Fodder Yield and Quality of Sorghum (*Sorghum bicolor* L.) As Influenced by Different Tillage Methods and Seed Rates

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Abstract: A field was conducted at Faisalabad, Pakistan during 2001, to study the effect of 80, 100 and 120 kg seed rate ha$^{-1}$ on sorghum (*Sorghum bicolor* L.) cultivar ‘Hegari’ grown on soil prepared by different tillage methods i.e. deep tillage (one ploughing with disc plough+two ploughing with cultivator+one planking), conventional tillage (two ploughings with cultivator+two planking) and zero tillage. The increase in seed rate significantly increased the green fodder (18-35%) and dry matter yields (21-40%) and yield components like plant density, plant height and number of leaves plant$^{-1}$ but decreased the stem diameter (0.9-8%). The quality parameters like ash, crude fibre and crude protein contents were decreased and dry matter percent increased with increased seed rate. The deep tillage owing to more number of leaves plant$^{-1}$ (11.21), plant density (47.30 m$^{-2}$), plant height (193.13 cm) resulted in significantly greater dry matter (5.66 t ha$^{-1}$) and green fodder yields (31.59 t ha$^{-1}$) than zero tillage. The seed rate of 120 kg ha$^{-1}$ , sown on soil prepared by deep tillage proved to be the best combination for getting higher green fodder yield (35.15 t ha$^{-1}$) of sorghum (*Sorghum bicolor* L.) cultivar ‘Hegari’ under Faisalabad conditions.

Key words: Fodder production, *Sorghum bicolor* L., yield, seed rate, tillage method, crude fibre, crude protein

Introduction

Sorghum is commonly grown as a fodder crop during the kharif season in Pakistan. Its fodder yield is very low and is considered poor in quality due to low protein contents. Therefore a need is felt to improve the quality and quantity of its fodder. The tillage method is considered one of the major factors for increasing the yield on unit$^{-1}$ area basis. Soils are tilled to provide conditions for optimum plant growth and for necessary field operations. Tillage induced changes in the soil physical properties and had degradation effect on soil (Lal, 1997). Jasa *et al.* (1999) obtained highest sorghum grain yield in no tilled plots. Similarly, Munyati (1997) while comparing five tillage practices on maize found that no tillage produced the highest mean grain yield of 5.9 t ha$^{-1}$ and sustained lowest soil loss. However, Zimmer *et al.* (2000) reported that average yield of not-tilled maize was less than conventional tilled maize. The effectiveness of tillage depends upon management practices. Low plant population has been suggested to be the main cause of low fodder yield using zero tillage (Hughes *et al.*, 1992). No tillage reduced the plant stand and
delayed the plant emergence (Drury et al., 1999). The seeding density is an important agronomic factor which can improve the yield by improving the plant population and is considered more important under zero tillage conditions. Plant density not only affected the growth and fodder production but also affected the quality of the forage (Ayub et al., 1999; Marwat et al., 1999; Ahmad, 1999). The informations on the Interactive effect of tillage and seed rates on sorghum fodder yield and quality are lacking in Pakistan. The present study was therefore, designed to find out the most suitable seed rate and tillage operation for fodder sorghum under Faisalabad conditions.

Materials and Methods
The experiment was conducted under field conditions in the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan. The experiment was quadruplicated in randomized complete block design with split plot arrangement using a net plot size 1.8 m × 10 m. Sorghum cultivar ‘Hegari’ was grown using a seed rate of 80, 100 and 120 kg ha⁻¹. The seedbed was prepared by different tillage methods i.e. deep tillage (one ploughing with disc plough + two ploughing with cultivar + two planking), conventional tillage (two ploughing with cultivator + one planking) and zero tillage. The crop was sown in 30 cm apart rows with single row hand drill. A basal dose of 75 kg N and 60 kg P₂O₅ ha⁻¹ was applied with first irrigation in the form of urea and single super phosphate, respectively. Quality parameters like crude protein, crude fibre, ether extractable fat and total ash were determined by using methods recommended by AOAC (1984). The data collected was analysed statistically by using Fisher’s analysis of variance technique and Duncan’s multiple range test (DMRT) at 5% probability level was employed to compare the significance of treatment’s means. (Steel and Torrie, 1984).

