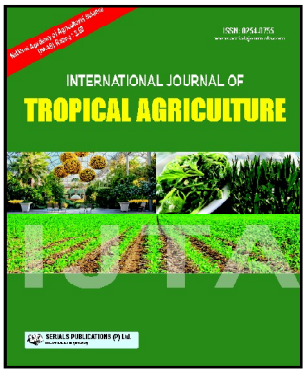

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Interaction Effect of Soil Fertility, Fertilizer Recommendation Approaches and Varieties on Yield and Quality of Oat (*Avena Sativa* L.)

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Abstract: A field experiment was conducted to assess the response behavior of Oats (*Avena sativa* L.) under different fertility levels and fertilizer recommendation approaches to workout interaction effects of soil fertility (low, medium and high) and fertilizer recommendation approaches (GRD, STCR and STCR with INM) for oats during Rabi 2014-15. The experiment was carried out with three treatments consisting of three fertility levels (F_1, F_2, F_3), three varieties (V_1, V_2, V_3) and three fertilizer recommendation approaches (M_1, M_2, M_3). The data were statistically analyzed for various parameters *viz.*, green forage and dry matter yield, nutrient content, nutrient uptake and nutrient requirement. The experimental results revealed that in interaction of fertility levels, fertilizer recommendation and varieties, UPO 94 produced significantly higher green forage yield in higher fertility levels with STCR than all other varieties. The dry matter yield was maximum in UPO 94 in interaction with higher fertility level and M_1 (GRD). Among all treatment combinations, the maximum nitrogen uptake was recorded in F_2 fertility levels with M_1(GRD), phosphorus and potassium uptake was recorded maximum in interaction of F_3 fertility levels with M_1(GRD). The maximum nitrogen requirement was found in interaction of F_2 fertility levels with M_1(GRD). Both phosphorus and potassium requirement were highest in F_2 fertility level with M_3 (STCR with INM).

Key words: Fertility levels, Oats varieties, Soil test crop response, General recommendation dose and Integrated nutrient management.

INTRODUCTION

India is the second largest consumer of fertilizer in the world next to China. Livestock is the integral component of agriculture since times immemorial and its contribution to national economy through milk, meat, wool as well as farm yard manure is enormous. However, the low productivity of our livestock is mainly due to poor availability of feed resources. Amongst several fodder crops, oat proved to be the most successful and suitable fodder crop **(Singh, 1971)** with the availability of high yielding early, medium and late maturing varieties.

There is a vast scope for increasing productivity of forage crops by adopting agro-techniques. For achieving the potential crop yield per unit area, high yielding varieties should be coupled with proper agronomic practices. Of the various factors known to augment the crop production, fertilizers added with suitable agronomic practices play a pivotal role to boost up the crop yield. Among the three primary nutrients (N, P and K) necessary for crop production, nitrogen plays a key role. The need for improved crop productivity is more now than ever before because sizeable area of productive land is being diverted to non agricultural uses. Low fertility of Indian soils is the main constraint in achieving high productivity. Maintenance of soil fertility and sustainability of crop production, therefore, is the key factor to ensure food security. In India the contribution of fertilizers to crop yield has been remarkable. Fertilizers constitute major input and increasing their efficiency may reduce cost of cultivation. Therefore, it becomes very necessary to develop a comprehensive approach of fertilizer recommendation incorporating soil test, field experimentation and economic evaluation of results. In increasing agriculture production and improving fertilizer use efficiency, soil testing has been developed into specialized field of great practical application. This helps to economize the cost of fertilizers and improve fertilizer use efficiency.

