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Influence of Dates of Sowing and Nitrogen on Yield, Quality Parameters, Nutrient Uptake and Economics of Fodder Oats in Southern Transition Zone of Karnataka

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Abstract

A field experiment was conducted at College of Agriculture, Hassan during *kharif* 2018 on the influence of dates of sowing and nitrogen applications on yield, quality parameters, uptake of nutrients and economics of fodder oats in southern transition zone of Karnataka. The experiment was conducted in red sandy loam soil and the experiment was laid out in factorial RCBD with 10 treatment combinations, which consisted of five different dates of sowing and two nitrogen levels with three replications. It was revealed that early sown crop on first fortnight of June recorded significantly higher plant height (133.42), number of tillers (93.80) per 0.5 m^{-1} row length, leaf to stem ration (0.76), leaf area (3.76 cm^2 0.5 m^{-1} row length), SPAD readings (29.83), dry matter accumulation (97.73 0.5 m^{-1} row length), green fodder yield (28.88 t ha^{-1}) and dry fodder yield (5.79 t ha^{-1}) production as compared to other dates of sowing. However significantly higher value of quality parameters and B:C ratio *viz*., crude protein (6.39 %), total carbohydrates (8.65%), total ash content (9.47%) and B:C ratio (2.32) were recorded in same treatment compared to other treatments. Among the different dates of sowing, first fort night of June showed significantly higher uptake of nutrients *viz*., N (121.50 kg ha^{-1}), K_2O_5 (21.39 kg ha^{-1}) and K_2O (105.48) than other treatments. Among the different nitrogen levels, application of 125 kg N ha^{-1} recorded significantly higher growth parameters *viz*., leaf to stem ratio (0.57), leaf area (3151 cm^2 0.5 m^{-1} row length), SPAD readings (25.46) and green fodder yield (23.57 t ha^{-1}). However significantly higher gross returns (47156 ha^{-1}) and net returns (22279 ha^{-1}) was recorded with 125 kg N ha^{-1} application as compared to 100 kg N ha^{-1}.

Keywords: Fodder oats, Dates of sowing, Different nitrogen levels

In India, the livestock is an integral component of agriculture economy which contributes about 4.11 per cent to total GDP and possess 15 per cent of world's livestock population of 512.05 million constituting 37.3 per cent cattle, 21.2 per cent buffaloes, 12.7 per cent sheep and 26.4 per cent goats. The success of animal husbandry and dairy farming largely depends on regular supply of good quality fodder in sufficient quantities. Among the different *rabi* fodder crops, oats (*Avena sativa* L.) is one of the most important *rabi* fodder crop. Oats requires the cool and moist weather for germination, tillering, booting and heading stage. It was produced in 102.12 M.ha area to the total cropped area (Kour *et al*., 2012). The total area under cultivated fodders is 8.6 M.ha on individual crop basis. The crop occupies maximum area in Uttar Pradesh (34 %), followed by Punjab (20 %), Bihar (16 %), Haryana (9 %) and Madhya Pradesh (6 %). Oats rank fifth in terms of world cereal production. It is extensively grown as forage crop and gaining importance in many regions of the world. It is the most important winter cereal fodder, which is highly palatable, rich source of energy, protein, vitamin B_1, phosphorus, iron and other minerals. The Nitrogen fertilizer is a key element in fertility management of oats. Several quality parameters of oats particularly in the late milky to early dough stage have been addressed the literature but the effect of N fertilizer rate on forage yield, quality of oats cultivars, have received little attention. It is generally agreed that oats should be harvested prior to maturity for fodder purpose because forage yield does not increase much after the milky stage and forage quality declines after heading. In Southern Transition Zone of Karnataka, optimum condition for growing of oats is prevailing during *kharif* season as compared to *rabi* season.

Hence, the study was undertaken to know the influence of dates of sowing and nitrogen applications on yield, quality parameters, uptake of nutrients and economics of fodder oats in southern transition zone of Karnataka.