Results and Discussions
Yield attributes and yield
Plant density was significantly increased with increased seed rate. The maximum number of plants m⁻² were recorded with a seed rate of 120 kg ha⁻¹. Whereas, the minimum plant density was obtained with a seed rate of 80 kg ha⁻¹. Ayub et al. (1999) also reported that plant density increased with increased seed rate. Since all treatments were sown with seed having almost same viability and 1000 grain weight, therefore it was obvious to get higher stand density at higher seed rates. Crop sown in plots prepared with deep tillage exhibited significantly higher number of plants m⁻² than zero tillage but it did not differ significantly from conventional tillage. Improper depth might have resulted in lower plant density in zero tilled plots. These results confirm findings of Drury et al. (1999.)

Increase in seed rate significantly increased the plant height (Table 1). Plots sown at a seed rate of 120 kg ha⁻¹ produced significantly taller plants than other seed rates. The increase in plant height at higher seed rates might have been due to the more competition among the plants for light. The results confirm the findings of Ayub et al. (1999). Plant height was also affected significantly by different tillage methods. The maximum plant height was recorded from deep tilled plots and it was not significantly different from conventional tillage. The minimum plant
Table 1: Effect of tillage and seed rates on growth and yield components of sorghum fodder

<table>
<thead>
<tr>
<th>Seed rates (kg ha(^{-1}))</th>
<th>Plant density (m(^{-2}))</th>
<th>Plant height (cm)</th>
<th>No. of leaves plant(^{-1})</th>
<th>Dry matter yield (t ha(^{-1}))</th>
<th>Crude protein (%)</th>
<th>Crude fibre (%)</th>
<th>Ash contents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>36.27c</td>
<td>178.99c</td>
<td>10.01c</td>
<td>8.66 (^{NC})</td>
<td>33.54a</td>
<td>8.08a</td>
<td>3.95c</td>
</tr>
<tr>
<td>100</td>
<td>43.11b</td>
<td>184.59b</td>
<td>10.53b</td>
<td>8.53</td>
<td>3196b</td>
<td>7.69a</td>
<td>4.77b</td>
</tr>
<tr>
<td>120</td>
<td>50.58a</td>
<td>191.71a</td>
<td>10.93a</td>
<td>8.43</td>
<td>28.42b</td>
<td>7.13b</td>
<td>5.55b</td>
</tr>
</tbody>
</table>

Tillage methods

- Deep tillage: 47.30a 193.13a 11.21a 8.66 \(^{NC}\) 7.90 \(^{NC}\) 31.17 \(^{NC}\) 5.66a
- Conventional tillage: 46.02a 190.75a 10.88a 8.52 7.50 33.67 5.04b
- Zero tillage: 36.64b 171.41b 9.38b 8.43 7.50 29.08 3.57c

Table 2: Effect of seed rate and tillage method on stem diameter, green fodder yield and dry matter percent

<table>
<thead>
<tr>
<th>Seed rates (kg ha(^{-1}))</th>
<th>Stem diameter (cm)</th>
<th>Green fodder yield (t ha(^{-1}))</th>
<th>Dry matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 (S(_1))</td>
<td>1.16a</td>
<td>23.80c</td>
<td>16.43c</td>
</tr>
<tr>
<td>100 (S(_2))</td>
<td>1.15a</td>
<td>28.15b</td>
<td>16.93b</td>
</tr>
<tr>
<td>120 (S(_3))</td>
<td>1.07b</td>
<td>32.06a</td>
<td>17.24a</td>
</tr>
</tbody>
</table>

Tillage methods

- Deep tillage (T\(_1\)): 1.14a 31.59a 17.88a
- Conventional tillage (T\(_2\)): 1.19a 30.11a 16.90ab
- Zero tillage (T\(_3\)): 1.04b 22.31b 15.81b

Interaction between seed rate and tillage method

- S\(_1\) × T\(_1\): 1.16b 27.95d 17.32c
- S\(_1\) × T\(_2\): 1.24a 25.78e 16.54c
- S\(_1\) × T\(_3\): 1.07cd 17.68g 15.44g
- S\(_2\) × T\(_1\): 1.16b 31.70c 17.87b
- S\(_2\) × T\(_2\): 1.26a 30.74c 16.93c
- S\(_2\) × T\(_3\): 1.04d 22.01f 15.98f
- S\(_3\) × T\(_1\): 1.12bc 35.13a 18.45a
- S\(_3\) × T\(_2\): 1.09cd 33.83b 17.22a
- S\(_3\) × T\(_3\): 1.02d 27.23d 16.00f

