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YIELD, QUALITY AND PROFITABILITY OF FODDER OAT VARIETIES IN RESPONSE TO DIFFERENT DATES OF SOWING

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SUMMARY

Genotypes, environmental conditions and their interaction plays an important role for time needed to attain anthesis and thereby affect forage yield potential. Therefore, a field study was carried out in the *Rabi* season of 2021-22 at Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar. The experiment was conducted using a split plot design with three varieties (Kent, JHO-822 and Local) in main-plots and four different sowing dates (15th November, 25th November, 5th December and 15th December) in sub-plots with three replications. The results obtained from the experiment showed that JHO-822 recorded 9.4 and 29.6% higher green and dry fodder yield than local variety. The highest N, P and K uptake, crude protein yield and economic parameters like net return and B: C ratio was noted with JHO-822. Among, the different sowing dates, 15th November recorded the highest green and dry fodder yield and N and K uptake. With advancement of sowing dates, crude protein content and ash content increased but for crude protein yield and ash yield it was just the reverse. Fodder oat sown on 15th November recorded the maximum net return and B: C ratio.

Key words: Fodder oat, date of sowing, productivity, economics, quality

Mixed farming and livestock keeping are an essential part of rural life in India, agricultural and animal husbandry are intertwined with the complex social structure in economic, cultural, and religious dimensions. The availability and delivery of sufficient quantities of high-quality green fodder to suit the nutritional needs of cattle are crucial to the industry's success, production and maintenance. Oat (*Avena sativa* L.) is a winter annual cereal crop in northern India (Paul *et al.*, 2022) which can be utilized as green fodder, hay or silage. To feed the current livestock population, quantity of fodder needed annually is 1594 million tonnes (1025 million tonnes green fodder and 569 million tonnes dry fodder) (Datta, 2013). Hence, giving efforts to enhance the productivity of forage crops will intensify the availability of green fodder consequently reducing the cost of feeding and increasing the profit. High yielding fodder crop varieties are necessary to meet the nutritional needs of the animals. However, oat genotypes interact differentially with the current environmental conditions and show significant variation in the time needed to attain anthesis and maturity and forage yield potential (Colville and Frey, 1987). Time of sowing, which is regulated by temperature and moisture, is a major yield contributing element for oat production. Fodder oat in Bihar is typically sown in the month of November but delayed cessation of monsoon and heavy rainfall at *Hathia nakshatra* (fag end of monsoon on many occasions) delays sowing operation. As genotypes and environmental conditions have an impact on the fodder yield (Malik *et al.*, 2011; Zute *et al.*, 2010). Hence, the impact of early and delayed sowing on yield and quality of fodder oat need to be investigated in order to optimize the best sowing time for higher production.

MATERIALS AND METHODS

The field experiment was taken place at the Forage Research Block (Plot no. 12) of Cattle Farm, APRI, Dr. Rajendra Prasad Central Agricultural University, Pusa (latitude of 25° 98′ N, longitude of 85° 68′ E and at a height of 63.9 metre above MSL), Samastipur, Bihar, India during *Rabi* 2021-22. The soil of the experimental plot had 7.96 pH, 0.25 dS m^{-1} EC, 0.49% organic carbon, low nitrogen (202.3 kg/ha) and potassium (104.0 kg/ha) availability and medium phosphorous (18.4 kg/ha) availability. The experiment was conducted using a split-plot design with three replications where Oat cultivars such as JHO-822, Kent, and Local were taken in the main plot and date of sowing (15th November, 25th November, 5th December and 15th December) was taken in sub-plot. Seeds of above cultivars were manually sown in lines in 4 different sowing dates (15th November, 25th November, 5th December and 15th December) at a distance of 25 cm using a seed rate of 100 kg/ha. The experimental crop received the recommended fertilizer dose for single-cut oats, which was 90:60:40 kg N, P_2O_5, K_2O/ha. Half of the nitrogen, the whole amount of phosphorous and the full amount of potassium were applied as a basal. At 21 DAS, the remaining amount of the nitrogen was applied. Urea, DAP and MOP were used as nitrogen, phosphorous and potassium fertilizers, respectively. Irrigation was done using the flood method, depending on the crop's needs and the weather. The first irrigation was applied at 21 DAS and at other stages as per need during the growing season. One hand weeding was done at 25 DAS to maintain the experimental crop free from weeds. When the crop reached the 50 per cent flowering stage, the crop stand in the net plot was manually picked with a sickle from the ground level and the green fodder yield was recorded. About one kilogram of fresh sample was collected from the harvested green fodder and preserved in marked brown paper to determine the dry fodder yield after removing moisture by placing it in a hot air oven at 70 °C. Leaf: stem (L: S) ratio at the time of harvest was obtained by dividing the leaf dry weight by the stem dry weight. Crude protein (CP) content (%) was obtained by multiplying the total nitrogen content estimated by the micro-Kjeldahl method with a factor of 6.25 (AOAC, 1995). Crude protein yield was estimated by multiplying CP content with dry fodder yield. Ash content of the oven dried ground plant samples were determined by placing these in silica crucibles and keeping in a muffle furnace at high temperature (550 ºC) for 5 hours. Ash yield was calculated by multiplying ash content with dry matter yield. Total N, P and K contents of the plant samples were estimated through modified Kjeldahl method (AOAC, 1995), Vanadium molybdate phosphoric acid yellow colour technique (Koenig and Johnson, 1942) and through flame photometty (Jackson 1973), respectively. All processes and inputs were taken into account for calculating cost of cultivation. Gross returns (Rs. ha^{-1}) was obtained from the crop based on the prevailing market price of green fodder (Rs. 2000/t). Net returns was worked out by subtracting the cost of cultivation from the gross return. Benefit: cost ratio (B:C ratio) is a profitability indicator computed by dividing the gross return by the total cost of cultivation. In order to determine whether there were any changes between the treatments, the experimental data was statistically analysed, as per split plot design (Gomez and Gomez, 1984). Least significant difference at $p<0.05$ was calculated to compare treatment means.

