EVALUATING NITROGEN LEVEL EFFECT ON YIELD, QUALITY AND ECONOMICS OF SINGLE CUT OAT

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SUMMARY

A field experiment was carried out during *Rabi* season, 2022-23 at Forage Section Research Farm Department of G&PB, CCS HAU, Hisar to in order to assess the effect of different nitrogen (N) levels on forage yield and quality of promising entries of single cut oat. The experiment was laid out in split plot design with ten promising entries of single cut oat (Seven test entries *i.e.* HFO-1003, HFO-1009, HFO-1013, JO-08-37, SKO-244, OL-1977, OL-1980 + 2 national checks *i.e.,* Kent and OS-6 + 1 zonal check *i.e.* OS 403 (North-West Zone, North-East Zone and South zone) in main plot and three nitrogen doses (80, 100, and 120 kg N/ha) in sub plot. Findings revealed that entry OL-1980 recorded highest green and dry fodder yields (482.69 and 87.96 q/ha, respectively) which were on a par with OS-6 and OL-1977. OL-1980 also gave highest per day productivity of green fodder (4.68 q/ ha/day) and dry matter (0.85 q/ha/day) which was statistically at par with entry OS 6 (NC) and OL-1977. Maximum B: C ratio (2.14) was fetched with entry OL-1980 followed by OS-6 and OL-1977. Highest crude protein content (13.24 %) was estimated with OL-1980 which was on a par with OS-6, OS-403, SKO-244 and JO-08-37. Among different nitrogen treatments, the application of 120 kg N/ha resulted in highest green fodder and dry matter yield (438.69 q/ha and 80.43 q/ha, respectively) which were on a par with 100 kg N/ha but significantly higher than 80 kg N/ha. The maximum crude protein content was also estimated with the application of 120 kg N/ha (13.08 %), which was on a par to 100 kg N/ha but significantly superior over 80 kg N/ha. Maximum B:C ratio (1.91) was also fetched with the application of 120 kg N/ha but it was same with 100 kg N/ha which indicated that nitrogen application was remunerative up to 100 kg N/ha in single cut oat.

Key words: Single cut, oat, entries, fodder, nitrogen levels, crude protein

According to 20th Livestock Census, India is home to 535.78 million livestock; there is 4.6 percent increase in livestock population compared to Livestock Census-2012. Also there is 1.0 percent increase of total bovine population, comprising of buffalo, cattle and yak which was 302.79 million in 2019 compared to previous census (Anonymous, 2019). Despite 192.49 million cattle and 109.85 million buffalo population in India, milk productivity is much lower than average for the world because the country is facing a net scarcity of 11.24 percent green fodder, 23.40 percent dry fodder and 28.90 percent concentrates (Roy *et al*., 2019). The availability of quality fodder and feed with better nutritive composition is a decisive factor that controls the productivity of livestock. The nutritional composition of fodder and feed directly impacts the health and productivity of livestock. India is facing limitations in terms of the availability of quality green fodder and dry fodder. Availability of improved varieties of fodder crop along with better nutrient management can be the key to the problem. Among different *rabi* fodder crops, oat fodder is an energy-rich crop with good regeneration ability and high dry matter content (Kumar *et al*., 2010). Oat (*Avena sativa* L.) is a cool-season annual cereal that is well adapted to diverse soil and climatic conditions. Its forage is highly palatable, nutritious, and digestible, making it an ideal feedstuff for ruminants. It has several uses, including the preparation of hay, silage, and concentrate feed grain, and is considered the most crucial cereal fodder crop suitable for the Haryana region, with a crude protein content ranging from 10 to 14 percent. Additionally, its quick-growing nature, high-yielding potential, and palatable and nutritious value make it popular. As a succulent cereal, oat provides a good source of protein, carbohydrates, fiber, minerals, and slightly less fats and protein when used as fodder or grain. The yield and quality of oat forage are influenced by several factors, including genotype, environmental and agronomic practices (Kumar *et al*., 2023). Among these, nutrient management plays a crucial role in determining the productivity of the crop. Among three macronutrients, nitrogen is the most essential nutrient, along with phosphorus and potassium, that are essential for plant growth and development, and its availability in the soil is a major limiting factor for crop yields (Wang *et al.,* 2023). Adequate N supply can significantly increase forage yields and improve the quality of the crop by increasing crude protein content and reducing fiber concentrations. As nitrogen is a crucial component of protein and chlorophyll, gives plant deep green color, encourages vegetative growth and improves the quality of fodder crops (Patel *et al.,* 2007). The majority of soils in the Haryana region are low in nitrogen, and if the necessary amount of nitrogen is not supplied to crops in sufficient quantities, this deficiency would be reflected in the quality of the fodder. Proper and optimum dose of fertilizers can increase the yield and improve the quality of the fodder. The nitrogen content of the fodder is a crucial indicator of crude protein and digestibility. However, an excessive amount of nitrogen can lead to crop lodging and nitrate poisoning in livestock. Nitrogen is also associated with high photosynthetic activity, vigorous growth, and a dark green color of fodder, which helps in carbohydrate utilization and increasing succulence of the fodder. Therefore, finding the optimum dose of nitrogen for obtaining a good yield of newly tested single cut oat entries is essential. In view of these aspects, the present study was undertaken to evaluate the performance of different promising genotypes of single cut oat with varying levels of nitrogen.

