Yield and quality of fodder sorghum during summer season in southern Rajasthan as affected by the nitrogen levels and seed rates

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ABSTRACT

A field experiment to evaluate the effect of nitrogen levels (40, 60, 80 and 100 kg N/ha) and seed rates (30, 35, 40 and 45 kg/ha) on fodder sorghum cv. SU-1080 was carried out at Udaipur. Nitrogen application significantly increased the green fodder and dry matter yield due to increased plant height and stem diameter. Crude protein content was also increased due to an increase in nitrogen level. However, increase in nitrogen level decreased the crude fibre, total digestible nutrient (TDN) and nitrogen free extract (NFE) percentage. Nitrogen application @ 100 kg/ha produced significantly highest green fodder yield (495.11 q/ha) which was statistically similar to 80 kg N/ha (462.0 q/ha). Increase in seed rate significantly increased the plant density, plant height, green and dry matter yield and its contents but decreased the stem diameter. Crude fibre, crude protein and ash contents were decreased with increased seed rate but could not reach to significant level. Seed rate of 40 and 45 kg/ha produced statistically similar green fodder yield (466.45 and 476.07 q/ha, respectively). Fodder sorghum sown with a seed rate of 40 kg/ha and supplied with 80 kg N/ha proved to be the best combination for getting higher green fodder yield and its quality during summer season in southern Rajasthan.

Key words: Crude fibre, crude protein, dry matter accumulation, ash, TDN and NFE and fodder yield.

Fodder sorghum commonly known as “jowar” is a quick growing and short duration crop, grown for fodder purposes mainly under rain fed conditions because of its potential drought and heat tolerance and high dry matter production. Rajasthan possesses animals of very good quality but majority of animals are in a very poor condition due to under feeding and the available fodder supply less than actual need. Animals in Rajasthan are facing a deficiency both in energy and protein. There is acute shortage of quality as well as quantity of green fodder during lean period for the livestock in Southern Rajasthan which needs to be strengthened for livelihood security and promotion of dairying. The growing of fodder sorghum is a suitable option especially under water constraint in such situations.

Among various agronomic factors that may affect the yield and quality of fodder sorghum, the application of nitrogen is considered to be the most important. Sharma et al. (1996) reported that stover yield increased with increasing nitrogen rates. Similarly, Cho et al. (2001) also obtained significant increase in plant height, stem diameter, dry matter and crude protein yield due to application of nitrogen. Planting density is another important agronomic factor in fodder production which largely influences the field micro climate and ultimately influences growth, yield and quality parameters. Ayub et al., 2003 concluded that dry matter accumulation in main axis of sorghum was unaffected by increased population but the increased population reduced the weight per plant and leaf area. Similarly,
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Ayub et al. (2002) also reported that seed rate significantly influences the plant height, stem diameter, leaf area, yield, crude fibre, crude protein and ash percentage.

Considering all these situations in account and to optimize the seed rates and nitrogen levels in fodder sorghum production a study was undertaken to evaluate their impact on fodder yield and quality during summer season in southern Rajasthan.

Materials and Methods

A study pertaining to seed rate and nitrogen application effects on fodder yield and quality of fodder sorghum was carried out at the Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur during summer 2011. The experiment was laid out in factorial randomized completely block design with three replications having a net plot of 7.2 m². The sixteen treatment combinations comprises of four seed rates (30, 35, 40 and 45 kg/ha) and four nitrogen levels (40, 60, 80 and 100 kg/ha) were studied in this experiment. Sorghum cultivar “SU -1080” was sowed on a well prepared seedbed at 30 cm apart rows on 8th April. Half dose of nitrogen and 40 kg P/ha was applied as basal at the time of sowing through DAP and urea. Remaining half dose of the nitrogen for the respective treatments was applied at 40 days after sowing. All other standard agronomic practices for the cultivation of fodder sorghum were followed uniformly in all the treatments.

Five plants were selected at random for taking individual plant observations like plant height and stem diameter. Total dry matter was calculated by taking the random samples of 100 g from chopped green fodder and it was dried in the oven at 80°C for 72 hours to estimate dry matter percentage and then it was multiplied with respective crop yield to work out total dry matter yield. Quality parameters like crude protein, crude fibre and total ash contents were determined using methods given by AOAC (1984). Data was analyzed by using Fisher’s analysis of variance technique and the least significant difference was used to compare treatment means.