RESULTS AND DISCUSSION

Fodder yield

Green forage yield (GFY) and Dry matter yield (DMY) was substantially affected by varieties (Table 1). JHO-822 showed the highest GFY and DMY (38.3 t ha^{-1} and 9.2 t ha^{-1}, respectively) which were markedly higher than other two varieties. The per cent increase in GFY and DMY over local variety was 9.4 and 29.6, respectively. These results support the work of Godara *et al.* (2016), Dabhi *et al.* (2017) and Sarkar *et al.* (2022). Higher plant height and tiller number coupled with greater leaf number per tiller with JHO-822 led to higher GFY. Nawaz *et al.* (2004) also observed similar considerable variation for dry matter yield among oat varieties. GFY and DMY was substantially impacted by dates of sowing. First date of sowing *i.e.,* 15th November showed the highest GFY (41.4 t ha^{-1}) and DMY (10.0 t ha^{-1}) than other dates of sowing. Sowing on 15th November increased the green forage and dry matter yield by 28.6% and 61.3 %, respectively than that of 15th December. Higher GFY with 15th November seeded crop is ascribed to higher growth attributes such as plant height and tiller number per metre row and leaf number per tiller as a result of congenial macro- and micro-environment pre-dominating during the crop growing season. Both Kalhapure and Shete (2013) and Lokesh *et al.* (2013) also noted similar results. Favourable micro- and macro-climatic conditions promoted production of taller plants with more leaves and tiller which increased the production of photosynthates and, ultimately, helped to increase the accumulation of dry matter so the dry matter content was higher in 15th November seeded crop. Higher GFY coupled with higher dry matter content resulted in higher DFY with 15th November seeded crop. This is in conformity with studies of Shekara and Lohithaswa (2012) and Dar *et al.* (2014) in oats. Substantially lower DFY of fodder oats were found when sowing was delayed beyond 15th November. This could be because of reduced photosynthetic activity as a result of unfavourable weather conditions that prevailed during the various stages of crops and negatively impacted the growth

TABLE 1

Effect of different varieties and date of sowing on yield and quality of fodder oat

Treatments	Yield (t/ha)			Quality parameters		
	Green forage	Dry matter	CP (%)	CPY (t/ha)	Ash (%)	Ash yield (t/ha)
Varieties						
Kent	36.8	7.7	9.98	0. 76	9.09	0.69
JHO-822	38.3	9.2	9.58	0.87	8.89	0.81
Local	35.0	7.1	9.05	0.64	8.19	0.58
S. Em±	0.3	0.2	0.13	0.01	0.06	0.02
LSD (p<0.05)	1.2	0.6	0.53	0.05	0.23	0.06
Date of sowing						
15th November	41.4	10.0	8.96	0.89	8.00	0.80
25th November	37.8	8.5	9.23	0.78	8.40	0.71
5th December	35.4	7.4	9.63	0.71	9.08	0.67
15th December	32.2	6.2	10.33	0.64	9.41	0.59
S. Em±	0.5	0.2	0.14	0.02	0.19	0.02
LSD (p<0.05)	1.5	0.5	0.40	0.07	0.55	0.06
Interaction	NS	NS	NS	NS	NS	NS

performance of the fodder oats. Similar findings were noted by Alam *et al.* (2005).

