International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(4): 683-686

Received: 05-05-2017
Accepted: 06-06-2017

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Response of oat (*Avena sativa* L.) varieties to methods of sowing and nitrogen levels on forage yield and quality

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Abstract
A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat to find out the response of oat (*Avena sativa* L.) varieties to methods of sowing and nitrogen levels on forage yield and quality during *Rabi* season of the year 2015-16. The experiment consist of eighteen treatment combinations comprised of three varieties (Kent, JHO 822 and JHO 03 91), two methods of sowing (Broadcasting and Line sowing) and three nitrogen levels (80, 100 and 120 kg ha^{-1}). Significantly the highest green forage yield (589.46 q ha^{-1}), dry matter yield (73.77 q ha^{-1}) and crude protein (10.10 q ha^{-1}) yield of forage oat were recorded by variety JHO 03 91 over Kent and JHO 822. Among methods of sowing green forage yield found non-significant but dry matter yield (70.57 q ha^{-1}), crude protein yield (9.83 q ha^{-1}) and crude protein content (13.64 %) were recorded significantly higher in line sowing method over broadcasting method. The green forage yield, dry matter yield and crude protein yield is significantly affected by nitrogen levels. Application of 120 kg ha^{-1} produced significantly higher green forage yield (576.27 q ha^{-1}), dry matter yield (73.16 q ha^{-1}) and crude protein (10.50 q ha^{-1}) yield as well as crude protein content (14.11%). The higher net realization of ₹ 46913 ha^{-1} and higher B.C.R. value of 2.75 were recorded in variety JHO 03 91. Among methods of sowing line sowing resulted in higher net realization ₹ 41504 ha^{-1} with B.C.R. of 2.53 and in different nitrogen levels, application of 120 kg ha^{-1} resulted in higher net realization ₹ 44972 ha^{-1} with B.C.R. of 2.66.

Keywords: *Avena sativa*, Agriculture, *Rabi*, combinations, Broadcasting

Introduction
Among different *Rabi* fodder crop, oat is an important one in India used for both feed and fodder. It is highly, nutritious and energy rich crop having good regeneration ability with high dry matter content. Among cereals, the grain of oat are rich in protein and can be used as a concentrated for animals baby food.

Oat (*Avena sativa* L.) is an important cereal fodder crop having wider adaptability in all the states. It is quick growing highly nutritious forage crop having crude protein content 12 to 14 percent. It is use for preparation of hay, silage and it is also as concentrate feed grain. In our country oat is cultivated in an area of about 2 lakh hectare (Singh, 1999) [15].

Variety affect the vegetative growth of any crop so, for higher green fodder yield, vegetative growth of this crop is very important. Although the vegetative growth of any crop is largely dependent upon the potential of the genotype, nutrient supply system, capacity of the soil to supply the nutrients to the crop and capacity of the plants to take and use the nutrients in unit time.

Planting methods affect plant growth and development by balancing the interplant competition. It defines the dissemination configuration of plant over a field and directly disturbs cosmological radiation, interception, evaporation and water use efficiency of crops.

Nitrogen play pivotal role in the quantitative as well as qualitative improvement in the productivity of fodder. It is an important constituent of protein and chlorophyll. It imparts dark green colour to the plants, promotes vegetative and early growth. It improves the quality by increasing the protein content of oat and also govern to a considerable degree, utilization of potassium, phosphorus and other essential elements (Patel *et al*., 2007) [9].

The purpose of investigation was to study the response of varieties, methods of sowing and nitrogen fertilization practices on growth, forage production and nutritive value of fodder oat.

Materials & Methods

A field experiment was conducted at Agronomy farm, Anand Agricultural University, Anand to find out the "Response of oat (*Avena sativa* L.) varieties to methods of sowing and nitrogen levels on forage yield and quality" during *rabi* season of 2015-16. The experiment consists of eighteen treatment combinations comprised three varieties (Kent, JHO 822 & JHO 03 91), two methods of sowing (Broadcasting & Line sowing) and three levels of nitrogen (80, 100 & 120 kg N ha^{-1}). The experiment was laid out in Randomized Block Design (Factorial RBD) with three replications. The soil of experimental plot was loamy sand in texture. The soil was low in organic carbon (0.39%) available nitrogen (230.50 kg ha^{-1}) and medium in available phosphorous (34.99 kg ha^{-1}) and potash (311.12 kg ha^{-1}). The oat varieties were sown with seed rate of 100 kg ha^{-1}. The economics was workout on current market price basis. Nitrogen was given as per treatment in the form of urea. The full dose of phosphorus from SSP and half dose of nitrogen applied as basal dose at the time of sowing and other half dose in two equal split at 30 DAS and after first cut, respectively. The first cut will be taken at 50-55 days after sowing while the second cut at 50% flowering stage. The crude protein content (%) was estimated from the powder of representative oven dried sample using Near-infrared spectroscopy method (NIR analyzer). The values off "F" was worked out and compared with the values of table F at 5 per cent level of significance. The value of S. Em. $\pm$, C.D. and C.V. per cent were also calculated (Cochran and cox, 1967).