Results and Discussion

Yield attributes

Plant height is controlled by the genetic make up of the species and the environment to which the plants are subjected during the growth and development. The nitrogen application significantly increased the plant height ranging from 186.50 to 209.59 cm. The increase in plant height was recorded at the increased nitrogen level (Table 1). This decrease can be attributed to low nutrient availability in the soil for the plant growth. Increase in plant height with nitrogen application has also been reported by Khateek et al. (1999). Plots sown at seed rate of 40 kg/ha produced significantly taller plants (206.96 cm) than 30 and 35 kg/ha but did not differ significantly from 45 kg/ha. Significantly minimum plant height was recorded when crop was sown at 30 kg/ha seed rate. The increased plant height under higher plant density might be due to enhanced competition for the light and plant starts increasing its inter-nodal length as well as have upright leaves under such situations for better photosynthesis.

Plant density at 30 DAS was not influenced significantly by the application of nitrogen fertilizer but the plant density was significantly increased with increase in seed rate (Table 1). The highest plant density was obtained with the seed rate of 45 kg/ha which was 60.76 percent higher than 30 kg/ha. The interaction between these two factors was also not significant for plant density. It is quite obvious to obtain higher stand densities at higher seed rate provided that seeds have similar viability and 1000-seed weight. The results are quite in line to those of Ayub et al. (2003).

Stem diameter was affected significantly by both nitrogen application and seed rate (Table 1). The maximum (1.15 cm) and minimum (0.98 cm) stem diameter was recorded with the nitrogen level of 100 kg and 40 kg/ha, respectively. The better accumulation of the photosynthesis under higher N level might be contributed for healthy plant and sturdy stem which ultimately had enhanced the stem girth. Cho et al. (2001) have also reported significant effect of nitrogen
application on stem diameter of pearl millet. The stem diameter was decreased with increased seed rate and decrease was significant at each increased seed rate. The maximum (1.15 cm) and minimum (1.04 cm) stem diameter was recorded at seed rate of 30 kg and 40 kg/ha, respectively. Under higher planting densities, the resource constraints especially water, nutrient, sunlight and moreover the space might had contributed for the significant variation in the stem girth. The similar results were also reported by the Ayub et al. (2003) and Mahdi et al. (2011).

**Fodder yield**

The green fodder yield was significantly increased by increasing the nitrogen rate up to 80 kg/ha (Table 1). The increase in yield with increased nitrogen rate was mainly associated with more plant height and stem diameter. Increase in green fodder yield with nitrogen application has also been reported by Trivedi (2011). The green fodder yield was significantly increased by increasing the seed rate up to 40 kg/ha (Table 1). Fodder yield was increased with increase in seed rate. The increase in yield was mainly due to greater plant density. Increase in yield with increased seed rate has also been reported by Mahdi et al. (2011).

Dry matter yield was significantly affected both by nitrogen levels and seed rate (Table 1). The nitrogen level gave significantly higher dry matter yield over lower doses and increase was significant at each increased nitrogen level. Increase in dry matter yield with nitrogen application has also been reported by Saini (2012). Dry matter yield was also increased with increased seed rate and increase was significant at each increased seed rate. The yield is the function of the growth attributes in the fodder crop and the enhancement of these attributes contributed significantly and which ultimately resulted in variation in dry matter production. These results are quite in line with those reported by the Tomer et al. (1984).

**Quality parameters**

Dry matter percentage was affected significantly by both nitrogen levels and seed rate and each nitrogen level resulted in significantly higher dry matter percentage over lower doses (Table 2). Increase in dry matter

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Table 1. Effect of nitrogen levels and seed rates on yield attributes and yield of the fodder sorghum at harvest