Material and Methods

Fodder oats was sown on five dates of sowing *viz.,* first fortnight of June (D_1), Second fortnight of June (D_2), First fortnight of July (D_3), Second fortnight of July (D_4) and First fortnight of August (D_5) at College of Agriculture, Hassan, University of Agricultural Sciences, Bangalore. The experimental site is geographically located in the Southern Transitional Zone (Zone-7) of Karnataka and situated between 12° 13' to 13° 33' N latitude and 75° 33' to 76° 38' E longitude at an altitude of 827 m above mean sea level. The total rainfall of 327.69 mm was recorded during the cropping season (June 2018 - August 2018). The crop was sown on different dates of sowing during *kharif* 2018 in plots consisting of 12 rows with 25 cm spacing between the rows. The experiment was conducted in randomized block design (RBD) in factorial arrangements with ten treatments and three replications. At all the date of sowing, two nitrogen treatments [100 kg N h^{-1} (N_1) and 125 kg N ha^{-1} (N_2)] were given. Nitrogen was supplied through urea in split doses as per the treatments. At the time of sowing 50 per cent of N was applied as basal and the remaining half was applied after 20 DAS. Whole plant samples were collected at three different growth stages *i.e.,* 15, 30 and at harvest to determine growth and quality components. Yield was determined at harvest stage of the crop. Fresh plant leaf samples were collected after every harvest, sun dried and completely dried in hot air oven until a constant weight was obtained. This plant material was ground using willy grinder to a uniform mesh size. The standard methods were used for crude protein and carbohydrates estimation.

Plant samples from each treatments were collected at harvest and oven dried, powdered and used for analysis of quality parameters such as crude fiber (%) and ash content (%). Nutrient uptake of nitrogen, phosphorous and potassium were analysed. Gross returns (ha^{-1}), net returns (ha^{-1}) and benefit cost ratio were worked out by using the following formula:

Gross returns = green fodder yield x market price

Net returns = gross returns - total cost of cultivation

$$\text{B : C Ratio} = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

All the data pertaining to the present investigation were statistically analyzed as per the method described by Panse and Sukhatme (1967). The level of significance used in 'F' and 't' was p = 0.05.

Results and Discussion

Influence of dates of sowing and Nitrogen level on growth, yield, quality parameters, uptake of nutrients and economics of fodder oats are presented in Table 1, 2 and 3. The results showed that, sowing during first fortnight of June recorded significantly taller plant height (133.42 cm), number of tillers (93.80) at 0.5 m^{-1} row length, green fodder yield (28.88 t ha^{-1}), dry fodder yield (5.79 t ha^{-1}), ash content (9.47 %), N uptake (121.50 kg ha^{-1}), P_2O_5 uptake (21.39 kg ha^{-1}), K_2O uptake (105.48 kg ha^{-1}), gross returns (Rs.57770 ha^{-1}), net returns (Rs.31223 ha^{-1}) and B:C ratio (2.32) as compared to other dates of sowing. Among the different levels of Nitrogen, application of 125 kg N ha^{-1} recorded significantly higher plant height (111.23 cm) of tillers (81.87) 0.5 ha^{-1} row length green fodder yield (23.57 %), total nitrogen, phosphorous and potassium uptake (96.80 kg ha^{-1}, 16.86 kg ha^{-1} and 82.11 kg ha^{-1}, respectively), gross returns (Rs.47156 ha^{-1}), net returns (Rs.22279 ha^{-1}) and benefit cost ratio (1.95) as compared 100 kg N ha^{-1} Table 1, 2 and 3.

Among different dates of sowing, significantly, taller plant height and higher number of tillers were noticed with fodder oats sown during first fortnight of June, might be attributed to better growth response of fodder oats because of favourable climatic conditions that prevailed during the crop growth period. The fodder oats sown after first fortnight of June experienced higher temperature and low rainfall condition during different stages of the crop growth, which adversely

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TABLE 1

Effect of dates of sowing and nitrogen levels on growth parameters of fodder oats

