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# Effect of Different Levels of Nitrogen and Harvesting Times on the Growth, Yield and Quality of Sorghum Fodder

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**Abstract**: In a field trail at Faisalabad, fodder yield and quality of sorghum (*Sorghum bicolor* L.) cultivar JS-263 as influenced by different nitrogen levels (0, 50, 100 and 150 kg $ha^{-1}$) and harvesting times (45, 60 and 75 days after sowing) was studied in 2000. Both green and dry matter yields were increased with increasing nitrogen levels and delaying harvest. The increase in yield was mainly due to higher plant height, stem diameter and number of leaves $plant^{-1}$. The contents of crude protein, ether extractable fat and ash were increased with increased nitrogen levels and decreased with delaying the harvest. Whereas, neutral and acid detergent fiber were increased by delaying the harvest and decreased by the nitrogen application. Based on these finding, the nitrogen level of 150 kg $ha^{-1}$ and harvesting time 75 days after sowing was found better combination for getting higher yields of sorghum cultivar JS-263 under Faisalabad conditions.

**Key words:** Sorghum (*Sorghum bicolor* L.), nitrogen, harvesting times, fodder yield and quality

## Introduction

Fodder scarcity is considered as a major limiting factor for a prosperous of livestock industry in Pakistan as the available fodder production is approximately 52 – 54 % less than actual requirement for animals (Bhatti, 1998). Sorghum in addition to being poor in quality is also low yielding due to non ratooning ability. Therefore, to improve yield and quality of sorghum fodder it is essential to determine its nitrogen requirement. The application of nitrogen not only affect the yield but also improve quality from view point of its protein contents (Mohamed and Hamed, 1988). According to Patel *et al*. (1994) dry matter yield was increased and crude fiber contents were decreased with increased nitrogen application from 40 to 120 kg $ha^{-1}$. Increased nitrogen rate increased the protein and digestible dry matter yield (Rana *et al*. 1990). The varieties vary greatly in their response to fertilizer application (Chandravanshi *et al*., 1973). Muhammad and Hasan (1994) reported that CSH6 and CSH9 responded better to the applied nitrogen than CSH14 and SPV 946.

Another important factor affecting the quality and yield of forage crops is their growth stage at harvest. The effects of harvesting date on the chemical composition of forage are greater than that of cultivars (Firdous *et al*., 1996). Rana *et al*. (1990) reported that sorghum harvested 90 days after sowing increased the yield of the first cut but decreased the second cut yield. Total yield was lowest, when first cut was taken 60 days after sowing.

The study was therefore, designed to determine the optimum nitrogen level and harvesting time for the obtaining higher fodder yield of sorghum having good quality under Faisalabad conditions.

## Materials and Methods

This field experiment to evaluate the effect of different nitrogen levels on yield and quality of sorghum fodder harvested at different times was conducted at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan. The experiment was laid out in Randomised Complete Block Design (factorial arrangement) having a net plot size of 2.4 x 5 $m^2$. The sorghum cultivar JS-263 was sown on May 22, 2000 in 30 cm apart rows with single row hand drill. The nitrogen fertilizer was applied at the rate of 0, 50, 100 and 150 kg $ha^{-1}$ in the form of urea and 60 kg P $ha^{-1}$ was applied as single super phosphate. Both phosphorus and prescribed levels of nitrogen were applied at sowing time. Ten plants were selected at random from each plot to record individual plant observations like plant height, stem diameter and number of leaves $plant^{-1}$. Plant height was taken with measuring tape from ground level up to the highest leaf tip. Stem diameter was measured with the help of vernier calliper from top, middle and bottom portions and then the averages were calculated. For quality parameters, samples were sun dried for five days and finally in the oven at 70 °C for 48 hours. Protein contents, crude fiber, ether extractable fat, ash, acid and neutral detergent fiber were determined by using methods recommended by AOAC (1984).

The data collected were analyzed statistically by using Fisher's analysis of variance technique and differences among treatment means were compared by using least significant difference (LSD) test at 5% probability level (Steel and Torrie, 1984).

## Results and Discussions

**Plant height (cm):** Plant height was affected significantly by both nitrogen levels and harvesting times (Table 1). All nitrogen levels produced significantly taller plants as compared to control and the differences among nitrogen levels were also significant. The results are in line with those of Ahmad (1999). The present results are different to those of Sumantri and Lestari (1997) and these differences can be attributed to difference in fertility status of the soil or genetic make up of the cultivars. Plant height was increased with the advancement in maturity. The crop harvested 75 days after sowing gave the maximum plant height and minimum plant height was obtained when the crop was harvested 45 days after sowing. An increase in the plant height with delayed harvesting has also been reported by Musa *et al*. (1993). The interaction between harvesting times and nitrogen levels was also significant. Nitrogen levels differed significantly from one an other when crop was harvested 60 and 75 days after sowing but differences between 50 and 100 kg N $ha^{-1}$ were not significant when the crop was harvested 45 days after sowing. The plots receiving 150 kg N $ha^{-1}$ and harvested 75 days after sowing produced the maximum plant height.

