Forage Res., **41** (2) : pp. 104-108 (2015) **http://forageresearch.in**

EFFECT OF NITROGEN LEVELS AND TIME OF APPLICATION ON GROWTH, YIELD, QUALITY, NITROGEN, PHOSPHORUS CONTENT AND UPTAKE FOR SEED PRODUCTION OF OAT (*AVENA SATIVA* L.)

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(Received : 27 July 2015; Accepted : 25 September 2015)

ABSTRACT

A field experiment was conducted during **rabi** 2014 at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of nitrogen levels and time of application on seed production of oat (*Avena sativa* L.). The soil of experimental plot was loamy sand in texture with low in organic carbon and available nitrogen, medium in available phosphorus and high in potash having pH value of 7.8. Total nine treatment combinations comprising three levels of nitrogen viz., 60 kg N/ha (N_1), 90 kg N/ha (N_2) and 120 kg N/ha (N_3) and three times of nitrogen application (T_1 : Two equal splits at basal and 30 DAS, T_2 : Three splits : 50% at basal, 25% each at 30 and 45 DAS and T_3 : Three equal splits at basal, 30 and 45 DAS) with factorial concept laid out in four replications. The results revealed that the higher production of oat and net realization could be achieved with the application of 90 kg N/ha with three equal splits of N i. e. at basal, 30 and 45 DAS or three equal splits of N i. e. 50 per cent at basal, 25 per cent each at 30 and 45 DAS during **rabi** season in loamy sand soil of north Gujarat agro-climatic condition.

Key words : Oat, nitrogen levels, time of application

Oat (*Avena sativa* L.) is presently grown in temperate parts of the world including USA, Canada, Europe, etc. as spring-sown cultivars. In the tropical countries and at higher altitude regions, it is grown as a winter annual. Oat ranks sixth in the world cereal area, production and productivity, followed by wheat, maize, rice, barley and sorghum. Oat is the most important cereal fodder crop grown in the winter season in the north-western and central India and now extending to the eastern regions. Oat requires a long and cool season for its growth. In India, it is being grown in Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal and in Gujarat where irrigation facilities are available. The genus *Avena* comprises about 70 species of which a few are cultivated. *Avena sativa* and *Avena byzantine* are the main spices of oat grown for fodder and grain purposes.

Vegetative growth of any crop depends upon the nutrient supply system and capacity of the soil to supply the nutrients to crop and capacity to take and use the nutrient is unit time. Among all the major and secondary nutrients, nitrogen plays a pivotal role in quantitative as well as qualitative improvement in the productivity of crop. It is an important constituent of proteins and chlorophyll. It imparts dark green colour to the plants, promotes vegetative growth and rapid early growth. It improves the quality by increasing the protein content of fodder crops and governs to a considerable degree, the utilization of potassium, phosphorus and other elements (Patel *et al.*, 2007).

Timing and placement of nitrogen fertilizer have a major effect on the efficiency of nitrogen management systems. Nitrogen should be applied to a crop at times that avoids periods of significant loss and provides adequate nitrogen when needed (Khosla *et al.,* 2000).

MATERIALS AND METHODS

A field experiment was conducted during **rabi**

2014 at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of nitrogen levels and time of application on seed production of oat (*Avena sativa* L.) Total nine treatment combinations comprising three levels of nitrogen viz., 60 kg N/ha (N_1), 90 kg N/ha (N_2) and 120 kg N/ha (N_3) and three times of nitrogen application (T_1 : Two equal splits at basal and 30 DAS, T_2 : Three splits : 50 per cent at basal, 25 per cent each at 30 and 45 DAS and T_3 : Three equal splits at basal, 30 and 45 DAS) with factorial concept laid out in four replications. The soil of experimental plot was loamy sand in texture with low in organic carbon and available nitrogen, medium in available phosphorus and high in potash having pH value of 7.8.

RESULTS AND DISCUSSION

Effect of Nitrogen Levels

Significantly the higher plant height was recorded with the application of 120 kg N/ha. However, it was statistically at par with 90 kg N/ha. The results are in conformity with the findings of Patel *et al.* (2010) and Banjara and Banjara (2014). The higher number of total tillers per metre row length was recorded with the application of 120 kg N/ha and it was statistically at par with the application of 90 kg N/ha. The lower number of total tillers per metre row length was recorded with the application 60 kg N/ha. Similar trend was also observed by the findings of Tiwana and Puri (2001), Sharma and Verma (2005) and Patel *et al.* (2010).

The number of effective tillers per metre row length increased significantly with the increase in the levels of nitrogen (Table 1). The higher number of effective tillers per metre row length was recorded with the application of 120 kg N/ha and it was statistically at par with the application of 90 kg N/ha. The lower number of effective tillers per metre row length was recorded with the application 60 kg N/ha. Similar trend was also observed by the findings of Tiwana and Puri (2004), Sharma and Verma (2005) and Patel *et al.* (2010).