Treatments	Planth height (cm)	No. of tillers ($0.5m^{-1}$ row length)	Leaf to stem ratio	Leaf area	SPAD readings
Dates of sowing (D)					
D_1: First fortnight of June	133.42	93.80	0.76	3766	29.83
D_2: Second fortnight of June	117.38	85.28	0.62	3319	27.17
D_3: First fortnight of July	101.30	80.31	0.53	3259	23.31
D_4: Second fortnight of July	95.83	68.38	0.49	2529	21.05
D5: First fortnight of August	89.50	59.71	1.36	1931	17.41
S.Em±	3.52	1.68	0.01	147.7	1.56
CD (P=0.05)	10.55	5.03	0.04	442.5	4.68
Nitrogen levels (N)					
N_1: l00 kg $ha^{-1)}$	103.74	75.833	0.53	2771	22.5
N_2: 125 kg $ha^{-1)}$	111.23	81.87	0.57	3151	25.46
S.Em±	2.22	1.01	0.01	93.47	0.98
CD (P=0.05)	6.67	3.05	0.02	279.86	2.96
Interaction (D x N)					
D_1N_1	128.85	89.52	0.75	3420	27.65
D_1N_2	138.00	98.09	0.78	4111	32.01
D_2N_1	107.97	83.77	0.57	3127	26.82
D_2N_2	126.80	86.80	0.69	3512	27.54
D_3N_1	98.37	79.47	0.52	3094	20.38
D_3N_2	104.24	81.17	0.54	3424	26.25
D_4N_1	94.60	64.45	0.48	2397	18.82
D_4N_2	97.07	72.31	0.51	2661	23.29
D_5N_1	88.95	58.55	0.36	1815	16.60
D_5N_2	90.06	60.87	0.37	2047	18.23
S.Em±	4.98	2.38	0.02	209.01	2.21
CD (P=0.05)	NS	NS	NS	NS	NS

affected the performance of fodder oats. The results are in line with findings Jehangir *et al*. (2013), Kour *et al*. (2012) in wheat and Mumtaz *et al*. (2015) in wheat. Nitrogen application at 125 kg per ha increased growth parameters like plant height and number of tillers which was be due to increased level of nitrogen which caused corresponding increase in plant height at all growth stages of crop. The nitrogen is attributed for synthesis of food materials resulting in greater cell division and cell elongation. Therefore, elongation in plant increased with increasing nitrogen application. Interaction effect was found to be not-significant. These findings are in agreement with the results of Patel *et al*. (2010) and Midha *et al*. (2015). Nitrogen is required in the larger quantities and its availability and internal concentration affect the partitioning of biomass between roots and shoots. The amount and timing of N application can also alter plant morphology, nutrient availability, and net photosynthesis. N supplementation is required to maximize seedling biomass during initial nursery stages of growth, even for some legume species. However, high N availability

TABLE 2

Effect of dates of sowing and nitrogen levels on growth, yield and quality parameters of fodder oats

Treatments	Dry matter accumulation	Green fodder yield (t ha^{-1})	Dry fodder yield ; (t ha^{-1})	Crude protein (%)	Total carbo-hydrates (%)	Total ash (%)
Dates of sowing (D)						
D_1: First fortnight of June	97.73	28.88	5.79	6.39	8.65	9.47
D_2: Second fortnight of June	87.11	26.19	5.39	5.78	10.09	8.81
D_3: First fortnight of July	80.81	22.66	4.64	5.07	11.85	7.64
D_4: Second fortnight of July	70.38	18.97	4.14	4.19	13.21	6.37
D_5: First fortnight of August	60.37	16.52	3.52	3.65	15.12	5.56
S.Em±	2.12	0.64	0.12	0.11	0.28	0.19
CD (P=0.05)	6.36	1.95	0.31	0.34	0.84	0.59
Nitrogen levels (N)						
N_1: l00 kg ha$^{-1)}$	76.25	21.72	4.53	4.83	12.32	7.09
N_2: 125 kg ha$^{-1)}$	81.78	23.57	4.86	5.20	11.24	8.05
S.Em±	1.25	0.44	0.06	0.07	0.17	0.12
CD (P=0.05)	3.76	1.22	0.20	0.21	0.54	0.37
Interaction (D x N)						
D_1N_1	97.70	27.60	5.64	6.11	15.69	9.93
D_1N_2	100.76	30.17	5.95	6.67	14.55	9.02
D_2N_1	88.43	25.94	5.25	5.74	13.75	9.15
D_2N_2	85.80	26.45	5.54	5.84	12.67	8.47
D_3N_1	80.47	20.15	4.40	4.59	13.09	8.71
D_3N_2	81.17	25.18	4.89	5.56	10.62	6.58
D_4N_1	62.78	18.83	4.07	4.17	10.27	6.61
D_4N_2	77.98	19.11	4.22	4.22	9.92	6.15
D_5N_1	60.22	16.08	3.29	3.56	8.83	5.87
D_5N_2	60.53	16.98	3.75	3.75	8.47	5.25
S.Em±	3.01	0.91	0.15	0.16	0.40	0.28
CD (P=0.05)	NS	NS	NS	NS	NS	NS

