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Green Forage Yield, Nutritional Value and Economics of Fodder Oat Genotypes as Influenced by Nitrogen Levels

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Abstract

The field experiment was conducted at Zonal Agricultural Research Station, Vishwesharaiah Canal Farm, Mandya, University of Agricultural Sciences, Bangalore, Karnataka, during winter season of 2020 to study the performance of oat genotypes under varied levels of nitrogen. The experiment was laid out in randomised design with factorial concept with 30 treatment combinations replicated thrice. Among genotypes, SKO-241 (254.4 q ha^{-1}) recorded significantly higher green forage, dry matter (53.9 q ha^{-1}), crude protein (5.70 q ha^{-1}), total digestible crude protein (4.86 q ha^{-1}) and crude fibre yield (14.37 q ha^{-1}) over rest of the genotypes. Application of nitrogen 120 kg ha^{-1} recorded significantly higher green forage (246.6 q ha^{-1}), dry matter (49.2 q ha^{-1}), crude protein (4.98 q ha^{-1}), total digestible crude protein (4.17 q ha^{-1}), crude fibre yield (12.50 q ha^{-1}) and net monetary returns. The genotype SKO-241 also recorded higher nitrogen use efficiency (294.1 kg green fodder/kg of nitrogen) and net monetary returns (Rs.18440 ha^{-1}) and benefit cost ratio (1.71).

Keywords : Fodder oat, Nitrogen levels, Green fodder yield, Crude Protein

Oat (*Avena sativa* L.) belongs to family Gramineae and ranks 6th in world cereal production, which is widely grown to meet grain, green and dry fodder requirement of the livestock. It is annual, short duration, highly palatable, free from ligules and suitable for cultivation under rainfed ecosystem during winter season (Shrinivasa Reddy *et al.,* 1994). It is a good source of protein, fibre and minerals and having manifold use in human food and industries. Most of the grain worldwide consumed as animal feed, the hulls a by-product of food processing industries used as animal feed, fuel for power plants and raw material for chemical industry. It has gained importance due to its multi-cut nature with quick regeneration habit and suitable for cultivation in alkali soils (Shekara *et al.*, 2019a) and also most suitable for green fodder production through hydrophonics (Ningoji *et al.,* 2021) which ensures regular supply of fodder during lean season and summer months, where resources are limited.

The vegetative growth of the crop is more important for getting higher green biomass. Although, the vegetative growth of the plant largely dependent on genetic potential of genotypes and to some extent agronomic management practices. Among them the nutrient supply system that too, nitrogen management plays a pivotal role in quantitative as well as qualitative improvement of the crop and it is an important constituent of protein, amino acids and chlorophyll, which plays a significant role in plant metabolism.

Nitrogen promotes vegetative growth and improves the quality by increasing the protein content of fodder crops. Since, it is a constituent of amino acid, the deficiency of this in fodder crops may cause severe disorders in animal health (Midha *et al.,* 2015). Keeping these things in view, it is essential to find out the optimum dose of nitrogen for fetching quantitative and qualitative fodder yield. Hence, the present investigation was undertaken to study the response of oat genotypes to varied nitrogen levels for enhancing the green forage yield and quality.

Material and Methods

The present investigation was carried out at Zonal Agricultural Research Station, Vishwesharaiah Canal Farm, Mandya, University of Agricultural Sciences, Bangalore, Karnataka during winter season of 2020 to optimise the nitrogen levels for higher green forage yield and quality in promising oat genotypes. The soil of the experimental site is red sandy loam in texture with neutral in reaction (pH-7.40) and low in available nitrogen (242 kg N ha^{-1}), medium in available phosphorus (37.3 kg ha^{-1}) and potassium (152.0 K_2O kg ha^{-1}). The experiment consisted of 30 treatment combinations including ten oat genotypes (V_1-OL-1874-1, V_2-Kent (National check), V_3-OL-1876-1, V_4-RO-11-1-3, V_5: JO-06-23 and V_6: SKO-241, V_7: OS-403, V_8: OS-6 (National check), V_9: RO-11-1-2 and V_{10}: HFO-806) and three nitrogen levels (60, 90 and 120 N Kg ha^{-1}) was laid out in factorial randomized block design with three replications. The crop was sown during the first week of december with a spacing of 30 cm between the rows. The recommended dose of phosphorus (60 kg ha^{-1}) and potassium (40 kg ha^{-1}) was applied at the time of sowing. The nitrogen was applied in the form of urea as per the treatment *i.e.,* 50 per cent as basal and remaining 50 per cent at 30 days after sowing. Other cultural practices were followed as per the recommendation for establishment of crop. The crop was harvested at 50 per cent flowering stage and immediately after the harvest, the green fodder yield was recorded treatment wise. The known quantity of fresh sample was taken and kept in thermo statically controlled oven at 70 ± 2°C temperature and dried till it attained constant weight for the estimation of dry matter content and yield as well as other quality parameters. The nitrogen use efficiency (NUE) was worked out using following formula and expressed in kg green fodder per kg of nitrogen applied. The total digestible crude protein yield (TDCPY) was calculated using following equation adopted by Iqbal *et al.* (2013). The economics was worked out with prevailing market price and input cost and the statistical analysis of data was carried out for interpretation of the results and draw conclusion.