**Stem diameter (cm)**: All nitrogen levels produced significantly thicker stem than control (Table 2) and differences within the nitrogen treatments were also significant. The maximum stem diameter (1.07 cm) was observed with the nitrogen application of 150 kg $ha^{-1}$. An increase in the stem diameter with nitrogen application has also been reported by Ahmad (1999) and Ali (2000). The plot harvested 75 days after sowing produced significantly thicker stem (1.08 cm) than other treatments. The crop harvested 45 days after sowing produced the minimum (0.70 cm) stem diameter. The interaction between nitrogen levels and harvesting times was also significant. Significant differences were recorded among fertilizer treatments when crop was harvested 60 and 75 days after sowing. The differences between nitrogen level of 100 and 150 kg $ha^{-1}$ were not significant when crop was harvested 45 days after sowing. The plot fertilized @ 150 kg N $ha^{-1}$ and harvested 75 days after sowing produced the maximum stem diameter.

**Green fodder yield (t $ha^{-1}$)**: All the nitrogen levels produced significantly higher fodder yield than control (Table 3). The plots

Table 1: Effect of different nitrogen levels and harvesting times on plant height (cm) of sorghum

| Nitrogen levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Mean |
|---|---|---|---|---|
| 0 | 135.00h | 149.67g | 171.00e | 151.89d |
| 50 | 145.33g | 162.67f | 182.00d | 163.33c |
| 100 | 151.33g | 174.00e | 207.33b | 177.56b |
| 150 | 164.00f | 198.67c | 241.67a | 201.44a |
| Mean | 148.92c | 171.25b | 200.50a | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table 2: Effect of different nitrogen levels and harvesting times on stem diameter (cm) of sorghum

| Nitrogen levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Mean |
|---|---|---|---|---|
| 0 | 0.60h | 0.68g | 0.86de | 0.72d |
| 50 | 0.71g | 0.83ef | 1.03c | 0.86c |
| 100 | 0.80f | 0.91d | 1.14b | 0.95b |
| 150 | 0.85ef | 1.07c | 1.29a | 1.07a |
| Mean | 0.70c | 0.87b | 1.08a | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table 3: Effect of different nitrogen levels and harvesting times on green fodder yield (t ha$^{-1}$) of sorghum

| Nitrogen Levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Mean |
|---|---|---|---|---|
| 0 | 30.93f | 37.09f | 45.35de | 37.79d |
| 50 | 34.14f | 47.92d | 60.87c | 47.64c |
| 100 | 38.95ef | 62.83c | 81.10b | 60.96b |
| 150 | 50.18d | 68.10c | 109.03a | 75.77a |
| Mean | 38.55c | 53.98b | 74.09a | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table 4: Effect of different nitrogen levels and harvesting times on dry matter yield (t ha$^{-1}$) of sorghum

| Nitrogen Levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Mean |
|---|---|---|---|---|
| 0 | 6.30i | 9.79gh | 15.75e | 10.61d |
| 50 | 7.13i | 12.74f | 21.79c | 13.89c |
| 100 | 8.18hi | 17.04de | 28.46b | 17.89b |
| 150 | 10.80fg | 18.80d | 38.03a | 22.54a |
| Mean | 8.10c | 14.59b | 26.01a | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table 5: Effect of different nitrogen levels and harvesting times on crude protein (%) of sorghum fodder

| Nitrogen Levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Mean |
|---|---|---|---|---|
| 0 | 7.00cde | 6.70de | 5.50f | 6.40d |
| 50 | 8.38b | 7.22cd | 6.34e | 7.31c |
| 100 | 8.89b | 8.41b | 7.22cd | 8.17b |
| 150 | 10.64a | 8.98b | 7.51c | 9.04a |
| Mean | 8.73a | 7.83b | 6.64c | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

