Response of oat (Avena sativa L.) to nitrogen and phosphorus levels under North Gujarat Agro-climatic conditions

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ABSTRACT

The field experiment, conducted to evaluate the effect of nitrogen and phosphorus on growth parameters and yield of fodder oat on loamy sand soil at sardarkrushinagar during rabi 2011-12 revealed that application of 125 kg ha⁻¹ nitrogen + 75 kg ha⁻¹ phosphorus appreciably recorded the highest plant height, leaf length, leaf width, leaf: stem ratio (green and dry), leaf area per plant and leaf area index at first cut, second cut (at harvest) and in the mean values. It also resulted in highest leaf and stem weight (green and dry), green and dry fodder yield per plant and green and dry fodder yield q ha⁻¹ recorded at first and second cut (at harvest) as well as in the total values.

Key words: Oat, Fodder, Nitrogen and Phosphorus

In India, about 6.91 million hectares of land which contributes about 4.4 per cent of the total cultivated area are under fodder crops. Out of this only 1.02 million hectares of land is irrigated. In Gujarat state, total animal population is about 18.44 million and their optimum fodder requirement is 42.2 million tonnes, whereas only 20.0 million tonnes of fodder is made available in normal year. Thus, fodder and concentrate production is inadequate to feed the animals and there is a wide gap between the actual requirements and availability of feeds and fodders for the present population of livestock. Moreover, due to rapid reduction of grassland and pasture areas in recent year, and also due to improper management of the remaining pasture the deficit further aggravated. As a result, livestock suffers continuously with malnutrition round the year, resulting in their production capacity at sub-optimum level. It is therefore, very essential to maximize the quantity and quality of fodder production per unit area and time by proper management of grassland, pasture and also by utilizing the proper agro techniques for fodder crop production during kharif and rabi seasons.

Oat is one of the most important among different rabi fodder crops. It requires the cool and moist weather for germination, tillering, booting and heading stage. More over, oat make their best growth on loam soil in the state of Punjab, Haryana, U.P., Maharashtra, Orissa, Bihar, West Bengal and Gujarat. The most important cultivated species of oat is Avena sativa, which covers about 80.0 per cent of world acreage. The rest of the area is cultivated mostly with A. byzantina and only a small area is taken under other species. Oat is used as green fodder, straw, hay or silage. Oat grain makes a good balanced concentrate in the rations for poultry, cattle, sheep and other animals. Looking to the chemical composition on dry matter basis oat at milk stage contain 6.44 crude protein, 28.72 fiber, 53.20 nitrogen free-extract. Beside this, it contains 2.31 ether extract, 9.33 total ash, 0.47 calcium, 0.22 phosphorus, 0.22 magnesium, 0.52 sodium and 2.84 per cent potassium. (Sen and Ray, 1971).

MATERIAL AND METHODS

The field experiment was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, during the rabi season of 2011-12. The soil of experimental field 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. Sixteen treatment combinations comprising of four levels of nitrogen viz., 50 kg ha⁻¹ N (N₀), 75 kg ha⁻¹ N (N₁), 100 kg ha⁻¹ N (N₂) and 125 kg ha⁻¹ N (N₃) and four levels of phosphorus viz., no phosphorus (P₀), 25 kg ha⁻¹ P₀₁₀ (P₁), 25 kg ha⁻¹ P₀₁₅ (P₂), 50 kg ha⁻¹ P₀₂₀ (P₃) and 75 kg ha⁻¹ P₀₂₅ (P₄) were laid out in Randomized Block Design (factorial concept) with three replications in 5.0 X 3.0 m sized plots. Oat seed were drilled by adopting a spacing of 30 cm. Kent cultivar was used in the study. Nitrogen and phosphorus chemical fertilizer treatments were applied in the form of urea and DAP, respectively.