$$\text{Nitrogen use efficiency (kg green forage yield / kg N)} = \frac{\text{Green forage yield (kg)}}{\text{Amount of Nitrogen applied (kg)}}$$

$$\text{Dry matter yield (q/ha)} = \frac{\text{Dry matter \% x Green forage yield (q/ha)}}{100}$$

$$\text{Crude protein yield (q/ha)} = \frac{\text{Crude protein \%} \times \text{Dry matter yield (q/ha)}}{100}$$

$$\text{Crude fibre content (\%)} = \frac{\text{(Weight of sample before ashing) - (Weight of sample after ashing)}}{\text{Weight of the dried plant sample taken}} \times 100$$

$$\text{Crude fibre yield (q/ha)} = \frac{\text{Crude fibre content (\%)} \times \text{Dry matter yield (q/ha)}}{100}$$

$$\text{Total digestible crude protein yield (q/ha)} = [0.97 \times \text{Crude protein yield (q/ha)}] - 0.67$$

Results and Discussion

Green Forage Yield (q/ha)

The green forage yield of fodder oat genotypes was significantly influenced by nitrogen levels (Table 1). Among genotypes significantly higher green forage yield was observed with SKO-241 (254.4 q ha^{-1}), which was on par with HFO-806 (231.9 q ha^{-1}), OS-403 (233.8 q ha^{-1}), JO-06-23 (233.9 q ha^{-1}) and RO-11-1-2 (234.2 q ha^{-1}). The lower green forage yield was observed with genotype OL-1874 (196.7 q ha^{-1}). Application of nitrogen 120 kg ha^{-1} recorded significantly higher green forage yield (246.6 q ha^{-1}) followed by 90 N kg ha^{-1} (232.9 q ha^{-1}). The interaction between genotypes and nitrogen levels was found to be non-significant. The increase in green forage yield with incremental increase in nitrogen is due to the effect that nitrogen plays a pivotal role in cell division, elongation and differentiation, leading to better root proliferation and luxuriant growth which is evidenced by higher plant height and leaf stem ratio which resulted in higher green forage yield. The similar results were reported by Rana *et al.*(2009), Joshi *et al.* (2015), Godara *et al.* (2016), Dabhi *et al.* (2017), Jat & Kaushik (2018), Shekara *et al.* (2019b), Shekara *et al.* (2021) and Naveena *et al.* (2021).

Dry Matter Yield

The dry matter yield of oat genotypes was significantly influenced by nitrogen levels recorded at harvest (Table 1), Among genotypes, SKO-241 recorded significantly higher dry matter yield (53.9 q ha^{-1}) over other genotypes. Application of Nitrogen 120 kg ha^{-1} recorded higher dry matter yield (49.2 q ha^{-1}) followed by 90 N kg ha^{-1} (39.8 q ha^{-1}). The interaction between genotypes and nitrogen levels was found significant. Since, nitrogen is an integral component of chlorophyll, it plays a primary role in photosynthesis and helped in accumulation, production and partitioning of photosynthates which resulted in higher dry matter content and green forage yield that led to increased dry matter yield. This is in conformity with the findings of Midha *et al.* (2015) and Shekara *et al.* (2020).

