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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 lock design with split plot arrangement using a net plot size 1.8 m $\times$ 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 P_2O_5 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

Seed rates (kg ha^{-1})	Plant density (m^{-2})	Plant height (cm)	No. of leaves $plant^{-1}$	Dry matter yield (t ha^{-1})	Crude protein (%)	Crude fibre (%)	Ash contents (%)
80	36.27c	178.99c	10.01c	8.66 ^{NS}	33.54a	8.08a	3.95c
100	43.11b	184.59b	10.53b	8.53	3196b	7.69a	4.77b
120	50.58a	191.71a	10.93a	8.43	28.42b	7.13b	5.55b
Tillage methods							
Deep tillage	47.30a	193.13a	11.21a	8.66 ^{NS}	7.90 ^{NS}	31.17 ^{NS}	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

	Stem diameter (cm)	Green fodder yield (t ha^{-1})	Dry matter (%)
Seed rate (kg ha^{-1})			
80 (S_1)	1.16a	23.80c	16.43c
100 (S_2)	1.15a	28.15b	16.93b
120 (S_3)	1.07b	32.06a	17.24a
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			
$S_1 \times T_1$	1.16b	27.95d	17.32c
$S_1 \times T_2$	1.24a	25.78e	16.54c
$S_1 \times T_3$	1.07cd	17.68g	15.44g
$S_2 \times T_1$	1.16b	31.70c	17.87b
$S_2 \times T_2$	1.26a	30.74c	16.93c
$S_2 \times T_3$	1.04d	22.01f	15.98f
$S_3 \times T_1$	1.12bc	35.13a	18.45a
$S_3 \times T_2$	1.09cd	33.83b	17.22a
$S_3 \times T_3$	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 had 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.

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