MATERIALS AND METHODS

A field experiment was conducted to study the 'Interaction effect of soil fertility, fertilizer recommendation approaches and varieties on yield and quality of oat oats (*Avena sativa* L.) during Rabi 2014-15 at Norman E. Borlogue Crop Research Centre of the G.B. Pant University of Agriculture and Technology, Pantnagar. The experiment was conducted in two phases, i.e. creation of soil fertility levels by applying graded doses of N, P_2O_5 and K_2O and growing exhaust crop in the preceding crop season (Kharif, 2014) with growing of Sorghum So, Before conducting the main experiment preparatory trail was conducted in selected field of area about 0.4 ha. In this plot, soil sample were collected randomly and analyzed for various soil properties. The field was divided into three strips. Strip I containing no fertilizer, strip II (100 kg N,100 kg P_2O_5,100 kg K_2O) and strip III (200 kg N,200 kg P_2O_5,200 kg K_2O).In these strips exhaust crop sorghum (Pant chari-5) was grown. The soil was sandy loam with pH 7.3, having 0.67 per cent organic C, 170 kg ha^{-1} available N, 28 kg ha^{-1} available P and 184 kg ha^{-1} available K. In the second phase (Rabi 2014-15), each strip size of 60 m × 22.5 m size (made in the fertility gradient stabilizing experiment in the previous season) was divided into thirty plots (27 treatments + 3 control) resulting in total ninety (30×3) plots. Among these each plot was in the size of 3× 3 m, the total of 9 m^2 in size. The main experiment was conducted in split-split plot design, taking three fertility levels i.e. F_1 low (0,0,0), F_2 medium (100,100,100) and F_3 high (200,200,200) in main plot, three variety of oats i.e. Kent (V_1), UPO 94(V_2) and UPO 212 (V_3) in sub plot and three methods of fertilizer recommendation, i.e. GRD (M_1), STCR (M_2) and STCR with INM (M_3) in sub-sub plot.

Soil samples at 0-15 cm depth were collected from each plot before sowing of test crop. Soil samples were air dried in shade, ground with the help of mortar and pestle, passed through 2 mm sieve

and stored for further chemical analysis for soil texture by Bouyoucos Hydrometer method (Black, 1965), pH by Glass electrode pH meter (Jackson, 1958), EC by 1:2 soil water suspension (Bower and Wilcox, 1965), organic carbon (Walkley and Black method, 1934), available nitrogen by Alkaline $KMnO_4$ method, (Subbiah and Asija, 1956), phosphorus by Olsen's extraction method, (Olsen *et al.*, 1954) and potassium by 1 N NH_4OAc extraction method, (Hanway and Hiedal, 1952) both in pre and post harvest soil sample as per the standard procedure. At the time of harvesting the plant samples were taken from each plot. The plant samples were first air dried and then oven dry at 60ÚC to a constant weight. The dried samples were ground in 'Weiley' type mill and stored in moisture proof plastic bags and finely collect in paper bag and numbering was done in each bag and analyzed for total nitrogen, phosphorus and potassium (Jackson, 1973). Other observations were also recorded *viz.,*green forage yield, dry matter yield, nutrient uptake and nutrient requirement.

$$\text{Dry matter yield (q ha}^{-1}) = \left(\frac{100 - \text{moisture percentage}}{100}\right) \times \text{Fresh yield (q ha}^{-1})$$

Nutrient uptake by Plant (kg ha^{-1}) = per cent nutrient in Plant × dry plant yield (q ha^{-1})

Nutrient requirement Nutrient requirement

$$(NR) = \frac{\text{Total nutrient uptake (kg ha}^{-1})}{\text{fresh yield of Oats (q ha}^{-1})}$$

The collected data during the experimentation were analyzed statistically. Test crop data was analyzed by Split-split plot design, in which fertility levels is considered as main plot (F_1, F_2, F_3), variety as sub plot (V_1, V_2, V_3) and fertilizer recommendations approaches (M_1, M_2, M_3) considered as a sub-sub plot. The interaction results was based on the analysis of variance and conclusion drawn some at 5% to test the difference among the treatment. Standard error of mean (SEm±) was calculated in each case.

RESULT AND DISCUSSION

1. Green forage yield of oats

Table 1
Interaction effect of fertility and variety on green forage yield of oats

Treatment ertility	*Green forage yield (q ha^{-1})*		
	V_1	V_2	V_3
F_1	339.41	405.43	362.24
F_2	428.89	495.34	415.00
F_3	418.09	486.02	482.39

	S.Em±	C.D.at 5%
1. For comparing two fertility levels at same or different Varieties	28.03	85.43
2. For comparing two varieties at same or different fertility levels	17.68	54.47

1.1. Interaction effect of fertility and variety on green forage yield of oats

The data presented in **table 1** shows that kent variety (V_1)significantly differ with F_1 and F_2 fertility levels. The maximum green forage yield of kent variety was recorded F_2 fertility levels i.e, 428.89 q ha^{-1}. The green forage yield of UPO 94 variety (V_2) significantly better in F_2. The maximum green forage yield of UPO 94 variety was recorded in F_2 fertility levels i.e. 495.34 q ha^{-1}. The maximum green forage yield of UPO 212 variety was recorded in F_3 fertility levels, i.e.482.39 q ha^{-1}. Among all the varieties, UPO 94 produced significantly higher green forage yield than all other varieties on F_2 fertility levels. The green forage yield was significantly influenced by the interaction of fertility and varieties.

