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Effect of varieties and nitrogen levels on growth, yield and economics of fodder oat (*Avena sativa* L.)

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Abstract
A field experiment was carried out during *rabi*2017-18 at Instructional Farm, Rajasthan College of Agriculture, Udaipur with the objective to study the response of fodder oat varieties to varying nitrogen levels. The treatment comprised of five varieties (Kent, JHO-851, JHO-822, JHO-99-2 and JHO-2000-4) and three nitrogen levels (80, 100 and 120 kg N ha^{-1}) cut twice at 55 DAS and at 50% flowering. The experiment was conducted in factorial randomized block design with three replications. The soil of the experimental site was low in available nitrogen, medium in phosphorus and rich in potassium. The findings of an experiment indicated that variety JHO-99-2 and application of 120 kg N ha^{-1} produced significantly higher plant height, number of tillers m^{-1} row length, dry matter accumulation m^{-1} row length and leaf stem ratio at first and second cut. Variety JHO-99-2 gave significantly higher total green fodder yield (70.5 t ha^{-1}), total dry fodder yield (15.5 t ha^{-1}) and production efficiency 594.9 and 786.8 kg ha^{-1} day^{-1} at first and second cut, respectively. Application of 120 kg N ha^{-1} gave the maximum green fodder yield (32.1 and 37.0 t ha^{-1}) and dry fodder yield (7.1 and 8.2 t ha^{-1}) at first and second cut. The highest net return (₹75874 ha^{-1}) and B C ratio (2.54) was recorded with JHO-99-2. Application of 120 kg N ha^{-1} fetched the maximum net return (₹73436 ha^{-1}) and B C ratio (2.43) respectively.

Keywords: Oat, varieties, green and dry fodder yield, nitrogen levels, economics

Introduction
Livestock is the essential component of agriculture in the developing countries like India since time immemorial and its contribution to national economy through meat, milk, wool as well as farm yard manure is vast. However, the productivity of our livestock is low due to less availability of feed resources. Under the limited water supply where farmer cannot grow legumes like berseem or lucerne, oat would be a good choice as green fodder crop. Oat (*Avena sativa* L.) is 'locally known as *jai*' an important forage crop of winter. The world area under oat is around 9.51 million hectare and production is 23.41 million metric tons (USDA, 2018). In India, it covers an area of about one lakh hectare with fodder productivity of 30-45 t ha^{-1} (FAO 2012). During recent years many improved varieties of oat have been evolved which have high yield potential are grown for producing green fodder as well as seed. These varieties are highly responsive to high doses of fertilizers. It is well known fact that no two varieties of any crop can show identical performance in all the regions because variation in their genetic makeup and eco-physiological responses to different habitats. Fertilization is considered one of the important practices for improving the yield and nutritive value of forage crops. Oat responds well to nitrogen, among various nutrients application, which produces more tonnage in per unit area per unit time under favorable environmental conditions (Purushottam *et al.*, 1995) [8]. Whereas, excess supply of nitrogen to oat under certain environmental conditions cause excessive nitrate accumulation in plant leaves, which may be toxic to the ruminants. These facts show the necessity of determining the adequate supply of nitrogen to the oat based on field experimentation for realizing the genetic yield potential of varieties.

Material and methods
The experiment was conducted at the Instructional Farm, Rajasthan College of Agriculture, Udaipur. The site is situated at Southern part of Rajasthan at an altitude of 582.17 m above mean sea level, at 24°35' N latitude and 73°42' E longitude. The soil of the experimental site was clay loam in texture having the pH 7.9, low in available nitrogen, medium in phosphorus and rich in potassium. The treatment comprised of five varieties (Kent, JHO-851, JHO-822, JHO-99-2 and JHO-2000-4) and three nitrogen levels (80, 100 and 120 kg N ha^{-1}) tested in

factorial randomized block design with three replications. Seeds were sown in line on 9th November 2017 in rows 25 cm apart using recommended seed rate 100 kg ha^{-1}. Nitrogen was applied in the form of urea as half dose as basal dose at the time of sowing, ¼ at 30 DAS and remaining ¼ after first cut. Phosphorus fertilizer was given as common dose 40 kg ha^{-1} at the time of sowing through DAP. Five irrigations were applied during entire crop growth period. The observation viz. plant height, number of tillers, dry matter accumulation and leaf stem ratio were recorded both at first and as well as at second cut. Plants of each plot were separately harvested at first and second cut to record green fodder yield plot^{-1} and it was converted to tones ha^{-1}.The plants in one meter row length were harvested up to ground level in each of the plot were sun dried for few days then oven dried at 65^{o} for 72 hours to a constant weight. From the dry weight of samples the dry fodder of each net plot was determined by using green fodder yield and converted into t ha^{-1}. The production efficiency was calculated as under:

$$\text{duction efficiency (kg ha}^{-1}\text{day}^{-1}) = \frac{\text{Fodder yield (kg ha}^{-1})}{\text{Number of days}} \times 100$$