Fodder quality

Varieties caused marked impact on quality parameters (CP content, crude protein yield (CPY), ash content and ash yield) (Table 1). Among varieties, Kent had the highest CP (9.98%) and ash content (9.09%) which was comparable to JHO-822. However, significantly higher CPY and ash yield were noted with JHO-822 compared to other varieties. The per cent increase in CPY and ash yield with JHO-822 over local variety was 35.9 and 39.7, respectively. Variation in crude protein content may be due to genetic variation of varieties. The finding of Dabhi *et al.* (2017) supports these results. Ash content (%) is the amount of inorganic material that remains in dried plant samples after organic material has been heated to a high temperature. These findings indicate that different varieties varied in their ability to absorb nutrients which might be related to different rooting depths and rooting patterns. This result was supported by Ayub *et al.* (2011). Higher CPY and ash yield with JHO-822 was due to higher DMY. CP content and ash content were influenced considerably by seeding dates. Among different sowing dates, fodder oat sown on 15th December registered significantly higher CP (10.33%) and ash content (9.41%) than other sowing dates. CP and ash contents were the least with seeding on 15th November. Dar *et al.* (2014) and Kaur *et al.* (2021) also found that delay in sowing results in higher CP content. Sowing on 15th November markedly increased the CPY and ash yield compared to other seeding dates and had 39.1% and 35.6% higher CPY and ash yield than that of 15th December.

NPK uptake

Different varieties had substantial impact on NPK uptake (Table 2). N, P and K uptake was significantly higher in JHO-822 and the least was observed in local variety. Variation in nutrient uptake in different varieties has already been noted by Shikha and Singh (2018). N and K uptake were considerably impacted by seeding dates. The 15th November crop had the highest N and K uptake, whereas P uptake was found highest in crop seeded on 25th November. Because of the favourable weather conditions that prevailed for the early date of sowing it caused higher accumulation of dry matter, which improved nutrient uptake from the soil and increased nutrient accumulation. Similar findings have also been reported in wheat crop (Kour *et al*., 2012; Gizawy and Nasser, 2009).

ECONOMICS

Varieties caused marked variation in gross return, net return and B: C ratio of fodder oat (Table 2). Among varieties, gross return, net return and B: C ratio was found to be the highest with JHO-822 (Rs. 76697/ha, Rs. 38926/ha and 2.03, respectively) which also involved the highest cost of cultivation (Rs. 37772/

TABLE 2
Effect of different varieties and date of sowing on nutrient uptake and economics of fodder oat

Treatments	Nutrient uptake (kg/ha)			Economics			
	N	P	K	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B: C ratio
Varieties							
Kent	122.1	20.0	137.6	37376	73661	36285	1.97
JHO-822	139.6	22.5	156.6	37772	76697	38926	2.03
Local	102.7	16.4	111.6	37626	70015	32389	1.86
SEm±	2.1	0.6	3.8	-	625	625	0.02
LSD ($p<0.05$)	8.2	2.4	15.0	-	2453	2453	0.07
Date of sowing							
15th November	143.6	19.9	149.1	37994	82855	44862	2.18
25th November	125.1	20.4	139.4	37827	75613	37786	2.00
5th December	114.1	19.7	131.3	37272	70879	33607	1.90
15th December	102.9	18.6	121.5	37272	64484	27212	1.73
SEm±	3.5	0.5	3.7	-	976	976	0.03
LSD ($p<0.05$)	10.5	1.4	11.1	-	2900	2900	0.08
Interaction	NS	NS	NS	-	NS	NS	NS

ha). The increase in cost of cultivation, gross return, net return and B: C ratio with JHO-822 over local variety was 1.05, 9.54, 20.18 and 9.13%, respectively. Gross and net return with JHO-822 was markedly higher than other varieties but in case of B: C ratio, it was found to be at par with Kent (1.97). Similar findings were observed by Siloriya *et al*. (2014), Dabhi *et al.* (2017) and Sheoran *et al*. (2017). Higher green fodder yield of JHO-822 which compensated high cost of cultivation incurred with it and resulted in higher net return and B:C ratio. Date of sowing had significant influence on gross return, net return and B: C ratio of fodder oat. The gross return (Rs. 82855/ha) and net return (Rs. 44862/ha) was the maximum when sown on 15th November and decreased with delay in sowing dates. When fodder oat was sown on 15th November, it also involved maximum cost (Rs. 37994/ha). But it also resulted in markedly superior B: C ratio of 2.18 in comparison to others. The increase in cost of cultivation, gross return, net return and B: C due to sowing on 15th November over 15th December was 1.93, 28.48, 0.64 and 26.01%, respectively. Higher gross and net return and B:C ratio with 15th November sown crop was due to higher green fodder yield. These results are in line with Jehangir *et al.* (2013) and Tomar *et al.* (2014). On the other hand lower green fodder yield with delayed sowing resulted in lower values of gross and net return and B:C ratio.

Thus, fodder oat variety JHO-822 could be sown on 15th November to get quality green fodder along with maximum productivity and profitability under agro-ecological conditions of Bihar.

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