Effect of Nitrogen Scheduling and Cultivars on Yield Attributes and Yields of Sorghum (*Sorghum bicolor* L.)

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ABSTRACT

A field experiment was conducted during kharif season of 2013 at Udaipur (Rajasthan) to find out the effect of nitrogen scheduling and cultivars on yield attributes, yield and soil fertility status after harvest of sorghum. Treatment consisted two cultivars (V₁: CSH 16 and V₂: CSV 20) and five nitrogen schedules (N₁: 50% at sowing as basal + 50% at 30 DAS, N₂: 50% at sowing as basal + 25% at 30 DAS + 25% at boot leaf stage, N₃: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₄: 25% at sowing as basal + 50% at 30 DAS + 15% at boot leaf stage + 10% at grain filling stage, N₅: 25% at sowing as basal + 45% at 30 DAS + 5% foliar spray at 45 DAS + 15% at boot leaf stage + 10% at grain filling stage) were assigned in a factorial randomized block design. The results revealed that the cultivar CSH 16 recorded significantly higher number of grains per panicle, 1000 grain weight, grain yield (1521 kg/ha), harvest index (13.17) and nitrogen content in plant, whereas significantly higher number of primaries per panicle, stover yield (11141 kg/ha) and available nitrogen in soil were recorded in CSV 20. Application of nitrogen in N₁ schedule (50% at sowing as basal + 25% at 30 DAS + 25% at boot-leaf stage) had marked influence on yield attributes, yield and nitrogen content in plant when compared to rest of the nitrogen schedules. Therefore, it was concluded that significantly higher grain yield was recorded in cultivar CSH 16 and N₅ schedule of nitrogen application from sorghum.

Key words: Nitrogen scheduling, Sorghum cultivars, Yield attribute, Yield.

INTRODUCTION

Sorghum (*Sorghum bicolor* L.) is the third important crop in the country after rice and wheat. Sorghum is not only staple food but it is also required to fulfill fodder requirement in order to make animal husbandry sector more viable. In India, the area under sorghum is approximately 5.82 million ha with an annual production of about 5.39 million tonnes and an average productivity of 926 kg/ha. In Rajasthan, it is cultivated over an area of 0.58 million ha with a production and productivity of 0.36 million tonnes and 615 kg/ha respectively (DAC, 2013).

The reason for low productivity of this crop is seems to be non-adoption of proper agrotechniques. Among the growth factor adequate supply of chemical fertilizer, especially nitrogen is considered to be of prime importance due to its profound impact on various aspects of growth and development, hence productivity of the crop. Nitrogen plays an important role in various metabolic process of plant. The complexities of N management occur due to its solubility, mobility and vulnerability to denitrification. The efficiency of fertilizer N is only 30-40 per cent in rice and 50-60 per cent in other cereals. The top–dressing of N fertilizer is considered as most effective strategy to reduce nutrient leaching, so that nutrient supply is synchronized with plant demand and increases yield and fertilizer–use efficiency (Choudhary et al., 2013). Genotype of a crop plays an important role in increasing crop production but information on the response of newly evolved genotypes to split application of nitrogen is meagre. Hence, present study was carried out to evaluate the performance of sorghum cultivars at different nitrogen scheduling.

MATERIALS AND METHODS

A field experiment was carried out during kharif 2013 at the Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur which is situated at 23°34’N latitude and 73°42’E longitude at an altitude of 582.17 meter above the mean sea level. The soil of experimental site was clay loam in texture having slightly alkaline pH (8.0) in reaction, organic carbon (0.65%), medium with respect to available nitrogen (257.06 kg/ha), available phosphorus (20.80 kg/ha) and high in available potassium (355.60 kg/ha) in the plough layer. The well distributed rainfall of 736 mm was recorded during crop growth period. The experiment consisting of 10 treatment combinations comprising two sorghum cultivars (V₁: CSH 16 and V₂: CSV 20) and five nitrogen scheduling (N₁: 50% at sowing as basal + 50% at 30 DAS, N₂: 50% at sowing as basal + 25% at 30 DAS + 25% at boot leaf stage, N₃: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₄: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₅: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₆: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₇: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₈: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₉: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage, N₁₀: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage) had marked influence on yield attributes, yield and nitrogen content in plant when compared to rest of the nitrogen schedules. Therefore, it was concluded that significantly higher grain yield was recorded in cultivar CSH 16 and N₅ schedule of nitrogen application from sorghum.
15% at boot leaf stage + 10% at grain filling stage, N\textsubscript{2}: 25% at sowing as basal + 45% at 30 DAS + 5% foliar spray at 45 DAS + 15% at boot leaf stage + 10% at grain filling stage) were tested in a factorial randomized block design having three replications. Sorghum cultivars were sown manually on 6 July 2013 at 45 x 15 cm row to row and plant to plant spacing with a seed rate of about 10 kg/ha. Full dose of P\textsubscript{2}O\textsubscript{5} and K\textsubscript{2}O was applied as basal at time of sowing through DAP and MOP. For supplying nitrogen, urea fertilizer was applied to each plot as per treatment schedule after deducting the nitrogen applied through DAP. For weed management atrazine 0.5 kg/ha a.i. was applied as pre-emergence to control the weeds in early stages of the crop. The nitrogen concentration in the plant was determined by adopting Nessler’s reagent colorimetric method (Lindner, 1944). Number of panicles m\textsuperscript{-2} was counted before harvesting by using the quadrate. The randomly selected five earheads were used for counting the number of grains with the help of wooden seed counting device and average was taken as the number of grains/earheads. The crop was harvested during second fortnight of October. For grain yield, earheads from each net plot were picked up and kept in gunny bags. After sun drying these was threshed, winnowed and cleaned and final yield was expressed in kg/ha, while after detaching the earheads the fodder was left in the field for sun drying for few days. After drying, the bundles of each plot were weight and noted stover yield per unit area. After harvest of crop the soil samples were taken up to the depth of 0-15 cm from the field for determination of nitrogen and organic carbon content in soil.