Data on plant population in different treatments was recorded at initial stage and also at harvest while on growth and yield parameters it was recorded at the first and second cut and also at harvest. The calculated mean values were subjected to statistical analysis.
RESULTS AND DISCUSSION

Growth parameters and Yield

Effect of Nitrogen

The mean data on plant population at initial and at harvest of the crop as well as on different growth and yield parameters of fodder as influenced by various treatments have been presented in table 1. The analysis of variance of individual treatments showed no significant influence on plant population at initial and at harvest and also similarly leaf: stem ratio (green and dry) at first cut, second cut (at harvest) and in the mean values. Different plant growth characters viz; plant height, leaf length, leaf width, leaf: stem ratio (green and dry), leaf area per plant and leaf area index at first cut, second cut (at harvest) and in the mean values. The results revealed that various doses of nitrogen manifested statistically equivalent influence on growth parameters of fodder oat and recorded significantly higher over lower dose as evident from the mean values of plant height, leaf length, leaf width, leaf: stem ratio (green and dry), leaf area per plant, leaf area index and the yield. The application of 125 kg nitrogen ha$^{-1}$ produced significantly taller plant of oat (63.4, 128.6 and 96.0 cm, respectively) at first cut, second cut (at harvest) and in the mean values as compared to lower dose. Similarly highest leaf length (42.5, 45.5 and 44.0 cm), leaf width (1.3, 1.7 and 1.5 cm, respectively), leaf area per plant (331, 744 and 537 cm$^2$, respectively), leaf area index (2.20, 4.96 and 3.58, respectively), leaf weight (green and dry) (7.63, 8.16, 15.79 and 1.14, 1.24 and 2.34 g, respectively), stem weight (green and dry) (28.80, 35.14, 63.94 and 4.99, 5.58 and 9.64 g, respectively), green forage yield plant$^{-1}$ (36.43, 43.30 and 79.73 g, respectively), dry matter yield plant$^{-1}$ (6.12, 6.82 and 12.94 g, respectively), green fodder yield ha$^{-1}$ (163, 275 and 438 q ha$^{-1}$, respectively) and dry fodder yield ha$^{-1}$ (38, 66 and 104 q ha$^{-1}$, respectively) at first cut, second cut (at harvest) and in the mean values were recorded under application of treatment 125 kg nitrogen ha$^{-1}$ (N$_3$) at first cut, second cut (at harvest) and in the mean values and it was to the tune of 42.8, 41.3 and 41.8 per cent higher plant height than the application of 50 kg nitrogen ha$^{-1}$ (N$_1$), respectively. Similarly leaf length (42.9, 42.9 and 42.8, respectively), leaf width was (42.0, 43.5 and 42.2, respectively), leaf area per plant was (43.0, 43.0 and 43.2), leaf area index was (42.9, 43.4 and 43.2), leaf weight (green and dry) per plant 39.7, 37.8, 38.9 and 42.5, 46.5 and 37.7 per cent, stem weight (green and dry) per plant 40.7, 39.6, 40.1 and 53.1, 44.9 and 39.7 per cent, green fodder yield per plant 40.5, 39.2 and 39.8 per cent, dry matter per plant 50.7, 45.1 and 47.5 per cent, green fodder yield per hectare 36.1, 33.5 and 34.4 per cent and dry fodder yield per hectare 60.8, 57.0 and 57.9 per cent, respectively. Thus, it appears that improvement in these parameters due to application of nitrogen at right quantity and right time to the oat crop might be due to the fact that supply of plant nutrients improves soil physical and biological properties and increase the availability of nutrients. Thus favorable influence of nutrients to produce larger cells with thinner cell walls and its contribution in cell division and cell elongation which improved vegetative growth and ultimately increased plant height, leaf length, leaf width, leaf area per plant and leaf area index. The findings are closely related with the findings of Singh et al. (1993), Bali et al. (1998), Patel and Rajgopal (2002), Sharma (2009), Malik and Paynter (2010) and Patel et al. (2010). More or less similar results were recorded by Sharma and Verma (2005) with respect to plant height, leaf length, leaf width, leaf area per plant, leaf area index and green and dry fodder yield q ha$^{-1}$ in oat crop.