Means having the similar letter did not differ significantly at 5% probability levels

height was recorded in plots which were not tilled. Vyn and Raimbault (1993) have also observed minimum plant height with zero tillage. However, these results are contradictory to those of Kapusta et al. (1996) who reported that plant height was greater in no tilled plots than in tilled plots. These differences might have been due to variation in soil type, fertility status or climatic conditions.
Increase in the seed rate significantly decreased stem diameter (Table 2). The plots sown at a seed rate of 120 kg ha\(^{-1}\) produced the plants having significantly less stem diameter than 80 and 100 kg ha\(^{-1}\). The decrease in stem diameter with increased seed rate might have been due to more competition among the plants. The results are in line with those of Ahmad (1999) and Ayub et al. (1999). The differences between deep and conventional tillage were not significant for stem diameter but both these treatments have significantly thicker stem than zero tillage. The interaction between seed rate and tillage methods was also significant. The conventionally tilled plots and sown at a seed rate of 80 and 100 kg ha\(^{-1}\) produced plants of similar stem diameter but significantly thicker than all other combinations. The minimum stem diameter was recorded in zero tilled plots sown at a seed rate of 120 kg ha\(^{-1}\).

All the seed rates differed significantly from one another regarding the number of leaves plant\(^{-1}\). Sorghum sown at seed rate of 120 kg ha\(^{-1}\) gave maximum number of leaves plant\(^{-1}\). These results are contradictory to those of Jeon et al. (1992). They reported that number of leaves plant\(^{-1}\) decreased with increased seed rate. These contradictory results might have been due to the difference in genetic traits of crop plants and fertility status of the soil. The crop sown in deep tilled plots gave maximum number of leaves plant\(^{-1}\) which remained at par with conventionally tilled plots. The reason for having lower number of leaves plant\(^{-1}\) in zero tilled plots might be the shorter plants and less number of nodes plant\(^{-1}\). The interaction between the seed rates and tillage methods was not significant.

The increase in seed rate significantly increased the green fodder and dry matter yield and all seed rates differed significantly from one another. The increase in yield was mainly due to greater plant density and height. The results are in line with those of Saheb et al. (1997), Ahmad (1999) and Ayub et al. (1999) who also reported that increase in seed rate increased green fodder and dry matter yield. Deep tilled plots gave the maximum green fodder and dry matter yield. The increase in green fodder yield can be attributed to early and better emergence and taller plants. Low fodder yield in zero tillage has also been reported by Hughess et al. (1992). The interaction between seed rates and tillage methods was significant for green fodder yield only. The maximum green fodder yield was obtained when crop was sown at seed rate of 120 kg ha\(^{-1}\) with deep tillage method and the minimum was recorded using a seed rate of 80 kg ha\(^{-1}\) in zero tilled plots.

**Quality parameters**

Dry matter percentage was significantly affected both by seed rates and tillage methods. There has been a gradual increase in the dry matter percentage with increase in seed rate and each increase was significant. Increase in dry matter percentage with increased seed rate has also been reported by Ahmad (1999). Deep tillage produced significantly higher dry matter percentage than zero tillage but was statistically similar to that of conventional tillage. The differences between zero and conventional tillage could not reach to a level of significance. The higher dry matter percentage in tilled plots might have been due to more competition between plants for water having greater number of plants in these plots. Interaction between seed rate and tillage methods was also significant. Sorghum sown at seed rate of 120 kg ha\(^{-1}\) with deep
tillage gave the maximum dry matter percentage and minimum was recorded when sorghum was sown without tillage using a seed rate of 80 kg ha\(^{-1}\).

Crude protein contents were not influenced by both seed rate and tillage methods, however, increase in seed rate resulted a decrease in crude protein. Non-significant effects of seed rate on crude protein contents have also been reported by Wermke and Hoyningen-Huene (1987).

Different seed rates significantly affected the crude fibre percentage. The crude fibre contents were decreased with increased seed rate. The crop sown at a seed rate of 80 kg ha\(^{-1}\) produced significantly more crude fibre contents than crop sown at a seed rate of 120 kg ha\(^{-1}\). The results are supported by the findings of Ayub et al. (1999) who also observed a decrease in crude fibre contents with increased seed rate. The effect of tillage methods on crude fibre percentage was not significant.

Seed rates significantly affected the ash contents. The plots sown at the seed rate of 80 and 100 kg ha\(^{-1}\) produced statistically similar ash contents but both these seed rates have significantly higher ash contents than seed rate of 120 kg ha\(^{-1}\). A decrease in ash contents with increased seed rate has also been reported by Ayub et al. (1999). The effects of tillage methods on ash percent were not significant.

References