and its concomitant affect root and shoot biomass production. The growth-promoting effect of N (up to the optimum level) increases Cytokinin production, which subsequently affects cell wall elasticity, number of meristematic cells and cell growth. In addition, N fertilization also increases seedling height and root collar. The present study demonstrated that N supplementation can increase growth parameters to a certain extent but has a negative effect at higher levels. Researchers have reported both positive and negative effects of fertilizer application on subsequent seedling growth and survival (Razak *et al*., 2017). Their beneficial effect on the growth characters *viz.,* plant height, number of leaf, leaf length and width which might be due to improved photosynthetic source of plants that cumulatively contributed to higher fodder yield (Kumar *et al.*, 2016).

Fodder oats sown on first fortnight of June recorded significantly higher green fodder yield (28.88 t ha^{-1}) and dry fodder yield (5.79 t ha^{-1}). The increase in green fodder yield in first fortnight of June was due to better

TABLE 3

Effect of dates of sowing and nitrogen levels on uptake of nutrients and economics of fodder oats

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	Gross returns (ha^{-1})	Net Returns (ha^{-1})	B : C ratio
Dates of sowing (D)						
D_1: First fortnight of June	121.50	21.39	105.48	57770	31,223	2.32
D_2: Second fortnight of June	109.50	19.64	94.33	52390	27,510	2.10
D_3: First fortnight of July	92.00	16.18	74.50	45715	20,450	1.94
D_4: Second fortnight of July	81.00	12.98	65.35	37940	13,060	1.52
D_5: First fortnight of August	63.50	11.33	57.88	33560	9,513	1.33
S.Em±	2.14	0.37	1.86	-	-	-
CD (P=0.05)	6.43	1.11	5.57	-	-	-
Nitrogen levels (N)						
N_1: l00 kg ha$^{-1)}$	90.20	15.74	76.90	43794	18,423	1.74
N_2 : 125 kg ha$^{-1)}$	96.80	16.86	82.11	47156	22,279	1.95
S.Em±	1.35	0.23	1.17	-	-	-
CD (P=0.05)	4.06	0.70	3.52	-	-	-
Interaction (D x N)						
D_1N_1	120.00	20.72	97.40	55200	29916	2.15
D_1N_2	123.00	22.06	113.57	60340	32530	2.50
D_2N_1	104.00	19.30	93.34	51880	26263	2.03
D_2N_2	115.00	19.99	95.33	52900	28757	2.19
D_3N_1	85.00	14.60	72.56	41071	14683	1.80
D_3N_2	99.00	17.76	76.44	50360	26217	2.09
D_4N_1	80.00	12.90	64.93	37660	12043	1.47
D_4N_2	82.00	13.07	65.78	38220	14077	1.58
D_5N_1	62.00	11.22	56.31	33160	9209	1.26
D_5N_2	65.00	11.44	59.45	33960	9816	1.41
S.Em±	3.04	0.53	2.63	-	-	-
CD (P=0.05)	NS	NS	NS	-	-	-

growth attributing parameters *viz.,* plant height, number of tillers, leaf area, leaf to stem ratio and dry matter accumulation. The better growth attributing parameters registered when the fodder oats was sown during first fortnight of June due to favorable environment conditions such as rainfall distribution, temperature and relative humidity prevailed during crop growth period. The similar findings was also noticed by Lokesh *et al*. (2013) and Kalhapure and Shete (2013). Application of nitrogen at 125 kg ha^{-1} significantly increased green fodder biomass production (23.57 t ha^{-1}) and dry fodder yield (4.86 t ha^{-1}) as compared to 100 kg N ha^{-1}. This may be due to improved growth and yield parameters.