MATERIALS AND METHODS

A field was conducted during *rabi* season, 2022-23 at Forage Section Research Farm of CCS Haryana Agricultural University, Hisar (Haryana), India (located 29°10' N latitude, 75°46' E longitude, at an average elevation of 215.2 m above mean sea level). The climate of site was semi-arid and sub-tropical with hot dry summers and severe cold winters. Average annual rainfall is about 450 mm, of which 75 per cent is received in three months, from July to September during South-West monsoon. Weekly weather parameters *i.e.* temperature (°C), relative humidity (%) and rainfall (mm) during the crop period are depicted in Fig. 1. The soil of the experimental site was sandy loam with a pH of 7.7, EC 0.34 dS/m, with a low of available nitrogen (122.0 kg/ha), medium available phosphorus (11.5 kg/ha) and potassium content (238.5 kg/ha). The

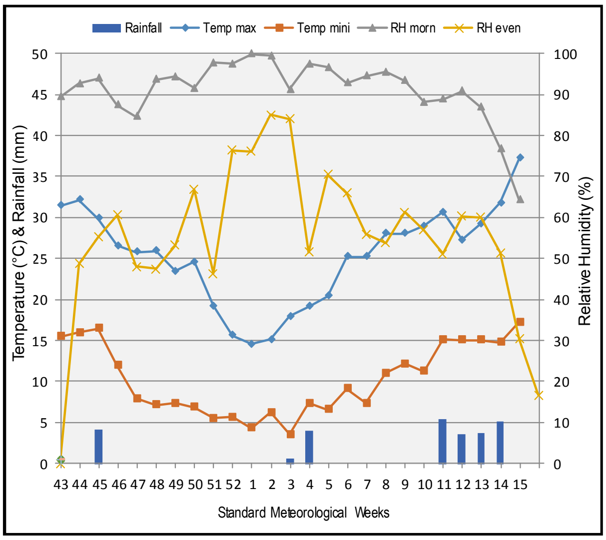

Fig. 1. Weekly weather parameters during *rabi* 2022-23 at the experimental site.

