha^{-1}	1.058	1.228	82.82	0.087	0.092	6.669	441.7	435.0	3273.8
T_{12}	75% RDF+FYM @ 10.0 t ha^{-1} + PSB	1.065	1.248	87.15	0.090	0.094	7.130	299.7	292.3	2303.9
T_{13}	75% RDF+FYM @ 10.0 t ha^{-1} +PSB+ $ZnSO_4$ @ 12.5 kg ha^{-1}	1.183	1.292	97.28	0.101	0.105	8.567	597.0	592.3	5009.2
T_{14}	Control	0.947	1.175	52.97	0.073	0.077	3.771	340.0	330.0	1701.1
SEm±		0.026	0.024	1.40	0.005	0.004	0.457	3.6	3.8	8.6
CD at 5%		0.074	0.070	4.06	0.013	0.013	1.328	10.4	11.0	24.9

integrated nutrient management treatments showed beneficial effect in terms of crude protein content and uptake over the control. Further analysis of data reveals that treatment 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1} showed significantly better result in terms of crude protein content over

Table 2. Effect of integrated nutrient management on crude protein content and yield and crude fiber content in fodder oat.

Treatments	Crude protein content (%) At 1st cut	Crude protein content (%) At harvest	Crude protein yield (kg ha^{-1})	Crude fiber content (%)
100% RDF	6.21	7.37	448.96	26.70
100% RDF + FYM @20.0 t ha^{-1}	6.86	8.04	605.60	24.48
100 % RDF+ PSB	6.23	7.51	482.36	26.68
100% RDF + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1}	6.58	7.88	540.50	25.61
75% RDF	5.96	7.34	350.01	27.32
75% RDF + Vermicompost @ 5.0 t ha^{-1}	6.15	7.50	443.61	26.44
75% RDF + Vermicompost @ 2.5 t ha^{-1}	5.62	7.37	358.04	27.69
75% RDF + Vermicompost @ 2.5 t ha^{-1} + PSB	6.08	7.39	388.12	26.68
75% RDF + Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1}	6.82	7.64	441.52	25.37
75% RDF + FYM @ 20.0 t ha^{-1}	6.75	7.91	589.07	24.96
75% RDF + FYM @ 10.0 t ha^{-1}	6.61	7.68	516.90	25.47
75% RDF + FYM @ 10.0 t ha^{-1} + PSB	6.66	7.80	546.90	25.21
75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1}	7.39	8.07	643.24	24.37
Control	5.92	7.22	281.26	28.87
SEm±	0.28	0.19	21.33	0.87
CD at 5%	0.82	0.56	62.01	2.54

rest of the treatments, other than 100% RDF + FYM @ 20.0 t ha^{-1}, 100% RDF + PSB + $ZnSO_4$@ 12.5 kg ha^{-1}, 75% RDF + Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$ @ 12.5 kg ha^{-1}, 75% RDF + FYM @ 20.0 t ha^{-1}, 75% RDF + FYM @ 10.0 t ha^{-1} and 75% RDF + FYM @ 10.0 t ha^{-1} + PSB. The increase in crude protein might be attributed to increase photosynthetic and meristematic activities of plants due to application of FYM and inorganic fertilizer which cause better availability of plant nutrients and favorable physical condition of soil. The results agree with findings of Singh (2017). Highest crude protein yield was obtained with application of 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1} (643.24 kg ha^{-1}), Application of 100% RDF + FYM @ 20.0 t ha^{-1} (605.60 kg ha^{-1}) and 75% RDF + FYM @ 20.0 t ha^{-1} (589.07 kg ha^{-1}) also obtained higher crude protein yield over rest of integrated nutrient management treatments (Table 2). The increase in fodder yield with application of 75% RDF + FYM @ 10.0 t ha^{-1} + PSB + $ZnSO_4$@ 12.5 kg ha^{-1} could also be explained by better nutritional condition of the crop as supported by higher nitrogen assimilation, ultimately increase in crude protein content. Crude protein yield is function of crude protein content and fodder yield. The results agree with findings of Yadav and Singh (2018).

Crude fiber content

Application of integrated nutrient management had depressing effect on crude fiber content because it resulted in increased leaf weight and wider leaf: Shoot ratio which might had decreased the crude fiber content in fodder oat. In control treatment was recorded maximum crude fiber content which was significantly higher over 100% RDF + FYM @ 20.0 t ha^{-1}, 100% RDF + FYM @ 20.0 t ha^{-1} + PSB + $ZnSO_4$@ 12.5 kg ha^{-1}, 75% RDF + Vermicompost @ 2.5 t ha^{-1} + $ZnSO_4$@ 12.5 kg ha^{-1}, 75% RDF + FYM @ 20.0 t ha^{-1}, 75% RDF + FYM @ 10.0 t ha^{-1}, 75% RDF + FYM @ 10.0 t ha^{-1} + PSB and 75% RDF + FYM @ 20.0 t ha^{-1} + PSB + $ZnSO_4$ @ 12.5 kg ha^{-1} (Table 2). This could be attributed to the fact that nitrogen and phosphorus application at higher doses had significant effect on crude protein content thereby reducing the proportion of carbohydrates. These findings are similar by Pandey (2018).

CONCLUSION

It is concluded from the trails based on the application of 75% RDF + FYM @ 10.0 tha^{-1} + PSB + $ZnSO_4$@ 12.5 kg ha^{-1} recorded significantly higher nutrient content and uptake, crude protein content and crude fiber yield of fodder oat at stage.

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