To find out most profitable treatment, economics of different treatment were worked out in terms of net monetary return (₹ ha^{-1}) by subtracting the cost of treatment and cost of cultivation from gross income obtained. Cost of cultivation and net profit were calculated on the basis of prevailing prices of produce and inputs. B-C ratio was calculated by dividing net return with cost of cultivation for each treatment to evaluate the economic viability of treatments. Benefit cost ratio was calculated by using following formula:

$$\text{BC ratio} = \frac{\text{Net return (₹ha}^{-1})}{\text{Total cost (cost of cultivation + cost of treatments) ₹ha}^{-1}}$$

Result and discussion

Growth attributes

The data presented in Table 1 showed that among the five oat varieties, variety JHO-99-2 registered significantly higher plant height (80.2 and 120.0 cm during first and second cut, respectively) over Kent, JHO-851, JHO-2004 but at par with variety JHO-822 (77.1 and 117.1 cm during first and second cut, respectively). This might be due to the genetic makeup of the particular variety, environment and their interaction on growth. Since growth and yield potential of crop and variety are outcome of genomic, environmental and agronomic interactions. The results are in conformity with the findings of Dabhi *et al*. (2017) [2]. At first and second cut, significantly higher number of tillers m^{-1} row length (104.7 and 214.9), dry matter accumulation m^{-1} row length (95.2 and 128.1g) and leaf stem ratio (0.98 and 0.94) were also recorded with variety JHO-99-2 over Kent, JHO-851, JHO-822 and JHO-2004. Higher dry matter accumulation in variety JHO-99-2 was mainly due to the higher plant height and more number of tillers m^{-1} row length compared to other varieties would have been created greater photosynthetic site which in turn high production of dry matter under this variety. Similar results were reported by Patel (2014) [7]. Application 120 kg N ha^{-1} recorded significantly higher plant height (77.9 and 120.1 cm), number of tillers m^{-1} row length (108.5 and 226.3), dry matter accumulation m^{-1} row length (103.1 and 135.2 g), leaf stem ratio (0.96 and 0.93) at first and second cut, respectively over 80 and 100 kg N ha^{-1}. This might be due to the reason that nitrogen is a major growth promoting and constituent of protoplasm which play major role in cell division and elongation which have contributed to improved vegetative growth such as plant height, number of tillers m^{-1} row length, dry matter accumulation m^{-1} row length and leaf stem ratio of fodder oat. The results are in close agreement with the findings Malik (2014) [6], AICRP-FCU (2016) [1] and Dabhi *et al*. (2017) [2].

Table 1: Growth attributes of fodder oats as influenced by varieties and nitrogen levels.

Treatment	Plant height (cm)		Number of tillers m^{-1} row length		Dry matter accumulation (g m^{-1} row length)		Leaf stem ratio	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Variety								
Kent	75.1	114.5	98.0	200.3	83.6	115.3	0.95	0.92
JHO-851	67.2	106.1	97.7	199.0	82.3	112.4	0.85	0.82
JHO-822	77.1	117.1	99.6	203.1	90.0	118.4	0.92	0.89
JHO-99-2	80.2	120.0	104.7	214.9	95.2x	128.1	0.98	0.94
JHO-2000-4	74.5	113.1	99.9	203.4	83.5	119.6	0.90	0.87
SEm±	1.28	1.36	1.54	3.13	2.00	2.49	0.006	0.006
CD (P=0.05)	3.72	3.93	4.46	9.08	5.81	7.23	0.018	0.017
Nitrogen (kg ha^{-1})								
80	71.4	107.2	93.6	189.1	71.5	104.2	0.88	0.85
100	75.2	115.2	97.8	197.1	86.2	116.9	0.92	0.88
120	77.9	120.1	108.5	226.3	103.1	135.2	0.96	0.93
SEm±	0.99	1.05	1.19	2.43	1.55	1.93	0.005	0.004
CD (P=0.05)	2.88	3.04	3.46	7.03	4.50	5.60	0.014	0.013