Effect of Phosphorus

The data on plant population at initial and at harvest on the crop as influenced by various phosphorus treatments have been presented in table 1. The analysis of variance of individual treatments had no significant influence on plant population at initial and at harvest and also similarly leaf: stem ratio (green and dry) at first cut, second cut (at harvest) and in the mean values. The results, however, revealed that various doses of phosphorus manifested statistically equivalent influence on growth parameters of fodder oat and recorded significantly higher over lower dose as evident from the mean values of plant height, leaf length, leaf width, leaf: stem ratio (green and dry), leaf area per plant, leaf area index and the yield. The application of 75 kg phosphorus ha$^{-1}$ produced significantly taller plant of oat (60.6, 122.7 and 91.6 cm, respectively) at first cut, second cut (at harvest) and in the mean values, respectively, as compared to lower dose. Similarly highest leaf length (40.6, 43.4 and 42.0 cm), leaf width (1.2, 1.6 and 1.4 cm, respectively), leaf area per plant (316, 710 and 513 cm$^2$, respectively), leaf area index (2.10, 4.74 and 3.42, respectively), leaf weight (green and dry) (7.28, 7.79, 15.08 and 1.08, 1.18 and 2.23 g, respectively), stem weight (green and dry) (27.65, 33.74, 61.39 and 4.75, 5.24 and 9.25 g, respectively), green forage yield plant$^{-1}$ (34.94, 41.53 and 76.47 g, respectively), dry matter yield plant$^{-1}$ of oat (5.83, 6.42 and 12.25 g, respectively), green fodder yield ha$^{-1}$ (160, 268 and 428 q ha$^{-1}$, respectively) and dry fodder yield ha$^{-1}$ (37, 64 and 101 q ha$^{-1}$, respectively) at first cut, second cut (at harvest) and in the mean values were recorded under application of treatment 75 kg phosphorus ha$^{-1}$ (P$_3$) at first cut, second cut (at harvest) and in the mean values and it was to the tune of 42.5, 40.7 and 41.5 per cent higher plant height than the application of no
Table 1. Mean values of growth and yield parameters of fodder oat as influenced by nitrogen and phosphorus levels.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Leaf</th>
<th>Leaf : stem ratio</th>
<th>Leaf area index</th>
<th>Leaf wt (g plant$^{-1}$)</th>
<th>Stem wt (g plant$^{-1}$)</th>
<th>Green forage yield (g plant$^{-1}$)</th>
<th>Dry matter yield (g plant$^{-1}$)</th>
<th>Green fodder (q ha$^{-1}$)</th>
<th>Dry matter yield (q ha$^{-1}$)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Green</td>
<td>Dry</td>
<td>Green</td>
<td>Dry</td>
<td>Green</td>
<td>Dry</td>
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<tr>
<td>Nitrogen levels (N kg ha$^{-1}$)</td>
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<tr>
<td>N0-50</td>
<td>30430</td>
<td>67.7</td>
<td>30.8</td>
<td>1.0</td>
<td>375</td>
<td>0.253</td>
<td>0.237</td>
<td>2.50</td>
<td>11.37</td>
</tr>
<tr>
<td>N75-100</td>
<td>31575</td>
<td>74.5</td>
<td>34.1</td>
<td>1.1</td>
<td>421</td>
<td>0.249</td>
<td>0.230</td>
<td>2.74</td>
<td>12.24</td>
</tr>
<tr>
<td>N125-150</td>
<td>32513</td>
<td>75.9</td>
<td>34.7</td>
<td>1.1</td>
<td>419</td>
<td>0.250</td>
<td>0.230</td>
<td>2.80</td>
<td>12.60</td>
</tr>
<tr>
<td>S.Em+</td>
<td>995.26</td>
<td>96.0</td>
<td>44.0</td>
<td>1.5</td>
<td>537</td>
<td>0.249</td>
<td>0.227</td>
<td>3.58</td>
<td>15.79</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>NS</td>
<td>8.0</td>
<td>3.7</td>
<td>0.1</td>
<td>42.00</td>
<td>NS</td>
<td>NS</td>
<td>0.28</td>
<td>1.22</td>
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<tr>
<td>Phosphorus levels (P$_0$, kg ha$^{-1}$)</td>
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<tr>
<td>P0</td>
<td>30296</td>
<td>64.9</td>
<td>29.5</td>
<td>1.0</td>
<td>363</td>
<td>0.249</td>
<td>0.233</td>
<td>2.42</td>
<td>10.83</td>
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<tr>
<td>P25</td>
<td>31467</td>
<td>74.5</td>
<td>34.1</td>
<td>1.1</td>
<td>408</td>
<td>0.255</td>
<td>0.233</td>
<td>2.72</td>
<td>12.28</td>
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<tr>
<td>P50</td>
<td>32252</td>
<td>83.1</td>
<td>38.1</td>
<td>1.2</td>
<td>460</td>
<td>0.248</td>
<td>0.230</td>
<td>3.06</td>
<td>13.82</td>
</tr>
<tr>
<td>P75</td>
<td>32439</td>
<td>91.6</td>
<td>42.0</td>
<td>1.4</td>
<td>513</td>
<td>0.248</td>
<td>0.228</td>
<td>3.42</td>
<td>15.08</td>
</tr>
<tr>
<td>S.Em+</td>
<td>995.26</td>
<td>2.8</td>
<td>1.3</td>
<td>0.04</td>
<td>14.71</td>
<td>0.07</td>
<td>0.04</td>
<td>0.10</td>
<td>0.42</td>
</tr>
<tr>
<td>C.D. at 5%</td>
<td>NS</td>
<td>8.0</td>
<td>3.7</td>
<td>0.1</td>
<td>42.00</td>
<td>NS</td>
<td>NS</td>
<td>0.28</td>
<td>1.22</td>
</tr>
</tbody>
</table>