1.2. Interaction effect of fertility and fertilizer recommendation approaches on green forage yield of oats

The data presented in **table 2** shows that F_3 fertility levels produced significantly maximum green forage yield with M_2 (STCR) i.e, 495.85 q ha^{-1}. The green forage yield in M_1 (GRD) significantly superior with

Table 2
Interaction effect of fertility and fertilizer recommendation approaches on green forage yield of oats

Treatment	*Green forage yield (q ha^{-1})*		
Fertility	M_1	M_2	M_3
F_1	309.79	439.38	357.92
F_2	413.46	464.37	461.40
F_3	450.80	495.85	479.85

	S.Em±	C.D.at 5%
1. For comparing two fertility levels at same or different management	25.33	75.23
2. For comparing two management at same or different fertility levels	13.89	39.85

F_2 and F_3 fertility levels. The green forage yield in M_1 (GRD) was recorded maximum with F_3 fertility levels followed by F_2 and F_1 fertility levels. The green forage yield in M_3 (STCR with INM) significantly higher with F_2 and F_3 fertility levels. The maximum green forage yield in M_3 (STCR with INM) was recorded with F_3 fertility levels followed by F_2 and F_1 fertility levels. In F_1 and F_2 fertility level the green forage yield significantly higher with M_2(STCR) and M_3 (STCR with INM). In F_3 fertility levels the green forage yield significantly superior in M_2(STCR) over M_1(GRD). Among all treatment combinations, the maximum green forage yield was recorded in interaction of F_3 fertility levels with M_2(STCR) i.e.495.85 q ha^{-1}, and minimum green forage yield was recorded in F_1 fertility levels with M_1(GRD) i.e.309.79 q ha^{-1}. **Gill and Malik (1983) and Joon *et al.* (1988)** have also recorded increase in yield of fodder oat with increasing fertilizer dose. Enhanced growth and forage yield of oats by application of nitrogen has also been reported by **Joon and Singh (1989), Patel and Vihol (1990).**

Table 3
Interaction effect of variety and fertilizer recommendation approaches on green forage yield of oats

Treatment	*Green forage yield (q ha^{-1})*		
Variety	M_1	M_2	M_3
V_1	368.72	427.35	390.32
V_2	405.75	484.12	496.93
V_3	399.58	488.14	411.92

	S.Em±	C.D.at 5%
1. For comparing two varieties at same or different management	15.26	45.22
2. For comparing two management at same or different varieties	13.89	39.85

1.3. Interaction effect of variety and fertilizer recommendation approaches on green forage yield of oats

The data presented in **table 3** shows that green forage yield in M_1(GRD), UPO 94 (V_2) recorded the maximum fresh yield i.e.405.75 q ha^{-1}. The green forage yield in M_2 (STCR) and M_3 (STCR with INM) was maximum of variety UPO 94 (V_2) followed by UPO 212 (V_3) and kent. The green forage yield of kent and UPO 212 variety significantly maximum with M_2 (STCR). Among all treatment combinations, the maximum green forage yield was recorded in UPO 94 in interaction with M_3 (STCR with INM) i.e.496.93 q ha^{-1}, and the minimum green forage yield was recorded in kent in interaction with M_1 (GRD) i.e.368.72q ha^{-1}. In the interaction of variety and management, UPO 94 perform better and gives maximum green forage yield on M_1 (GRD) and M_3 (STCR with INM) management. The green forage yield obtained by this trend was also reported by **Sheoran *et al.*(2005).**