Application of nitrogen significantly and linearly increased the earhead length of the oat crop (Table 1). The higher earhead length and number of seeds per earhead were recorded with the application of 120 kg N/ha being at par with 90 kg N/ha, whereas the lowest earhead length and number of seeds per earhead were recorded with the application of 60 kg N/ha.

Crude protein content and crude protein yield per hectare were recorded higher with the application of 120 kg N/ha than that of 60 kg N/ha (Table 2). The increase in protein yield was due to increase in crude protein content and also increase in dry straw yield of oat crop because, the protein yield proportionally increased with the increased in dry straw yield of oat crop.

In case of nitrogen content, the application of

TABLE 1
Yield parameters of oat as influenced by nitrogen levels and time of application

Treatment	No. of effective tillers/ metre row length	Earhead length (cm)	No. of seeds/ earhead	Nitrogen content (%)	Nitrogen uptake (kg/ha)	Phosphorus content (%)	Phosphorus uptake (kg/ha)
Nitrogen levels (N)							
N_1 : 60 kg/ha	45.84	23.86	34.56	3.41	63.57	0.23	4.28
N_2 : 90 kg/ha	52.18	27.28	37.62	3.98	85.65	0.30	6.26
N_3 : 120 kg/ha	56.14	28.82	39.42	4.12	94.98	0.34	7.77
S. Em±	1.88	0.63	1.02	0.16	2.77	0.01	0.16
C. D. (P=0.05)	5.52	1.86	3.00	0.46	8.10	0.03	0.47
Time of application (T)							
T_1 : Two equal splits : At basal and 30 DAS	45.95	24.83	35.06	3.47	71.14	0.31	5.87
T_2 : Three splits : 50% at basal, 25% each at 30 and 45 DAS	50.60	26.36	37.34	3.85	81.74	0.27	6.05
T_3 : Three equal splits : At basal, 30 and 45 DAS	56.61	28.76	39.20	4.01	91.32	0.28	6.39
S. Em±	1.88	0.63	1.02	0.16	2.77	0.01	0.16
C. D. (P=0.05)	5.52	1.86	3.00	NS	8.10	NS	NS

NS–Not Significant.

TABLE 2
Growth parameters of oat as influenced by nitrogen levels and time of application

Treatment	Plant height (cm)			No. of total tillers/ metre row length	Crude protein content (%)	Crude protein yield (kg/ha)
	30 DAS	60 DAS	At harvest			
Nitrogen levels (N)						
N_1 : 60 kg/ha	34.40	85.49	130.57	74.26	30.56	360
N_2 : 90 kg/ha	36.02	90.43	136.60	81.15	34.00	408
N_3 : 120 kg/ha	37.75	94.34	141.46	85.16	35.46	426
S. Em±	1.51	2.16	4.33	2.32	0.28	3.39
C. D. (P=0.05)	NS	6.33	NS	6.81	0.82	9.93
Time of application (T)						
T_1 : Two equal splits : At basal and 30 DAS	34.01	84.93	129.79	74.64	31.15	369
T_2 : Three splits : 50% at basal, 25% each at 30 and 45 DAS	36.58	91.28	137.60	80.44	33.44	402
T_3 : Three equal splits : At basal, 30 and 45 DAS	37.58	94.05	141.25	85.49	35.43	422
S. Em±	1.51	2.16	4.33	2.32	0.28	3.39
C. D. (P=0.05)	NS	6.33	NS	6.81	0.82	9.93

NS : Not Significant.

90 and 120 kg N/ha was found at par. The highest nitrogen and phosphorus uptake was recorded with the application of 120 kg N/ha and it was statistically at par with the application of 90 kg N/ha than that of the lower dose of nitrogen application, respectively (Table 1). The higher uptake of nitrogen and phosphorus was due to higher seed yield of oat crop as a resultant of higher growth and yield parameters due to higher availability of nitrogen to the crop throughout the crop period. The results are in accordance with the findings of Patel *et al.* (2010).

The higher seed yield per plant led to the higher seed yield per hectare. Significantly higher seed yield per hectare was recorded with the application of 120 kg N/ha and it was statistically at par with the application of 90 kg N/ha. The lower seed yield per hectare was recorded with the application of 60 kg N/ha. The higher seed yield per hectare was due to higher growth and yield attributing characters of the oat plant. It means that the higher plant height, higher number of seeds per earhead and higher earhead length led to higher seed yield per hectare. The similar results were also found by Mohr *et al.* (2007), Khafi *et al.* (2007) and Devi *et al.* (2014).

The higher straw yield per plant led to the higher straw yield per hectare. Significantly higher straw yield per hectare was recorded with the application of 120 kg N/ha and it was statistically at par with the application of 90 kg N/ha. The higher straw yield per hectare was due to higher plant height and total tillers per metre row length led to higher straw yield per hectare. The similar results were also found by Khafi *et al.* (2007) and Devi *et al.* (2014).