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Stem girth (cm)</th>
<th>Dry matter accumulation (g/plant)</th>
<th>Plant population (per meter row length)</th>
<th>Fodder Yield (q/ha)</th>
<th>CD (P = 0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed rate (kg/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>178.80</td>
<td>1.15</td>
<td>120.84</td>
<td>21.69</td>
<td>367.79</td>
<td>134.56</td>
</tr>
<tr>
<td>35</td>
<td>195.93</td>
<td>1.13</td>
<td>113.26</td>
<td>23.12</td>
<td>403.35</td>
<td>144.73</td>
</tr>
<tr>
<td>40</td>
<td>206.83</td>
<td>1.04</td>
<td>111.52</td>
<td>30.37</td>
<td>466.45</td>
<td>163.23</td>
</tr>
<tr>
<td>45</td>
<td>209.96</td>
<td>1.04</td>
<td>109.50</td>
<td>34.87</td>
<td>476.07</td>
<td>173.45</td>
</tr>
<tr>
<td>SEM ±</td>
<td>3.98</td>
<td>0.03</td>
<td>2.36</td>
<td>0.75</td>
<td>12.45</td>
<td>3.53</td>
</tr>
<tr>
<td>CD (P = 0.05)</td>
<td>11.50</td>
<td>0.09</td>
<td>6.83</td>
<td>2.18</td>
<td>35.98</td>
<td>10.21</td>
</tr>
<tr>
<td>Nitrogen levels (kg/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>186.50</td>
<td>0.98</td>
<td>99.46</td>
<td>28.30</td>
<td>357.89</td>
<td>133.23</td>
</tr>
<tr>
<td>60</td>
<td>195.10</td>
<td>1.11</td>
<td>109.19</td>
<td>26.66</td>
<td>398.66</td>
<td>144.78</td>
</tr>
<tr>
<td>80</td>
<td>200.33</td>
<td>1.12</td>
<td>120.03</td>
<td>28.25</td>
<td>462.00</td>
<td>164.14</td>
</tr>
<tr>
<td>100</td>
<td>209.59</td>
<td>1.15</td>
<td>126.44</td>
<td>26.84</td>
<td>495.11</td>
<td>173.81</td>
</tr>
<tr>
<td>SEM ±</td>
<td>3.98</td>
<td>0.03</td>
<td>2.36</td>
<td>0.75</td>
<td>12.45</td>
<td>3.53</td>
</tr>
<tr>
<td>CD (P = 0.05)</td>
<td>11.50</td>
<td>0.09</td>
<td>6.83</td>
<td>NS</td>
<td>35.98</td>
<td>10.21</td>
</tr>
</tbody>
</table>
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Percentage with nitrogen application has also been reported by Ayub et al. (2002 and 2003) for maize and sorghum fodder, respectively. Dry matter percentage was also increased with increased seed rate and increase was significant at each increased seed rate. The maximum dry matter (120.84 g plant⁻¹) was noted at seed rate of 30 kg/ha. The results are quite in line with those of Ayub et al. (2002) for maize fodder.

Crude fibre is one of the most important parameter influencing the quality of fodder crops. The crude fibre contents increase with the age of the plant. The higher the crude fibre contents lower will be the digestibility. It is obvious from the data given in Table 2 that the effect of nitrogen application on crude fibre content was significant. Crude fibre decreased with increasing the nitrogen rate up to 100 kg/ha.

Table 2. Effect of nitrogen levels and seed rates on fodder quality parameters of the sorghum at harvest

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Crude protein (%)</th>
<th>Crude fibre (%)</th>
<th>Ether extract (%)</th>
<th>Mineral ash (%)</th>
<th>TDN (%)</th>
<th>NFE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed rate (kg ha⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>7.53</td>
<td>32.03</td>
<td>1.769</td>
<td>8.00</td>
<td>56.59</td>
<td>50.67</td>
</tr>
<tr>
<td>35</td>
<td>7.46</td>
<td>31.95</td>
<td>1.731</td>
<td>7.68</td>
<td>56.73</td>
<td>51.17</td>
</tr>
<tr>
<td>40</td>
<td>7.33</td>
<td>31.93</td>
<td>1.724</td>
<td>7.63</td>
<td>56.78</td>
<td>51.39</td>
</tr>
<tr>
<td>45</td>
<td>7.29</td>
<td>31.42</td>
<td>1.722</td>
<td>7.51</td>
<td>56.86</td>
<td>52.06</td>
</tr>
<tr>
<td>SEm ±</td>
<td>0.07</td>
<td>0.24</td>
<td>0.019</td>
<td>0.12</td>
<td>0.08</td>
<td>0.29</td>
</tr>
<tr>
<td>CD (P = 0.05)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.85</td>
</tr>
<tr>
<td>Nitrogen levels (kg ha⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>6.43</td>
<td>32.70</td>
<td>1.665</td>
<td>7.29</td>
<td>57.02</td>
<td>51.91</td>
</tr>
<tr>
<td>60</td>
<td>7.12</td>
<td>32.29</td>
<td>1.715</td>
<td>7.44</td>
<td>56.90</td>
<td>51.44</td>
</tr>
<tr>
<td>80</td>
<td>7.72</td>
<td>31.40</td>
<td>1.757</td>
<td>7.80</td>
<td>56.67</td>
<td>51.32</td>
</tr>
<tr>
<td>100</td>
<td>8.34</td>
<td>30.94</td>
<td>1.809</td>
<td>8.30</td>
<td>56.36</td>
<td>50.61</td>
</tr>
<tr>
<td>SEm ±</td>
<td>0.07</td>
<td>0.24</td>
<td>0.019</td>
<td>0.12</td>
<td>0.08</td>
<td>0.29</td>
</tr>
<tr>
<td>CD (P = 0.05)</td>
<td>0.20</td>
<td>0.69</td>
<td>0.054</td>
<td>0.36</td>
<td>0.24</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Table 3. Correlation coefficient and regression equation between dependent (y) and independent variables (x)