The growth, yield, quality and availability of N, P and K differed significantly at different stages of growth Table No. 1, 2 and 3. Significantly higher leaf to stem ratio (0.76), dry matter accumulation (97.73 g), leaf area (3766 g), SPAD readings (29.83), green fodder yield (28.88 t ha^{-1}), dry fodder yield (5.79 t ha^{-1}), crude protein (6.39 %), total ash content (9.47 %) and total

carbohydrates (8.65 %) were recorded in first fortnight of June followed by second fortnight of June compared to other dates of sowing and interaction effect which were not-significant. Better growth in early sown crop may be due to availability of favourable environments for rapid metabolic activities and better biomass production as compared to late sown crop. The results are in conformity with Kumar (2012). Among the levels of nitrogen application, significantly higher leaf to stem ratio (0.57), dry matter accumulation (81.78 g), leaf area (3151 cm^2), SPAD readings (25.46), green fodder yield (23.57 t ha^{-1}), dry fodder yield (4.86 t ha^{-1}), crude protein (5.20 %) and total carbohydrates (11.24 %) were recorded with 125 kg N ha^{-1} compared to 100 kg N ha^{-1} and interaction effects which were not-significant. Nitrogen is one of the important constituents of the chlorophyll pigment and N fertilization not only increases the chlorophyll content but also increases the leaf area in plants which are responsible for maximizing radiation load and the rate of photosynthesis leading to increasing biomass accumulation (Wortman *et al.*, 2011 and Diacono *et al.*, 2013).

Among the treatments, significantly higher leaf to stem ratio, leaf area, dry matter accumulation and SPAD readings were noticed with fodder oats sown during first fortnight of June which might be attributed to better response of fodder oats because of favourable climatic conditions that prevailed during crop growth period. The fodder oats sown after first fortnight of June experienced higher temperature and low rainfall condition during different stages of the crop growth, which adversely affected the growth performance of fodder oats. The results are in line with findings Jehangir *et al*. (2013), Kour *et al*. (2012) and Mumtaz *et al*. (2015) in wheat. The Nitrogen application at 125 kg ha^{-1} increased growth parameters like leaf to stem ratio, leaf area, dry matter accumulation and SPAD readings which might be due to increased level of nitrogen caused corresponding increase in plant height at all growth stages of crop. Therefore, elongation in plants increases with increasing nitrogen application. Interaction effect was found to be not-significant. These results are in agreement with the findings of Patel *et al*. (2010) and Midha *et al*. (2015).

In different treatments there was increase in crude protein content, when the crop was sown at first fortnight of June was due to higher dry matter accumulation. The higher crude protein content was because of favourable climatic conditions prevailed during crop growth period which helped in better uptake of nutrients from the soil and lead to more nutrient accumulation resulting in higher crude protein content in the fodder oats. When nitrogen was applied at 125 kg per hectare, there was significant increase in crude protein. This might be due to nitrogen application, which resulted in availability of adequate nutrients resulting in more uptake and correspondingly increase in the quality of herbage. Apart from this, nitrogen plays a key role in plant metabolism as a constituent of amino acids (DNA and RNA). It is responsible for transfer of genetic transformation and helps in regulating cellular metabolism of amino acids and protein that form structural units and biological catalyst of phosphorylated compounds which are involved in transformation of energy. It is a major structural constituent of cell wall thus increasing fodder quality by improving the protein content. These findings are in close conformity with Harikesh *et al*. (2017) and Iqbal *et al*. (2013).