Table 1
Growth and yield of fodder oat genotypesas influenced by nitrogen levels recorded at harvest

Genotypes	Plant height (cm)	Leaf Stem ratio	Green Forage yield (q/ha)	Dry matter yield (q/ha)
OL-1874-1	92.4	0.57	196.7	33.9
Kent	81.1	0.56	223.7	44.5
OL-1876-1	96.8	0.59	209.3	43.3
RO-11-1-3	90.9	0.59	226.2	38.7
JO-06-23	97.8	0.48	233.9	37.5
SKO-241	96.2	0.72	254.4	53.9
OS-403	100.6	0.72	233.8	45.1
OS-6	100.0	0.72	207.0	40.7
RO-11-1-2	87.0	0.72	234.2	39.7
HFO-806	99.6	0.49	231.9	40.3
S.Em±	3.00	0.02	8.14	1.69
C.D at 5%	8.97	0.05	24.37	5.06
Nitrogen Levels (Kg/ha)				
60	88.6	0.55	195.9	36.3
90	93.0	0.62	232.9	39.8
120	101.10	0.68	246.6	49.2
S. Em±	1.71	0.01	3.30	0.73
C.D at 5%	4.92	0.03	9.47	2.10
Interaction	NS	NS	NS	*
S. Em±	5.19	0.03	14.09	2.92
C.D at 5%	NS	NS	NS	6.77

Fodder Quality

The genotypes differed significantly with crude protein content, crude protein yield, total digestible crude protein yield and crude fibre yield (Table 2 & 3). Among Oat genotypes SKO-241 recorded significantly higher dry matter content (21.2 %), crude protein (5.70 q ha^{-1}), total digestible crude protein (4.86 q ha^{-1}) and crude fibre yield (14.37 q ha^{-1}) over rest of the genotypes. Application of nitrogen at 120 kg ha^{-1} recorded significantly higher crude protein (4.98 q ha^{-1}), total digestible crude protein (4.17 q ha^{-1}) and

Table 2
Quality parameters of fodder oats genotypes as influenced by nitrogen levels at harvest

Genotypes	Crude Protein (%)	Crude fibre (%)	Dry Matter (%)
OL-1874-1	11.1	26.79	17.2
Kent	9.9	26.27	20.0
OL-1876-1	9.2	27.30	20.8
RO-11-1-3	9.0	27.24	17.1
JO-06-23	10.5	27.07	15.9
SKO-241	10.8	26.82	21.2
OS-403	9.5	25.99	19.2
OS-6	10.2	26.44	19.5
RO-11-1-2	10.8	26.38	17.0
HFO-806	9.8	26.07	17.2
S. Em±	0.28	0.43	0.39
C.D at 5%	0.84	NS	1.18
Nitrogen Levels (Kg/ha)			
60	9.1	27.86	16.5
90	10.9	26.64	18.7
120	10.2	25.41	20.3
S. Em±	0.12	0.15	0.22
C.D at 5%	0.34	0.42	0.63
Interaction			
S. Em±	0.49	0.75	0.68
C.D at 5%	1.09	NS	2.0

TABLE 3
Nutritive value and nitrogen use efficiency of fodder oats genotypes as influenced by nitrogen levels at harvest

Genotypes	Crude Protein Yield (q/ha)	Crude fibre Yield (q/ha)	Total Digestible crude protein yield (q/ha)	Nitrogen use efficiency (Kg Green fodder per Kg Nitrogen)
OL-1874-1	3.76	9.04	2.97	230.2
Kent	4.40	11.67	3.60	263.3
OL-1876-1	3.90	11.79	3.11	245.3
RO-11-1-3	3.52	10.58	2.75	265.6
JO-06-23	3.96	10.03	3.17	273.6
SKO-241	5.70	14.37	4.86	294.1
OS-403	4.31	11.67	3.51	274.4
OS-6	4.22	10.70	3.42	243.3
RO-11-1-2	4.30	10.47	3.50	275.4
HFO-806	4.01	10.42	3.22	270.5
S. Em±	0.23	0.45	0.23	-
C.D at 5%	0.70	1.36	0.68	-
Nitrogen Levels (Kg/ha)				
60	3.32	10.10	2.55	326.5
90	4.32	10.61	3.52	258.7
120	4.98	12.50	4.17	205.5
S. Em±	0.10	0.20	0.10	-
C.D at 5%	0.30	0.57	0.29	-
Interaction				
S. Em±	0.40	0.79	0.40	-
C.D at 5%	0.96	1.84	0.94	-