Yield and production use efficiency

The Data (Table 2) revealed that green and dry fodder yield as well as production efficiency day^{-1} influenced significantly with different varieties. The highest green (32.7 and 37.8 t ha^{-1} during first and second cut, respectively) and dry (7.3 and 8.2 t ha^{-1} during first and second cut, respectively) fodder yield as well as production efficiency (594.9 and 786.8 kg ha^{-1} day^{-1} during first and second cut, respectively) was recorded under variety JHO-99-2. These might be due to high vigour of growth parameters viz. plant height, number of tillers, dry matter accumulation and leaf stem ratio. The findings are in accordance with Godara *et al*., (2016) [4] and Dabhi *et al.*, (2017) [2]. Increased in nitrogen levels significantly increased green fodder yield, dry fodder yield and production efficiency day^{-1}. Significantly higher green fodder (32.1 and 37.0 t ha^{-1} during first and second cut, respectively) and dry fodder (7.1 and 8.2 t ha^{-1} during first and second cut, respectively) yield of oat was produced with the application of 120 kg N ha^{-1} over 80 and 100 kg N ha^{-1}. The production efficiency day^{-1} (583.2 and 755.4 kg ha^{-1} day^{-1} during first and second cut, respectively) was also significantly higher with the application of 120 kg N ha^{-1} over 80 and 100 kg N ha^{-1}. The increased green and dry fodder yield as well as production efficiency day^{-1} due to higher dose of nitrogen which cause luxuriant vegetative growth as evident by higher plant height, number of tillers m^{-1} row length, dry matter accumulation and leaf stem ratio. These results are in close collaboration with Jehangir (2013) [5], Malik (2014) [6], AICRP-FCU (2016) [1] and Dabhi *et al*., (2017) [2].

Table 2: Yield and production use efficiency of fodder oats as influenced by varieties and nitrogen levels

Treatment	Green fodder yield (t ha^{-1})			Dry fodder yield (t ha^{-1})			Production efficiency (kg ha^{-1} day^{-1})	
	1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut
Variety								
Kent	29.5	34.7	64.1	6.5	7.7	14.3	535.8	769.5
JHO-851	27.8	32.5	60.3	5.9	6.9	12.9	505.9	712.2
JHO-822	30.6	35.9	66.5	6.8	7.7	14.5	556.4	722.5
JHO-99-2	32.7	37.8	70.5	7.3	8.2	15.5	594.9	786.8
JHO-2000-4	30.1	35.3	65.4	6.7	7.8	14.5	547.5	727.8
SEm±	0.33	0.35	0.65	0.10	0.18	0.14	5.91	8.04
CD (P=0.05)	0.94	1.00	1.87	0.28	0.53	0.40	17.13	23.30
Nitrogen (kg ha^{-1})								
80	28.5	33.6	62.1	6.2	7.2	13.5	517.7	743.8
100	29.9	35.1	65.0	6.6	7.6	14.2	543.3	732.2
120	32.1	37.0	69.1	7.1	8.2	15.3	583.2	755.4
SEm±	0.25	0.27	0.50	0.08	0.14	0.11	4.58	6.23
CD (P=0.05)	0.73	0.78	1.45	0.22	0.41	0.31	13.27	18.05

Economics

The data Table 3 showed that highest net return (₹75874ha^{-1}) and B C ratio (2.54) were fetched by the variety JHO-99-2. The higher net return was due to the higher green fodder yield at first and second cut in variety JHO-99-2. The results are in corroboration with Sheoran *et al*., (2017) [9]. The maximum net return (₹73436 ha^{-1}) and B-C ratio (2.43) were fetched with the application of 120 kg N ha^{-1} which was significantly higher over 80 and 100 kg N ha^{-1}.

Table 3: Net return and B-C ratio of fodder oat as influenced by varieties and nitrogen levels

Treatment	Net return (₹ ha^{-1})	B:C Ratio
Variety		
Kent	66308	2.22
JHO-851	60524	2.02
JHO-822	69893	2.34
JHO-99-2	75874	2.54
JHO-2000-4	68244	2.28
SEm±	968	0.033
CD (P=0.05)	2805	0.094
Nitrogen (kg ha^{-1})		
80	63513	2.15
100	67558	2.26
120	73436	2.43
SEm±	1061	0.025
CD (P=0.05)	2173	0.073

Conclusion

Oat variety JHO-99-2 fertilized with 120 kg N ha^{-1} should be grown for getting higher green fodder yield and net return.

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