2. Dry matter yield of oats

Statistical analysis of the data pertaining to dry matter yield with respect to different fertility levels, varieties and fertilizer recommendation approaches are presented in **table 4** Where variety exhibited significant differences on dry matter production. It indicated that dry matter yield of oats significantly

affected in different varieties. The variety UPO 94 gave significantly superior yield over other varieties. The trend of yields of different varieties was UPO 94> UPO 212> Kent. The yield trend in respective of fertility was $F_2>F_3>F_1$. And fertilizer recommendation approaches was GRD, STCR, STCR with INM. The trend was $M_2>M_3>M_1$. The significant difference among varieties was due to genetic variation. However fertilizer recommendation and fertility creation were applied variation which have not created much difference in dry matter production of oats. such results was also reported by other worker **(Singh and Sachan,1976 and Verma and Dadheech, 2005)**. The abundant supply of nutrient (nitrogen) may have increased protoplasmic constituents and accelerated the process of cell division and elongation which might have resulted in luxuriant vegetative growth and thereby, higher biomass and dry matter yield **Kumari *et al.* (2014).**

Table 4
Interaction effect of varieties and fertilizer recommendation approaches on dry matter yield of oats

Treatments	*Dry matter yield (q ha^{-1})*		
Variety	M_1	M_2	M_3
V_1	119.47	155.94	142.89
V_2	170.29	162.42	158.84
V_3	156.19	151.53	149.34

1.	For comparing two varieties at same or different management	S.Em± 8.82	C.D.at 1% 30.97
2.	For comparing two management at same or different varieties	7.43	21.33

2.1. Interaction effect of varieties and fertilizer recommendation approaches on dry matter yield of oats.

The data presented in **table 4** shows that the dry matter yield in M_1(GRD), UPO 94 and UPO 212 were significantly superior over kent. The dry matter yield of kent variety significantly higher in M_2(STCR) and M_3 (STCR with INM) over M_1 (GRD). Among all treatment combinations, the maximum dry matter yield was recorded UPO 94 in interaction with M_1 (GRD) i.e.170.29 q ha^{-1} and the minimum dry matter yield was recorded in kent in interaction with M_1 (GRD) i.e. 119.47 q ha^{-1}. In the interaction of variety and management, UPO 94 perform better and gave maximum dry matter yield on M_1 (GRD). Such trend was also reported by **Kumar and Ramawat, (2006).** The dry matter yield of oats was significantly influenced by different varieties and fertilizer recommendation approaches.

3. NUTRIENT UPTAKE IN OATS

3.1. Nitrogen uptake

Table 5
Interaction effect of fertility and fertilizer recommendation approaches on nitrogen uptake of oats

Treatment	*Nitrogen uptake (kg ha^{-1})*		
Fertility	M_1	M_2	M_3
F_1	248.77	326.21	318.08
F_2	456.160	386.13	409.17
F_3	400.61	447.50	397.04

1.	For comparing two fertility levels at same or different management	S.Em± 8.82	C.D.at1% 30.97
2.	For comparing two management at same or different fertility levels	7.43	21.33

3.1.1. Interaction effect of fertility and fertilizer recommendation approaches on nitrogen uptake of oats

The data presented in **table 5** shows that F_2 and F_3 fertility levels have significantly higher nitrogen uptake over F_1 under M_1(GRD). The nitrogen uptake in M_2 (STCR) and M_3 (STCR with INM) was significantly superior in F_2 and F_3 fertility levels over F_1 fertility levels. In F_1 fertility level the nitrogen

uptake was also significantly superior in M_2(STCR) and M_3 (STCR with INM) over M_1(GRD). In F_2 fertility levels the nitrogen uptake significantly better in M_2(STCR) and M_3 (STCR with INM) over M_1(GRD). Among all treatment combinations, the maximum nitrogen uptake was recorded in F_2 fertility levels with M_1(GRD) i.e.456.16 kg ha^{-1}, and minimum nitrogen uptake was recorded in F_1 fertility levels with M_1(GRD) i.e. 248.77 kg ha^{-1}.