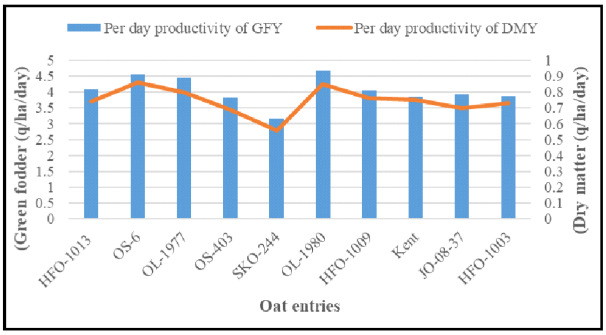

Fig. 2. Per day productivity of fodder (q/ha/day).

Picture 1. Trial picture

experiment was conducted in split plot design in three replicates. The main plot included 10 promising entries (Seven test entries *i.e.* HFO-1003, HFO-1009, HFO-1013, JO-08-37, SKO-244, OL-1977, OL-1980 + 2 national checks *i.e.*, Kent and OS-6 + 1 zonal check *i.e.* OS 403 (North-West Zone, North-East Zone and South zone) in main plot and three nitrogen doses (80, 100, and 120 kg N/ha) in sub plot. Using a seed rate of 100 kg/ha, oat genotypes as per treatment were sown manually on November 9, 2022 in opened furrows spaced 25 cm apart. All the other standard agronomic practices for the cultivation of oat were followed uniformly in all the treatments. All the genotypes were harvested just after 50 per cent flowering. The harvested green fodder from each plot was weighed in situ in kg/plot and then converted into q/ha. A 500 g sample was taken randomly from each plot at the time of green fodder at harvest, chopped well and put into paper bag. These bags were aerated by making small holes all over. The samples were first dried in the sun for 15 days and then transferred in an electric hot air oven for drying at a temperature of 60±5°C till constant weight was achieved. Based on these samples, the green fodder yield was converted into dry matter yield (q/ha). Crude protein content (%) was estimated in dried and grinded samples (2 mm sieve size), collected at 50 per cent flowering stage. The crude protein content was calculated by multiplying the nitrogen percentage with 5.83 by conventional micro-kjeldal method (AOAC, 1995). Crude protein yield was calculated by the multiplication of crude protein content with dry matter yield (q/ha). The local market's prevailing input and product prices were used to calculate economics. The trial data were analyzed by using OPSTAT software (Sheoran *et al*., 1998).

RESULTS AND DISCUSSION

Performance of oat entries

Data presented in Table 1 revealed that maximum plant height (133.48 cm) was recorded with entry OL-1980. However, lowest plant height (99.70 cm) was recorded with entry SKO-244. Entry OL-1980 had the maximum number of tillers/m row length (84.67) which was at par with OS-6 and OL-1977. Whereas, lowest number of tillers/m row length (75.48) was recorded with entry SKO-244. The highest leaf: stem ratio (0.93) was measured with entry SKO-244 which was significantly higher than all other entries. The entry OL-1980 gave highest per day productivity of green fodder (4.68 q/ha/day) and dry matter (0.85 q/ha/day) which was statistically at par with entry OS 6 (NC) and OL-1977. Similarly, the among single cut oat entries, the genotype OL-1980 recorded highest green and dry fodder yields (482.69 and 87.96 q/ha, respectively) which were on a par with OS-6 and OL-1977. The differential values of fodder oat genotypes could be ascribed to their genetic makeup (Satpal *et al*., 2018). Data presented in Table

TABLE 1

Response of promising entries of single cut fodder oat to different nitrogen levels