receiving nitrogen @ 150 kg ha$^{-1}$ gave significantly higher green fodder yield (75.77 t ha$^{-1}$), whereas, minimum green fodder yield was observed in control. The increase in green fodder yield was due to greater plant height and stem diameter. Ahmad (1999) and Ali (2000) have also reported significant effect of nitrogen application on green fodder yield of sorghum. But Chittapur *et al.* (1994) reported non-significant effect of nitrogen application on fodder yield of sorghum. These contradictory results might have been due to variation in fertility status of soil, climatic conditions or genetic trait of crop plants. The crop harvested 75 days after sowing produced maximum green fodder yield, whereas plots harvested 45 days after sowing gave the minimum green fodder yield. Increase in fodder yield with delayed harvesting has been mainly due to taller plants and thicker stems. Increase in fodder yield by extending period before harvest has also been reported by Balasubramanian and Ramamoorthy (1996). The interaction between nitrogen levels and harvesting times was also significant. The nitrogen levels differed significantly from one another when crop was harvested 75 days after sowing and the differences between 100 and 150 kg ha$^{-1}$ could not reach to a significant level when crop was harvested 60 days after sowing and similarly differences among 0, 50 and 100 kg ha$^{-1}$ were not significant when crop was harvested 45 days after sowing. The plots receiving nitrogen @ 150 kg ha$^{-1}$ and harvested 75 days after sowing produced maximum fodder yield.

Table 6: Effect of different nitrogen levels and harvesting times on Neutral detergent fiber (%)of sorghum fodder

| Nitrogen levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Means |
|---|---|---|---|---|
| 0 | 63.50g | 65.10d | 69.50a | 66.03a |
| 50 | 62.57h | 64.50e | 68.37b | 65.15b |
| 100 | 61.40i | 64.00f | 67.60c | 64.33c |
| 150 | 60.90j | 62.51h | 67.40c | 63.60d |
| Mean | 62.09c | 64.03b | 68.22a | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table 7: Effect of different nitrogen levels and harvesting times on acid detergent fiber (%)of sorghum fodder

| Nitrogen levels (kg ha$^{-1}$) | Harvesting times (Days after sowing) 45 | 60 | 75 | Means |
|---|---|---|---|---|
| 0 | 49.40e | 49.47e | 51.80a | 50.22a |
| 50 | 48.44fg | 49.20e | 51.40b | 49.68b |
| 100 | 48.10h | 48.70f | 50.80c | 49.20c |
| 150 | 48.10h | 48.30gh | 50.10d | 48.83d |
| Mean | 48.51c | 48.92b | 51.03a | |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

Table 8: Ether extractable fat and total ash percent as influenced by nitrogen application and harvesting time

| Parameters | Ether extractable fat | Total ash |
|---|---|---|
| Nitrogen levles (kg ha$^{-1}$) | | |
| 0 | 1.59c | 7.64c |
| 50 | 1.77b | 7.83bc |
| 100 | 1.82b | 7.98b |
| 150 | 1.95a | 8.26a |
| Harvesting times (days after sowing) | | |
| 45 | 1.97a | 8.22a |
| 60 | 1.75b | 7.89b |
| 75 | 1.63c | 7.67c |

Any two means not sharing a letter in common differ significantly from each other at 5% level of probability

**Dry matter yield (t ha$^{-1}$)**: Application of nitrogen significantly affected the dry matter yield (Table 4). Dry mater yield was increased significantly at each increased rate of nitrogen. The maximum dry matter yield was recorded from the plots fertilized @ 150 kg N ha$^{-1}$ and plots receiving no nitrogen gave the

minimum dry matter yield. The significant effect of nitrogen levels on dry matter yield has also been reported by Ahmad (1999) and Ali (2000).

Harvesting times also significantly affected the dry matter yield. The maximum dry matter yield (26.01 t $ha^{-1}$) was recorded from plots harvested 75 days after sowing and the minimum (8.10 t $ha^{-1}$) from plots harvested 45 days after sowing. Similar results have also been reported by Balasubramanian and Ramamoorthy (1996). The interaction between nitrogen levels and harvesting times was also found to be significant. At first (45 days after sowing) and third (75 days after sowing) harvest, the application of 150 kg N $ha^{-1}$ produced significantly higher yield than other nitrogen levels, whereas at second harvest (60 days after sowing) the application of 100 and 150 kg N $ha^{-1}$ had a statistically similar dry matter yield. The differences among 0, 50 and 100 kg N $ha^{-1}$ were not significant at first harvest but differences were significant at second and third harvest. The maximum dry matter yield was produced when nitrogen was applied @ 150 kg $ha^{-1}$ and crop was harvested 75 days after sowing.