The data showed that the application of 120 kg N/ha recorded the highest net realization of Rs. 74784/ha, whereas BCR was higher with the application of 120 kg N/ha (2.16) but it was statistically at par with the application of 90 kg N/ha (Table 3).

Effect of Time of Application

The plant height linearly increased with increasing split application of nitrogen. Fertilizing the crop with three equal splits of N i. e. at basal, 30 and 45 DAS recorded significantly higher plant height and number of total tillers per metre row length. However, these were statistically at par with three splits of N i. e. 50 per cent at basal, 25 per cent each at 30 and 45 DAS. Significantly the lower plant height was recorded with two equal splits of N i. e. at basal and 30 DAS.

Among the different growth attributes studied, plant height (Table 2) and number of total tillers per metre row length were significantly influenced by different treatments of time of nitrogen application. Crop fertilized in three equal splits of nitrogen i. e. at basal, 30 and 45 DAS (T_3) recorded the maximum values for all these characters. However, it remained statistically at par with three splits of N i. e. 50 per cent at basal, 25 per cent each at 30 and 45 DAS (T_2).

Various yield parameters, namely, number of

TABLE 3

Seed and straw yield, net returns and benefit : cost ratio of oat influenced by nitrogen levels and time of application

Treatment	Seed yield (g/plant)	Straw yield (g/plant)	Seed yield (kg/ha)	Straw yield (kg/ha)	Net returns (Rs./ha)	B : C ratio
Nitrogen levels (N)						
N_1 : 60 kg/ha	1.88	8.64	1879	8469	57434	1.70
N_2 : 90 kg/ha	2.16	9.29	2143	9104	68132	1.99
N_3 : 120 kg/ha	2.26	9.51	2328	9315	74784	2.16
S. Em±	0.07	0.21	68	210	2200	0.06
C. D. (P=0.05)	0.20	0.63	198	615	6447	0.19
Time of application (T)						
T_1 : Two equal splits : At basal and 30 DAS	1.81	8.41	1880	8242	56787	1.68
T_2 : Three splits : 50% at basal, 25% each at 30 and 45 DAS	2.15	9.46	2192	9272	70149	2.04
T_3 : Three equal splits : At basal, 30 and 45 DAS	2.35	9.57	2277	9375	73414	2.13
S. Em±	0.07	0.21	68	210	2200	0.06
C. D. (P=0.05)	0.20	0.63	198	615	6447	0.19

seeds per earhead, earhead length and seed yield per plant were significantly influenced by various times of nitrogen application (Table 1).

Crude protein content, crude protein yield and nitrogen uptake (Tables 1 and 2) in oat were significantly influenced under various times of nitrogen application. Crop fertilized in three splits of N i. e. at basal, 30 and 45 DAS recorded significantly the highest crude protein content, crude protein yield and nitrogen uptake than three equal splits of N i. e. 50 per cent at basal, 25 per cent each at 30 and 45 DAS and two equal splits of N i. e. at basal and 30 DAS. The differences in protein content in oat were found significant due to various times of nitrogen application. These findings are substantiated to those reported by Alipatra *et al.* (2013).

Crop fertilized in three equal splits of N i. e. at basal, 30 and 45 DAS (T_3) recorded maximum values for all the yield parameters. It remained statistically at par with the three splits of N i. e. 50 per cent at basal, 25 per cent each at 30 and 45 DAS (T_2) except earhead length. The better development of almost all the growth and yield parameters under T_3 and T_2 treatments ultimately resulted in higher seed as well as straw yields. This might be due to reduced leaching losses under three split applications than two split applications for better reserve of nitrogen during the maximum utilization period of crop growth and development which resulted in adequate food supply to sink and ultimately reflected into better development of yield attributes. The treatments T_3 and T_2 increased the seed and straw yields over two equal splits of N i. e. at basal and 30 DAS (T_1) (Table 3). These results are in conformity with the findings of Alipatra *et al.* (2013) and Patel *et al.* (2013).

So far economics is concerned, three equal splits of N i. e. at basal, 30 and 45 DAS secured higher net realization of Rs. 73414/ha and BCR (2.13), which were statistically at par with net realization of Rs. 70149/ha and BCR (2.04) with three splits of N i. e. 50 per cent at basal, 25 per cent each at 30 and 45 DAS (Table 3). This might be due to higher seed and straw yields in both the treatments.

CONCLUSION

On the basis of one year experimentation, it seems quite indicative that the higher production of oat and net realization can be achieved with the application of 90 kg N/ha with three equal splits of N i. e. at basal, 30 and 45 DAS or three equal splits of N i. e. 50 per cent at basal and 25 per cent each at 30 and 45 DAS during **rabi** season in loamy sand soil of north Gujarat agro-climatic conditions.

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