Treatments	No of tillers/mrl	Plant height	LS ratio	Days to 50% flowering	Green fodder yield (q/ha)	Dry matter yield (q/ha)
Entry						
HFO-1013	79.18	127.22	0.74	99.67	407.50	74.04
OS-6	83.37	130.67	0.55	98.00	446.12	83.84
OL-1977	84.22	131.11	0.78	100.33	446.10	80.46
OS-403	78.37	114.26	0.80	103.89	395.93	71.23
SKO-244	75.48	99.70	0.93	114.22	361.86	63.83
OL-1980	84.67	133.48	0.72	103.00	482.69	87.96
HFO-1009	78.52	128.67	0.56	101.78	413.70	77.64
Kent	77.82	126.04	0.43	99.11	382.40	73.84
JO-08-37	78.63	116.30	0.88	104.22	410.46	73.04
HFO-1003	78.00	120.52	0.51	100.44	389.35	73.80
SEm±	0.79	0.95	0.01	0.61	15.95	2.94
CD at 5%	2.36	2.84	0.03	1.83	47.76	8.79
N levels (kg/ha)						
80	75.67	115.62	0.67	100.43	374.19	68.95
100	81.22	124.17	0.70	102.93	427.95	78.53
120	82.59	128.60	0.70	104.03	438.69	80.43
SEm±	0.52	0.49	0.00	0.25	4.57	0.85
CD at 5%	1.50	1.41	0.01	0.73	13.12	2.43
Factor(B) at same level of A						
SEm±	1.36	1.64	0.05	1.06	27.63	5.08
CD at 5%	NS	NS	NS	NS	NS	NS
Factor A at same level of B						
SEm±	1.56	1.58	0.01	0.89	19.85	3.66
CD at 5%	NS	NS	NS	NS	NS	NS
CV%	3.59	2.18	1.20	1.35	6.06	6.10

2 revealed that among genotypes, maximum crude protein content (13.24 %) was estimated with OL-1980 which was on a par with OS-6, OS-403, SKO-244 and JO-08-37. Maximum crude protein yield (11.69 q/ha) was also recorded in OL-1980 which was on a par with genotype OS-6 only. Economic analysis given in Table 3 revealed that highest net returns (Rs. 51508/ha) and B: C ratio (2.14) was fetched with entry OL-1980 followed by OS-6 and OL-1977.

Effect of nitrogen levels

Data presented in Table 1 revealed that maximum plant height (128.60 cm) was recorded with the application of 120 kg N/ha which was significantly higher over lower N levels. The application of 120 kg N/ha also resulted in the highest number of tillers/m row length (82.59), which was statistically at par to 100 kg N/ha. Maximum and same leaf: stem (L:S) ratio was measured with the application of 120 kg and 100 kg N/ha which was significantly higher than 80 kg N/ha. With 120 kg N/ha, which was statistically at par to 100 kg N/ha, the maximum per day productivity of green fodder (4.23 q/ha/day) and dry matter (0.78 q/ha/day) was observed. As nitrogen is an important constituent of protein and chlorophyll. It imparts dark green colour to the plants, promotes vegetative growth and rapid early growth (Godara *et al.,* 2016). This will lead to better crop growth with increase in levels of nitrogen. According to Sheoran *et al.* (2017), raising nitrogen levels from 40 to 120 kg/ha had a substantial impact on the number of tillers/m row length. Likewise, the application of 120 kg N/ha resulted in highest green fodder and dry matter yield (438.69 q/ha and 80.43 q/ha, respectively) which were on a par with 100 kg N/ha but significantly higher than 80 kg N/ha (Table 1). As nitrogen is one of the most important nutrient it occupies prominent role in plant metabolism. It increases physiological indices by improving leaf production and expansion rate that ultimately achieve more interception of photo synthetically active radiation and consequently more total biomass accumulation (Kumar *et al.,* 2017).

TABLE 2

Per day productivity and quality parameters of single cut fodder oat promising entries as influenced by nitrogen levels