3.2. Phosphorus uptake

Table 6
Interaction effect of fertility and fertilizer recommendation approaches on Phosphorus uptake of oats

Treatment	*Phosphorus uptake (kg ha^{-1})*		
Fertility	M_1	M_2	M_3
F_1	19.80	28.68	24.47
F_2	33.49	33.89	29.29
F_3	33.98	33.30	32.40

1.	For comparing two fertility levels at same or different management	S.Em± 2.00	C.D.at1% 7.04
2.	For comparing two management at same or different fertility levels	1.64	4.71

3.2.1. Interaction effect of fertility and fertilizer recommendation approaches on Phosphorus uptake of oats

The data presented in **table 6** shows that F_2 and F_3 fertility levels have significantly higher phosphorus uptake over F_1 under M_1(GRD) nutrient management. The phosphorus uptake in M_1 (GRD) was recorded maximum in F_3 fertility levels followed by F_2 and F_1 fertility levels. The phosphorus uptake in M_3 (STCR with INM) significantly higher in F_3 fertility levels over F_1 fertility levels. Among all treatment combinations, the maximum phosphorus uptake was recorded in interaction of F_3 fertility levels with M_1(GRD) and minimum phosphorus uptake was recorded in F_1 fertility levels with M_1(GRD) i.e. 19.80 kg ha^{-1}.

3.3. Potassium uptake

Table 7
Interaction effect of fertility and fertilizer recommendation approaches on Potassium uptake on oats

Treatment	*Potassium uptake (kg ha^{-1})*		
Fertility	M_1	M_2	M_3
F_1	237.59	335.73	294.95
F_2	337.48	311.06	330.93
F_3	344.00	340.85	319.73

1.	For comparing two fertility levels at same or different management	S.Em± 20.83	C.D.at 5% 72.89
2.	For comparing two management at same or different fertility levels	17.91	51.39

3.3.1. Interaction effect of fertility and fertilizer recommendation approaches on potassium uptake of oats

The data presented in **table 7** shows that F_2 and F_3 fertility levels have significantly higher potassium uptake over F_1 at M_1 (GRD). In F_1 fertility level the potassium uptake differ significantly with M_2 (STCR) and M_3 (STCR with INM) over M_1 (GRD). Among all treatment combinations, the maximum potassium uptake was recorded in interaction of F_3 fertility levels with M_1(GRD) and minimum potassium uptake was recorded in F_1 fertility levels with M_1(GRD) i.e. 237.59 kg ha^{-1}.The interaction of fertility and management significantly influenced the potassium uptake of oats. Decrease in uptake of potassium by application of FYM might be decreased due to less decomposition of applied FYM.

4. NUTRIENT REQUIREMENT OF OATS

4.1. Nitrogen requirement

Table 8
Interaction effect of fertility and fertilizer recommendation approaches on nitrogen requirement of oats

Treatment	*Nitrogen requirement (kg q^{-1})*		
Fertility	M_1	M_2	M_3
F_1	0.73	0.81	0.88
F_2	1.10	0.83	0.88
F_3	0.89	0.92	0.82

1.	For comparing two fertility levels at same or different management	S.Em± 0.27	C.D.at 5% 0.91
2.	For comparing two management at same or different fertility levels	0.054	0.15

4.1.1 Interaction effect of fertility and fertilizer recommendation approaches on nitrogen requirement of oats

The data presented in **table 8** shows that F_2 and F_3 fertility levels have significantly higher nitrogen requirement at M_1 (GRD). In F_2 fertility levels the nitrogen requirement significantly higher at M_1 (GRD) over other management practices. Among all treatment combinations, the maximum nitrogen requirement was found in interaction of F_2 fertility levels with M_1(GRD) i.e. 1.10 kg q^{-1} , and minimum nitrogen requirement was recorded in F_1 fertility levels with M_1(GRD) i.e. 0.73 kg q^{-1} . The interaction of fertility and management significantly influenced the nitrogen requirement of oats.

4.2. Phosphorus requirement

4.2.1 Interaction effect of fertility and fertilizer recommendation approaches on nitrogen requirement of oats

The data presented in **table 9** shows that in F_1 and F_2 fertility levels the phosphorus requirement

Table 9
Interaction effect of fertility and fertilizer recommendation approaches on phosphorus requirement of oats

	Treatment potassium requirement (kg q^{-1})		
Fertility	M_1	M_2	M_3
F_1	0.80	0.81	0.71
F_2	0.70	0.88	0.77
F_3	0.73	0.87	0.91

1.	For comparing two fertility levels at same or different management	S.Em± 0.27	C.D.at 1% 0.98
2.	For comparing two management at same or different fertility levels	0.031	0.091

significantly higher in M_2 (STCR). In F_3 fertility levels the potassium requirement significantly higher at M_3 (STCR with INM). Among all the treatment combinations, the maximum potassium requirement was found in F_3 fertility levels with M_3(STCR with INM) and minimum potassium requirement was recorded in F_1 fertility levels with M_3(STCR with INM).