Total carbohydrates content decreased significantly with increased nitrogen levels. It has been documented that application of nitrogen causes increased meristematic activity and in this condition more mineral salts are absorbed and the respiration process becomes rapid which leads to the conversion of most of the carbohydrates into fats. These results are in conformity with findings of Aravind Neelar (2011) and Smitha Patel (2014).

Significantly higher uptake of nutrients was observed during first fortnight of June as compared to other dates of sowing. This might be due to better nutrient uptake during early dates of sowing which resulted in better growth and growth attributing parameters which is superiorly influenced by favorable environmental conditions that prevailed during crop growth period. Among various climatic factors, well distribution of rainfall helps in better uptake of nitrogen, phosphorous

and potassium due to better availability of moisture content in the soil, which increased the available concentration of nitrogen, phosphorous and potassium in the soil, which in turn helped better uptake of these nutrients by the crop plants. These results are in agreement with the findings of Murthy *et al*. (2012), Kour *et al*. (2012) and Lokesh *et al*. (2013). The increase in nitrogen application significantly influenced N, P and K uptake. Application of 125 kg N ha^{-1} resulted in significantly highest uptake of N (96.80 kg ha^{-1}), P (16.86 kg ha^{-1}) and K (82.11 kg ha^{-1}) over 100 kg N ha^{-1}. Highest N, P and K uptake may be attributed to the beneficial effect of nitrogen sufficiency in the soil solution and higher dry matter yields leading to improved uptake to a sufficiency level. Interaction effect was found to be non-significant. These findings corroborated the results of Joshi *et al*., 2015; Jat *et al.* (2015) and Verma *et al*. (2016).

Gross returns (Rs.57770 ha^{-1}), net returns (Rs.31223 ha^{-1}) and B:C ratio (2.32) was found to be higher when the fodder oats sown during the first fortnight of June followed by second fortnight of June sowing (Rs.52390 ha^{-1}, Rs.27510 ha^{-1} and 2.10, respectively). The higher gross returns, net returns and B:C ratio was due to higher green fodder yield obtained during the first fortnight of June which was due to better growth of crop and favorable climatic conditions. However, the lower gross returns (Rs.33560 ha^{-1}), net returns (Rs.9513 ha^{-1}) and B:C ratio (1.33) was noticed with the fodder oats sown during first fortnight of August which was due to lower green fodder yield attributed to poor crop growth and development. These results are in conformity with the findings of Devi *et al*. (2014), Smitha Patel (2014) and Tomar *et al*. (2014) in fodder sorghum.

Higher gross returns (Rs.47156 ha^{-1}), net income (Rs.22279 ha^{-1}) and benefit cost ratio (1.95) was obtained with the application of 125 kg N ha^{-1} compared to application of 100 kg N ha^{-1} (Table 3). This might be due to higher green fodder yield obtained with the 125 kg N ha^{-1} due to better growth of crop supported by favourable climatic conditions. Lower gross returns (Rs.43794 ha^{-1}), net returns (Rs.18423 ha^{-1}) and B: C ratio (1.74) was obtained with the application of N 100 kg ha^{-1} due to lower green fodder yield attributed to poor crop growth and development. This is in conformity with findings of Devi *et al*. (2014) and Joshi *et al*. (2015) in oats.

Pertaining to uptake of nutrients, the available nitrogen, phosphorous and potassium was found to be significantly superior in the soil after the harvest of the crop sown during first fortnight of June as compared to other dates of sowing. This might be attributed to increased available nutrient status in the soils after harvest of crop sown during first fortnight of June. This is due to better rainfall received during the early season of crop which resulted in increased moisture content in soil. Which in turn increased the solubility of nutrients in the soil and it was available in soil for a longer period of time. The higher available nitrogen status of soil after harvest of the crop was observed with increased nitrogen levels, which was mainly due to build-up of nutrients in soil because of addition of nitrogenous fertilizer into the soil. These results are in agreement with Jat *et al*. (2015) in oats.

In southern transition zone of Karnataka, sowing during the first fortnight of June is the optimum time for growing of fodder oats with the Nitrogen application of 125 Kg ha^{-1} as it recorded higher fodder yield, net returns and B:C ratio.

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