Treatments	Per day productivity GFY (q/ha)	Per day productivity DMY (q/ha)	Crude protein content (%)	Crude protein yield (q/ha)	Nitrogen content (%)
Entry					
HFO-1013	4.09	0.74	11.31	8.39	1.94
OS-6	4.55	0.86	12.77	10.75	2.19
OL-1977	4.45	0.80	12.40	10.00	2.13
OS-403	3.82	0.69	12.72	9.08	2.18
SKO-244	3.17	0.56	13.09	8.38	2.24
OL-1980	4.68	0.85	13.24	11.69	2.27
HFO-1009	4.06	0.76	12.48	9.69	2.14
Kent	3.86	0.74	12.33	9.14	2.12
JO-08-37	3.94	0.70	13.08	9.56	2.24
HFO-1003	3.87	0.73	12.27	9.07	2.10
SEm±	0.16	0.03	0.16	0.37	0.03
CD at 5%	0.47	0.09	0.46	1.10	0.08
N levels (kg/ha)					
80	3.74	0.69	11.72	8.08	2.01
100	4.17	0.77	12.90	10.13	2.21
120	4.23	0.78	13.08	10.52	2.24
SEm±	0.05	0.01	0.08	0.12	0.01
CD at 5%	0.13	0.02	0.22	0.34	0.04
Factor B at same level of A					
SEm±	0.27	0.05	0.27	0.64	0.05
CD at 5%	NS	NS	NS	NS	NS
Factor A at same level of B					
SEm±	0.2	0.04	0.25	0.48	0.04
CD at 5%	NS	NS	NS	NS	NS
CV%	6.15	6.04	3.31	6.85	3.27

TABLE 3
Economics of promising entries of single cut fodder oat as influenced by nitrogen levels

Treatments	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	BC ratio
Entry				
HFO-1013	45029	81500	36471	1.81
OS-6	45029	89222	44193	1.98
OL-1977	45029	89222	44193	1.98
OS-403	45029	79185	34156	1.76
SKO-244	45029	72370	27342	1.61
OL-1980	45029	96537	51508	2.14
HFO-1009	45029	82741	37712	1.83
Kent	45029	76482	31453	1.70
JO-08-37	45029	82093	37064	1.82
HFO-1003	45029	77870	32841	1.73
SEm±	-	3191	3191	0.07
CD at 5%	-	9554	9554	0.21
N levels (kg/ha)				
80	44423	74839	30416	1.68
100	44687	85589	40902	1.91
120	45976	87739	41763	1.91
SEm±	-	915	915	0.02
CD at 5%	-	2625	2625	0.06

According to Midha *et al*. (2015), the application of 80 kg N/ha significantly increased the green fodder and dry matter yield over the treatment of 40 kg N/ha, from 253.4 to 360.5 q/ha and 52.8 to 73.5 q/ha, respectively. The maximum crude protein content was also estimated with the application of 120 kg N/ha (13.08 %), which was on a par to 100 kg N/ha but significantly superior over 80 kg N/ha. (Table 2). However, significantly highest crude protein yield was observed with the application of 120 kg N/ha (10.52 q/ha) over lower N doses which clearly indicate the increasing N doses influenced the protein content of oat. (Table 2). The increase in protein content with increased in dose of nitrogen application may be ascribed due to synthesis of more amino acid and protein in plant. Higher crude protein at 120 kg N/ha was attributed to higher uptake of nitrogen which is constituent of amino acids and protein. Kumar *et al.* (2021), Godara *et al.* (2016) and Midha *et al.* (2015) also reported improvement in protein content with increase in nitrogen levels. The increase in crude protein yield was owing to increase in protein content as well as dry matter yield of crop since the protein yield proportionally increased with the increase in dry matter yield. Similarly, Patel *et al.* (2022) also revealed that plant growth, yield and quality parameters of forage oat were increased significantly when fertilised with 140 kg N/ha. Moreover, the application of 120 kg N/ha generated the highest net returns (Rs. 41763/ha) and B: C ratio (1.91). However, the BC ratio fetched with 120 kg N/ha was same as that with the application of 100 kg N/ha which indicated that nitrogen application was remunerative up to 100 kg N/ha in single cut oat (Table 3).

CONCLUSION

In terms of B:C and fodder yield (green and dry), oat genotype OL-1980 performed superior being on a par with OS-6 and OL-1977, however at par with OS-6 only for crude protein yield. Application of 100 kg N/ha was sufficient to fetch maximum B:C along with sustaining higher yield (green and dry fodder). Crude protein yield of single cut oat can be increased with increasing nitrogen dose up to 120 kg N/ha.