Result & Discussion

The finding of present study as well as relevant discussion have been presented under following heads:

Effect of varieties

The data presented in table 1 showed that, among the varieties, Variety JHO 03 91 (V_3) recorded significantly the highest green forage yield of 387.22, 202.24 and 589.46 q ha^{-1} in first cut, second cut and total of both the cut, respectively over variety Kent and JHO 822 (V_1 and V_2). The increase in green forage yield of variety JHO 03 91 was to the extent of 9.84 and 19.70 per cent over variety kent and JHO 822, respectively. The variation in green forage yield of varieties might be related to inherent differences and high vigour in growth parameters viz., plant height, number of tillers per meter square and leaf: stem ratio. Significantly the highest plant height (91.98 cm) at harvest, higher number tillers per meter square (395.55) and maximum leaf: stem ratio (3.55) was recorded in variety JHO 03 91 over all other varieties. Plant height generally depend on gentical makeup of particular variety. The results are conformity with findings of Jha *et al.* (2012) [6], Roshan *et al.* (2012) [12], Godara *et al.* (2016) [4] and Ratan *et al.* (2016) [11].

Significantly highest dry matter yield (73.77 q ha^{-1}) and crude protein yields (10.10 q ha^{-1}) were recorded in variety JHO 03 91 (V_3) among other variety. The significant increase in dry matter yield and crude protein yield under variety V_3 was 7.66, 17.65 per cent and 5.53, 19.10 per cent over variety kent and JHO 822 (V_1 and V_2), respectively. Significantly higher crude protein content (13.67%) was recorded in variety kent while the higher neutral detergent fibre content (57.45%) was recorded in variety kent.

Effect of methods of sowing

The data presented in Table 1 showed that, The effect of method of sowing on green forage yield was found non-significant, while higher green forage yield was observed in method of sowing M_1 (Line sowing).

Significantly higher dry matter yield (70.57 q ha^{-1}), crude protein yield (9.83 q ha^{-1}) and crude protein content (13.64%) were recorded in line sowing (M_2) method. The increase in dry matter and crude protein yield under line sowing method was 6.71, 10.07 per cent over broadcasting method (M_1). Significantly the highest plant height (90.43 cm) at harvest and number of tillers per meter square (384.92) was found in line sowing method. The variation in this character is due to efficient utilization of resources by plants due to proper plant spacing. The results is conformity with findings of Sharma *et al.* (2001^b) [14], Soomro *et al.* (2009) [16] and Hameed *et al.* (2014) [5].

Table 1: Green forage, dry matter and crude protein yields (Total of two cuts), growth attributes and quality parameter (Mean of two cuts) and economics of forage oat as influence by different varieties, methods of sowing and nitrogen leve.

Treatments	Plant height at harvest (cm)	No. of tillers m^{-2}	Leaf: Stem ratio	Green forage yield (q ha^{-1})	Dry matter yield (q ha^{-1})	Crude protein yield (q ha^{-1})	Crude protein content (%)	NDF content (%)	Net realization (₹ ha^{-1})	B. C. R.
Varieties (V)										
V_1 : Kent	87.05	383.33	3.24	536.62	68.52	9.57	13.67	57.45	40307	2.50
V_2 : JHO 822	84.64	350.89	2.98	492.53	62.77	8.48	13.24	55.81	34796	2.30
V_3 : JHO 03 91	91.98	395.55	3.55	589.46	73.77	10.10	13.47	56.51	46913	2.75
S. Em. $\pm$	1.25	5.37	0.04	9.21	1.27	0.19	0.12	0.56	-	-
C.D. (P=0.05)	3.61	15.44	0.11	26.50	3.66	0.54	NS	NS	-	-
Method of Sowing (M)										
M_1 : Broadcasting	85.35	368.25	3.22	530.31	66.13	8.93	13.29	56.11	39840	2.51
M_2 : Line sowing	90.43	384.92	3.30	548.77	70.57	9.83	13.64	57.06	41504	2.53
S. Em. $\pm$	1.02	4.38	0.03	7.52	1.04	0.15	0.09	0.45	-	-
C.D. (P=0.05)	2.94	12.61	NS	NS	2.98	0.44	0.28	NS	-	-
Nitrogen levels (kg ha^{-1}) (N)										
N_1 : 80	84.10	359.17	3.04	499.19	63.62	8.28	12.75	59.44	35920	2.36
N_2 : 100	88.35	378.56	3.26	543.15	68.29	9.38	13.52	56.57	41124	2.54
N_3 : 120	91.23	392.06	3.49	576.27	73.16	10.50	14.11	53.75	44972	2.66
S. Em. $\pm$	1.25	5.37	0.04	9.21	1.27	0.19	0.12	0.56	-	-
C.D. (P=0.05)	3.61	15.44	0.11	26.50	3.66	0.54	0.35	1.60	-	-
Interaction										
V x M	NS	NS	NS	NS	NS	NS	NS	NS	-	-
V x N	NS	NS	NS	NS	NS	NS	0.59	NS	-	-
M x N	NS	NS	NS	NS	NS	NS	0.35	NS	-	-
V x M x N	NS	NS	NS	NS	NS	NS	NS	NS	-	-
C.V. %	6.05	6.05	5.10	7.24	7.89	8.56	3.80	4.16	-	-