Phosphorus (P$_0$), respectively. Similarly leaf length (42.5, 42.5 and 42.5 %, respectively), leaf width was (41.7, 41.1 and 41.8 %, respectively), leaf area per plant was (41.4, 41.4 and 41.3 per cent, respectively), leaf area index was (40.9, 41.5 and 41.3), leaf weight (green and dry) per plant (39.2, 39.1, 39.2 and 38.5, 42.2 and 38.5 per cent), stem weight (green and dry) per plant (40.4, 40.5, 40.4 and 46.6, 40.5 and 40.4 per cent), green fodder yield per plant (40.2, 40.2 and 40.2 per cent), dry matter per plant (45.1, 40.8 and 42.8 per cent), green fodder yield per hectare (43.6, 38.1 and 40.3 per cent) and dry fodder yield per cent (70.6, 63.1 and 65.6 per cent). Thus, it appears that improvement in these parameters due to application of phosphorus at right quantity and right time to the oat crop might be due to supply of plant nutrients. Thus, improvement of the various metabolic and physiological processes and thus known as “energy currency” which is subsequently used for vegetative and reproductive growth through phosphorylation which seems to have enhanced the meristematic activity and increased cell division and their elongation and ultimately increased plant height, leaf length, leaf width, leaf area per plant and leaf area index. The findings are closely related with the findings of Sood and Kumar (1994) and Patel and Rajgopal (2002) with respect to plant height, leaf length, leaf width, leaf area per plant, leaf area index and green and dry fodder yield q ha$^{-1}$ in oat crop.

**Interaction effect**

The interaction effect of nitrogen and phosphorus levels on plant height, leaf length, leaf width, leaf: stem ratio (green and dry), leaf area per plant, leaf area index, leaf and stem weight (green and dry) per plant, green and dry fodder yield per plant and green and dry fodder yield q ha$^{-1}$ were non-significant at first cut, second cut (at harvest) and in the mean values. The findings are closely related with the findings of Sood and Kumar (1994) and Patel and Rajgopal (2002) with respect to plant height, leaf length, leaf width, green and dry fodder yield q ha$^{-1}$ in oat crop.

**CONCLUSION**

The one year data indicate the maximum production and net realization of rabi fodder oat (Kent) through the application of 125 N + 75 P$_0$ kg ha$^{-1}$ under loamy sand soil of North Gujarat Agro-climatic conditions.

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