REFERENCES

Anonymous 2019 : 20th Livestock Census : Ministry of Fisheries, Animal Husbandry & Dairying, Government of India. *https://pib.gov.in/PressReleasePage.aspx?PRID=1588304.*

AOAC, 1995: Official Methods of Analysis, 16th edn. Association of Official Analytical Chemists, Arlington, U. S. A, ID No. 984.13.

Godara, A.S., Satpal, B.S. Duhan and S.K. Pahuja, 2016: Effect of different nitrogen levels on forage yield, quality and economics of oat (*Avena Sativa* L.)

genotypes. *Forage Res*., **41**(4): 233-236.

Kumar, A., R.K. Arya, and S.K. Pahuja, 2010: Effect of cutting and fertilizer management on seed quality parameters of oat (*Avena sativa* L.). *Forage Res*., **35**: 198-200.

Kumar, N., Satpal, N. Kharor, and S. Bhardwaj, 2023: Response of multi cut oat entries to different nitrogen levels. *Forage Res.,* **49**(3): 341-345.

Kumar, N., B.R. Kamboj, T. Mal and M. Singh, 2017: Physiological indices and biomass accumulation of wheat as influenced by nitrogen scheduling under rice residue retained situation. *Int. Arch. App. Sci. Technol*., **8**(4): 42-47.

Kumar, N., Satpal and N. Kharor, 2021: Response of promising entries of single cut fodder oat to different nitrogen levels. *Forage Res*., **46**(4): 374-378.

Midha, L.K., B.S. Duhan, and S. Arya, 2015: Performance of promising entries of oat (*Avena sativa* L.) under different nitrogen levels. *Forage Res*., **41**: 122-125.

Patel, A.S., T.N. Barevadia, M.R. Patel, A.C. Sadhu, and H.P. Parmar, 2007: Effect of nitrogen and different management practices on growth and seed production of oat (*Avena sativa* L.). *Forage Res*., **41**: 104-108.

Patel, G.N., T.V. Reddy and B.R. Patel, 2022: Management of N levels and time of cut in *rabi* forage oat (*Avena sativa* L.). *Journal of Crop and Weed*, **18**(2): 284-292.

Roy, A. K., R. K. Agrawal, N. R. Bhardwaj, A. K. Mishra and S. K. Mahanta, 2019 : In: Indian Fodder Scenario: Redefining State Wise Status (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR - AICRP on Forage Crops & Utilization, Jhansi, India, pp. 1-21.

Satpal, R.S. Sheoran, J. Tokas and Y. Jindal, 2018 : Quality, yield and economics of oat (*Avena sativa* L.) Genotypes for fodder under different nitrogen levels. *International Journal of Chemical Studies*, **6**(1): 1987-1991.

Sheoran R.S., Satpal, U.N. Joshi, B.S. Duhan, P. Kumari, S. Arya and D.S. Phogat, 2017: Agronomic evaluation of oat (*Avena sativa* L.) genotypes for forage yield, quality and economics under varying levels of nitrogen. *Forage Res*., **43**(1): 35-38.

Sheoran, O.P., D.S. Tonk, L.S. Kaushik, R.C. Hasija and R.S. Pannu, 1998: Statistical Software Package for Agricultural Research Workers. Recent Advances in information theory, Statistics & Computer Applications by D. S. Hooda & R. C. Hasija, Department of Mathematics Statistics, CCS HAU, Hisar (139-143).

Wang, Y., Liu, K., Liang, G., Jia, Z., Ju, Z., Ma, X. and Q. Zhou, 2023: Comprehensive evaluation of low nitrogen tolerance in oat (*Avena sativa* L.) seedlings. *Agronomy*, **604**(13): 1-13. *https://doi.org/10.3390/ agronomy13020604.*