Effect of nitrogen levels

There was progressive increase of green forage yield in response to increasing N supply. Nitrogen fertilization had significantly effect on green forage yield (576.27 q ha^{-1}) with 120 kg N ha^{-1}. The remarkable increase in yields with higher levels of nitrogen might be attributed to favourable effect on yield attributes *viz*., plant height (Table 4.2), number of tillers per meter square (Table 4.3) and leaf : stem ratio (Table 4.4). The increase in leafy part due to nitrogen application might have ultimately resulted in higher photosynthetic activities and also in production of more photosynthates. This readily supplied food growing parts might have helped in improvement of growth and yield attributes like plant height, number of tillers per meter square and leaf: stem ratio (Table 1). Application of 120 kg n ha^{-1} recorded significantly higher plant height at harvest (91.23 cm), number of tillers per meter square (392.06) and Leaf: stem ratio (3.49) than other lower levels of nitrogen. Nitrogen is main component of the protoplasm, stimulation of cell diviosion and elongation. As a results of which, nitrogen yielded better response of forage yield similar results were also observed by Uma *et al.* (2010) [17], Patel *et al.* (2010) [10], Midha *et al.* (2015) [8], Godara *et al.* (2016) [4] and Ratan *et al.* (2016) [11].

Dry matter and crude protein yield showed significant variation by application of different levels of nitrogen (Table 1). The highest dry matter (73.16 q ha^{-1}) and crude protein (10.50 q ha^{-1}) yield were found when nitrogen was applied @ 120 kg N ha^{-1}.The dry matter follows the same trend as observed in green forage yield due to application of nitrogen. Nitrogen is used largely in synthesis of protein, but structurally it is constitute of chlorophyll molecule combined with the carbohydrate and fatty acids. It help in formation of protoplasm, which is physical base of life of plant. Thus, more production of dry matter can be explained at higher rate. The higher dry matter yield with higher nitrogen rates also reported by Sarkar and Mallick (2010) [13], Patel *et al*. (2010) [10], Edwin *et al.* (2012) [3], Midha *et al.* (2015) [8], and Godara *et al.* (2016) [4]. This increase in crude protein yield with higher level of nitrogen could be ascribed to additive effect of increased dry matter yield.

The data presented in Table 1 showed that application of 120 kg N ha^{-1} recorded significantly higher crude protein content (14.11%).This increase in crude protein content of forage oat could be attributed to increase in nitrogen content in plant along with increase in nitrogen rate which might have helped in synthesis of more protein as nitrogen being a constituent of various metabolites including protein and amino acids. Increase in crude protein content with increase in level of nitrogen in forage oat has been reported by Uma *et al*. (2010) [17], Sarkar and Mallick (2010) [13], Edwin *et al.* (2012) [3], and Ratan *et al.* (2016) [11]. The reduction in neutral detergent fibre content was observed with increase in the level of nitrogen might be due to increase in succulence *i.e*. leaf: stem ratio (Table 4.4) of plant by reducing formation of polysaccharides *viz*., cellulose, hemi-cellulose and lignin, which generally account for content of NDF in the plant. These results are in line with the findings of Kumar (2001) [7] and Bhilare and Joshi (2007) [1].

Economics of different treatments

Economics play important role in deciding the adoption of particular treatment by the farmers. Therefore, the gross realization, net realization and benefit cost ratio (B.C.R.) were calculated for varieties, methods of sowing and nitrogen levels.

Effect of varieties

The data on economics (Table 1) revealed that variety JHO 03 91 (V_3) recorded maximum gross and net realization of ₹ 73683 and 46913 ha^{-1}, respectively. Variety JHO 03 91 (V_2) recorded maximum B.C.R. of 2.75.

Effect of methods of sowing

Among methods of sowing M_2 (Line sowing) recorded maximum gross and net realization of ₹ 68596 and 41504 ha^{-1}, respectively. In case of B.C.R., method of sowing M_2 (Line sowing) recorded maximum B.C.R. of 2.53.

Effect of nitrogen levels

The data on economics (Table 1) revealed that nitrogen level 120 kg N ha^{-1} (N_3) realized maximum gross and net income of ₹ 72034 and 44972 ha^{-1}, respectively. In respect of B.C.R., 120 kg N ha^{-1} (N_3) recorded maximum B.C.R. of 2.66.

Conclusion

In light of results obtained from this investigation, it can be concluded that to obtain maximum good quality green forage yield with higher monetary returns, forage oat variety JHO 03 91 should be sown at 25 cm line sowing method and crop should be fertilized @ 120 kg N ha^{-1}. Fifty per cent N should be applied as basal before sowing and remaining fifty percent N should be applied in two equal splits, first at 30 day after sowing and second after first cut. Common dose of phosphorous @ 40 kg ha^{-1} and Zinc sulphate @ 25 kg ha^{-1} should be applied as basal.

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