<table>
<thead>
<tr>
<th>Dependent (Y)</th>
<th>Independent (X)</th>
<th>r</th>
<th>r²</th>
<th>Regression equation Y = a + bx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green fodder yield</td>
<td>Plant height at harvest</td>
<td>0.732**</td>
<td>0.536</td>
<td>Y = -343.037 + 3.899 X</td>
</tr>
<tr>
<td>Dry fodder yield</td>
<td>Plant height at harvest</td>
<td>0.752**</td>
<td>0.566</td>
<td>Y = -90.964 + 1.238 X</td>
</tr>
<tr>
<td>Dry fodder yield</td>
<td>Crude fibre</td>
<td>0.867**</td>
<td>0.752</td>
<td>Y = 977.6 - 25.87x</td>
</tr>
<tr>
<td>Dry fodder yield</td>
<td>Total digestible nutrient</td>
<td>0.412</td>
<td>0.170</td>
<td>Y = 2062 - 33.63x</td>
</tr>
<tr>
<td>Dry fodder yield</td>
<td>Mineral ash</td>
<td>0.365</td>
<td>0.133</td>
<td>Y = 9.390 + 18.76x</td>
</tr>
<tr>
<td>Dry fodder yield</td>
<td>Crude protein</td>
<td>0.615*</td>
<td>0.378</td>
<td>Y = 13.65 + 18.95x</td>
</tr>
</tbody>
</table>

** Significant at 1 per cent level of probability
* Significant at 5 per cent level of probability
Fig. 1. Correlation of different quality parameters with the dry matter yield in fodder sorghum.
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The effect of seed rate on the crude fibre contents was not significant. The maximum (32.03%) and minimum (31.42%) crude fibre contents were noted at seed rate of 30 and 45 kg/ha, respectively. Non-significantly effect of seed rate on crude fibre has also been reported by Medina et al. (1984) and Ayub et al. (2002).

The application of nitrogen fertilizer significantly influenced the crude protein contents (Table 2). All nitrogen levels produced significantly higher crude protein contents than lower doses. The differences between 40 and 100 kg N/ha were significant. The increase in crude protein contents with the application of nitrogen fertilizer has also been reported by Ayub et al. (2003). The effect of seed rate on crude protein contents was not significant. The results are similar to those of Medina et al. (1984).

The nitrogen levels of 100 kg N/ha produced ash contents significantly higher than 40, 60 and 80 kg N/ha (Table 2). The differences between 40 kg N/ha and 60 were not significant. Safdar (1997) and Tariq (1998) have also reported significant effect of nitrogen application on ash contents. The effect of seed rate on ash contents was not significant but decreased with increased seed rate. These results are contradictory to those of Ayub et al. (2002). These contradictory results might have been due to species differences.

**Regression and correlation studies**

A significant correlation was found between the dry matter yield to the crude fibre, crude protein content and plant height of the fodder sorghum while the weak correlation was found with total digestible nutrients and mineral ash content (Table 3 and Fig. 1). It indicates that yield of sorghum can be predicted well with the crude fibre, crude protein and plant height but it can not done with the mineral ash content and total digestible nutrients.

Based on the above-mentioned discussion it may be concluded that the fodder sorghum yield and quality can be improved with the application of 80 kg N/ha and 40 kg seed rate/ha under southern Rajasthan conditions during summer season.

**REFERENCES**