4.3. Potassium requirement

Table 10
Interaction effect of fertility and fertilizer recommendation approaches on potassium requirement of oats

	Treatment potassium requirement (kg q^{-1})		
Fertility	M_1	M_2	M_3
F_1	0.80	0.81	0.71
F_2	0.70	0.88	0.77
F_3	0.73	0.87	0.91

1.	For comparing two fertility levels at same or different management	S.Em± 0.27	C.D.at 1% 0.98
2.	For comparing two management at same or different fertility levels	0.031	0.091

4.3.1 Interaction effect of fertility and fertilizer recommendation approaches on potassium requirement of oats

The data presented in **table 10** shows that in F_1 fertility level the potassium requirement significantly higher in M_2 (STCR). In F_2 fertility levels the potassium requirement differ significantly with M_2 (STCR). In F_3 fertility levels the potassium requirement significantly higher at M_3 (STCR with INM). Among all the treatment combinations, the maximum potassium requirement was found in F_3 fertility levels with M_3(STCR with INM).

CONCLUSION

Green forage yield were highest in UPO 94 in medium fertility level with STCR. The dry matter yield were maximum in UPO 94 with GRD. The nitrogen uptake were highest in medium fertility level with GRD. Phosphorus and potassium uptake were highest in higher fertility level with GRD. The nitrogen requirement is highest in medium fertility level with GRD. Both phosphorus and potassium requirement were highest in higher fertility level with STCR (INM). Integrated nutrient management is important for sustainable agricultural production and protecting environment quality and has been widely investigated around the world. Therefore it is necessary to screening of variety for different fertility levels is essential to get maximum production and sustaining crop yield, quality and soil health for the future.

REFERENCES

Bouyoucos, G.J. (1962), Direction for making mechanical analysis of soil by hydrometer method. *Soil Sci*., 42: 225-228.

Gill, P.S. and Malik, B. S. (1983), Response of Oat Varieties to Soil Moisture Regime and Nitrogen levels. *Forage Res.* 9(2): 151-154.

Hanway, J.J. and Hiedal, H. (1952), Soil analysis method used in Iowa State Soil Testing Laboratory. Iowa Agric. (c.f. methods of soil analysis, part 2 Ed. C.A. Black, Medison Wisconsin. *American Soc. of Agron.* 57: 1025-1027.

Jackson, M.L. (1973), Soil chemistry analysis Prentice Hall of India Pvt. Ltd., New Delhi, 183.

Joon, R.K. and Singh, K.P. (1989), Response of of forage oat (*Avena sativa* L.) to irrigation and nitrogen. *Forage Res.* 15(1): 33-42.

Kumar, N. and Ramawat, Naleeni (2006), Effect of NPK and Sulphur Application on Forage Production of Oat under Rainfed Conditions of North Western Himalaya. *Forage Res.* 32(1): 1-3.

Kumari A., Kumar P., Ahmad E., Singh M., Kumar R., Yadav R.K., Datt, C. and Chinchmalatpure, A. (2014), Fodder yield and quality of oats fodder (*Avena sativa* L.) as influenced by salinity of irrigation water and applied nitrogen levels .*Indian J. Anim. Nutr.*31 (3) : 266-27.

Olsen, S. R.; Cate, C.V.; Watnobe, F.S. and Dean, L.A. (1954), Estimation of available phosphorus in soils by extraction with sodium bicarbonate, USDA, Cies 939.

Patel, R. H. and Vihol, P.P. (1990), Effect of nitrogen, phosphorus and Zinc sulphate on production traits of forage production. *Gujrat Agri. Univ. Res . J.* 16(1): 42-46.

Sheoran, R.S.; Rana, D.S. and Singh, K.P. (2005), Integrated Nutrient Management for Sustainable Fodder Yield of Oat under Semi-arid Conditions. *Forage Res.* 31(2): 126-129.

Subbiah, B.V. and Asija, G.L. (1956), A rapid procedure for assessment of available nitrogen in rice plots. *Curr. Sci.* 31: 196-200.

Verma, A. K. and R. C. Dadheech, (2005), Yield and economics of fodder oat as influenced by balanced fertilization and legume mixture. *Forage Res.* 31: 73-74.