crude fibre (12.50 q ha^{-1}) over rest of the nitrogen levels. The interaction between genotypes and nitrogen levels with respect to crude protein, crude fibre and total digestible crude protein yield were found to be significant and rest of quality parameters were found non-significant. The higher crude protein yield was attributed due to the higher crude protein content and dry matter yield with higher level of nitrogen. The total digestible crude protein yield with higher level of nitrogen is mainly due to higher crude protein yield. The results are similar with the findings of Bhat *et al.* (2012), Joshi *et al.* (2015), Godara (2016), Chouhan *et al.* (2015), Sheoran *et al.* (2017), Dabhi *et al.* (2017), Shekara *et al.* (2015) and Manoj *et al.* (2021).

Nitrogen Use Efficiency

Nitrogen use efficiency of genotypes was influenced by nitrogen levels (Table 3). Among genotypes, SKO-241 recorded higher nitrogen use efficiency (294.1 kg green fodder per kg of nitrogen). Application of nitrogen 60 kg ha^{-1} recorded the higher nitrogen use efficiency (326.5 kg green fodder per kg of nitrogen), whereas, higher level of nitrogen (120 kg ha^{-1}) recorded lower nitrogen use efficiency (205.5 kg green fodder per kg of nitrogen). The nitrogen use efficiency was higher at lower level of nitrogen and decreased with incremental nitrogen levels. This might

TABLE 4
Economics of fodder oat genotypes as influenced by nitrogen levels recorded at harvest

Genotypes	Total Cost of Cultiva-tion (Rs./ha)	Gross Returns (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
OL-1874-1	24685	34423	9738	1.39
Kent	25296	39148	13852	1.55
OL-1876-1	25875	36628	10753	1.42
RO-11-1-3	25697	39585	13888	1.54
JO-06-23	25676	40933	15267	1.59
SKO-241	26080	44520	18440	1.71
OS-403	25720	40915	15195	1.59
OS-6	25609	36225	10616	1.41
RO-11-1-2	25125	40985	15860	1.63
HFO-806	26176	40583	14407	1.55
S. Em±	857	1182	1609	0.08
C.D at 5%	NS	3353	4566	NS
Nitrogen Levels (Kg/ha)				
60	24089	34283	10194	1.42
90	24559	40758	16199	1.66
120	25028	43155	18127	1.72
S. Em±	469	647	881	0.04
C.D at 5%	NS	1837	2500	0.12
Interaction				
S. Em±	1484	2046	2786	0.13
C.D at 5%	NS	NS	NS	NS

be due to higher nitrogen levels which might have led to lower utilization of applied nitrogen within short period of growth and also subjected to various forms of nitrogen losses *viz.,* leaching, runoff, seepage and volatilization. This is in harmony with the findings of Gunri *et al.* (2004), Shekara *et al.* (2008), Devi *et al.* (2014) and Joshi *et al.* (2015).

Economic Analysis

Total cost of production among genotypes and nitrogen levels found not significant. The genotype SKO-241 recorded significantly higher gross returns (Rs.44,520 ha^{-1}), net monetary returns (Rs.18,440 ha^{-1}) and benefit-cost ratio (1.71) (Table 4) over rest of the genotypes. Application of nitrogen 120 kg ha^{-1} recorded significantly higher gross returns (Rs.43,115 ha^{-1}) and benefit-cost ratio (1.72). The same nitrogen level registered significantly higher net monetary returns (Rs.18,127 ha^{-1}), which was on par with nitrogen at 60 kg ha^{-1} (Rs.16,199 ha^{-1}). The interaction between genotypes and nitrogen levels found non-significant. This might be due to better growth attributers which resulted in higher green forage yield with a marginal increased cost of nitrogen at higher nitrogen levels. These results are in conformity with the findings of Sharma & Bhunia (2001) and Bama *et al.* (2013).

Based on the results it can be inferred that oat genotype SKO-241 with nitrogen level of 120 kg ha^{-1} found suitable and economical, which recorded higher green forage, dry matter, crude protein, total digestible crude protein, crude fibre yield and net monetary returns in southern dry zone of Karnataka under protective irrigated situation.

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