**Crude protein:** Crude protein contents were significantly influenced by different nitrogen levels (Table 5). A significant increase in the crude protein contents were observed at each increased level of nitrogenl. A maximum and minimum crude protein contents were recorded, when nitrogen was applied @ 150 and 0 kg $ha^{-1}$, respectively. Nitrogen being a basal component of amino acid might have enhanced the protein contents. Increase in crude protein with nitrogen application has also been reported by Ahmad (1999) and Ali (2000). Crude protein contents were also influenced significantly by different harvesting times. The crude protein contents were decreased as the period before harvest was extended. The maximum and minimum crude protein contents were obtained when crop was harvested 45 and 75 days after sowing, respectively. The results are quite in line with those of Siddique *et al.* (1989). The interaction was also significant and differences between nitrogen levels of 50 and 100 kg $ha^{-1}$ could not reach to a significant level when crop was harvested 45 days after sowing. Whereas, at remaining harvesting times the differences between 50 and 100 kg N $ha^{-1}$ were significant. The differences between nitrogen levels of 100 and 150 kg $ha^{-1}$ also could not reach to significant level when crop was harvested 60 and 75 days after sowing. The maximum crude protein percent was recorded at first harvest with the application of 150 kg N $ha^{-1}$.

**Neutral detergent fiber:** Nitrogen application significantly affected the neutral detergent fiber concentration (Table 6). The maximum neutral detergent fiber concentration was recorded in control plots and it decreased with increased nitrogen levels. This is probably due to the fact that nitrogen application enhanced the vegetative growth and delayed the maturity of the crop. Neutral detergent fiber contents were increased with advancement in maturity. The maximum and minimum neutral detergent fiber contents were recorded when crop was harvested 75 and 45 days after sowing, respectively. Lemerle *et al.* (1985) also reported an increase in neutral detergent fiber with delayed harvesting. The interaction between nitrogen and harvesting times was also significant. The fertilizer levels differed significantly at first (45 days after sowing) and second (60 days after sowing) harvest. Whereas, the difference between 100 and 150 kg N $ha^{-1}$ were not significant when crop was harvested 150 days after sowing. The maximum neutral detergent fiber concentration was recorded in plots receiving no nitrogen and harvested 75 days after sowing.

**Acid detergent fiber:** Acid detergent fiber concentration was decreased significantly with increased nitrogen level (Table 7). The maximum and minimum acid detergent fiber concentration was recorded in control and plots receiving 150 kg N $ha^{-1}$, respectively. The results are similar to those reported by Lemerle *et al.* (1985). The acid detergent fiber concentration was increased significantly with advancement in maturity. The maximum and minimum Acid detergent fiber concentration were noted when crop was harvested 75 and 45 days after sowing. Lemerle *et al.* (1985) and Firdous *et al.* (1996) had also reported significant effect of harvesting time on acid detergent fiber concentration.

Interaction between nitrogen levels and harvesting times was also significant. At third harvest (75 days after sowing ), decrease in acid detergent fiber at each increased nitrogen level was significant. Whereas, difference between control and 50 kg N $ha^{-1}$ at second harvest (60 days after sowing) and 100 and 150 kg N $ha^{-1}$ at first harvest (45 days after sowing) were not significant. The maximum acid detergent fiber concentration was observed at third harvest (75 DAS) in control plots.

**Ether extractable fat:** Ether extractable fat concentration was increased with increased nitrogen levels (Table 8). However, the differences between nitrogen levels of 50 and 100 kg $ha^{-1}$ could not reach to a significant level. The maximum and minimum ether extractable fat concentration was recorded with the application of 150 kg N $ha^{-1}$ and control, respectively. The results are supported by the findings of Bajwa *et al.* (1983).

Ether extractable fat percent was decreased with advancement in maturity and all harvests differed significantly from each other. The maximum value was recorded when crop was harvested 45 days after sowing. Decrease in fat content with delayed harvesting has also been reported by Bajwa *et al.* (1983). The interaction between nitrogen levels and harvesting times was not significant.

**Total ash (%):** The total ash percent was significantly influenced by nitrogen levels and harvesting times (Table 8). The application of nitrogen @ 150 kg $ha^{-1}$ produced significantly higher ash percent than other nitrogen levels. The application of 100 kg N $ha^{-1}$ also produced significantly higher ash percent than control but statistically similar to 50 kg N $ha^{-1}$. An increase in ash percent with nitrogen application has also been reported by Ayub *et al.* (1999). Ash percent decreased with delayed harvesting. The maximum and minimum values were recorded at the first (45 DAS) and third harvest (75 DAS), respectively. The results are quite in line with those of Ahmad (1999) and Ali (2000). The interaction between nitrogen levels and harvesting times was not significant.

In conclusion, nitrogen level of 150 kg $ha^{-1}$ and harvesting time of 75 days after sowing was found better combination for higher yield of sorghum cultivar JS-263 under Faisalabad conditions.

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