**RESULTS AND DISCUSSION**

Yield attributes and Yield

The number of panicle m\textsuperscript{-2} did not differ significantly between the cultivars (Table 1). Cultivar CSH 16 recorded significantly higher number of grain per panicle, 1000 grain weight, grain yield (1521 kg/ha) and harvest index (13.17%) over CSV 20. However, cultivar CSV 20 provided significantly higher number of primaries per panicle and stover yield (10070 kg/ha) over CSH 16. The higher grain yield by CSH 16 and stover yield registered by CSV 20 appear to be a resultant of remarkable improvement in different yield components, which was brought about due to adoption of cultivars. Grain yield was found positively correlated with the number of grains per panicle and 1000 grain weight. These results are in close conformity with findings of Dixit et al. (2005), Kushwaha and Thakur (2006), Kumar et al. (2008), Sumeriya and Singh (2008).

Application of nitrogen in N\textsubscript{2} schedule (50 per cent at sowing as basal + 25 per cent at 30 DAS + 25 per cent at boot leaf stage) produced significantly maximum primaries per panicle, grains per panicle, 1000 grain weight, grain (1613 kg/ha) and stover yield (11811 kg/ha) which was at par with N\textsubscript{4} schedule for number of primaries per panicle and grain yield (Table 1). However, the N\textsubscript{2}, N\textsubscript{4} and N\textsubscript{5} schedules was at par with one another for number of grains per panicle and N\textsubscript{1}, N\textsubscript{3} and N\textsubscript{5} schedules for 1000 grain weight. The number of panicles (m\textsuperscript{-2}) was not influenced significantly by various nitrogen schedules. The significantly highest harvest index was recorded in N\textsubscript{4} schedule (13.18%) which was at par with N\textsubscript{2} schedule. The application of nitrogen in N\textsubscript{2} schedule coincided with active growth phase of the plant, which in turn helped in maintaining the higher level of available nitrogen in soil resulting in higher root growth and their proliferation that able to extract more nutrients and moisture from deeper layers of soil. Thus with greater availability of metabolites and nutrients thus increases yield attributes and yield of sorghum (Hankrishna et al., 2005, Singh, 2010 and Choudhary et al., 2013).

**Nitrogen content**

The nitrogen content in plant was affected significantly by the cultivars. CSH 16 recorded significantly higher N content at 30 DAS, boot leaf and at grain filling stage over CSV 20 (Table 2). The improvement in nitrogen status of plant under different cultivars might be due to their genetic makeup. Thus, the greater availability of nitrogen with CSH 16 seems to have critical concentration at cellular level and fulfilled their requirements for profuse plant growth and their efficient translocation towards sink (Dixit et al., 2005, Sumeriya et al. 2005 and Panwar et al., 2015).

Similarly, application of nitrogen in N\textsubscript{2} schedule (50 per cent at sowing as basal + 25 per cent at 30 DAS + 25 per cent at boot leaf stage) significantly enhanced nitrogen content in plant at 30 DAS over N\textsubscript{4} schedule but at par with rest of the nitrogen schedules (Table 2). Highest nitrogen content at boot leaf and grain filling stages was recorded in N\textsubscript{5} schedule (25% at sowing as basal + 50% at 30 DAS + 15% at boot leaf stage + 10% at grain filling stage) and it was significantly superior over N\textsubscript{4} schedule. However, the result of this treatment was at par with N\textsubscript{2}, N\textsubscript{3} and N\textsubscript{5} schedules. It is generally believed that in plant system extracted nutrients are used for maintaining their optimum concentration, which can be used for growth of developing structures. Thus greater availability of nitrogen seems to have synergistic interactions between primary nutrients for maintained optimum concentration at cellular level, fulfilled their requirements for plant growth (Kharub and Chander, 2010 and Mahajan et al., 2010).

**Soil fertility status**

The significantly higher available nitrogen in soil was recorded in CSV 20 sown plots. The organic carbon content after harvest of the crop was not affected significantly due to the cultivars. Likewise Nitrogen and organic carbon content under N\textsubscript{4} schedule of N application was significantly higher over N\textsubscript{2}, N\textsubscript{3} and N\textsubscript{5} schedules but proved statistically at par with N\textsubscript{4} schedule of nitrogen application. The results are close conformity with findings of Choudhary et al., 2013. Based on the results, it is inferred that higher grain yield was obtained from cultivar CSH 16 but higher stover yield was recorded in CSV 20. Application of nitrogen in N\textsubscript{2} schedule i.e.50 per cent at sowing as basal + 25 per cent at...
Table 1: Effect of nitrogen scheduling and cultivars on yield attribute and yield of sorghum.

| Treatments                        | Number of panicle (m²) | Number of primaries/ panicle | Number of grains/panicle | 1000 grain weight (g) | Yield (kg/ha) | Harvest index (%) |
|-----------------------------------|------------------------|------------------------------|--------------------------|-----------------------|----------------|-------------------|
| Cultivars                         |                        |                              |                          |                       |                |                   |
| V₁: CSH 16                        | 14.52                  | 53.12                        | 1476                     | 28.30                 | 1521           | 10070             | 13.17             |
| V₂: CSV 20                        | 14.31                  | 57.61                        | 1341                     | 26.59                 | 1276           | 11141             | 10.25             |
| SEm+                              | 0.10                   | 0.64                         | 22                       | 0.15                  | 34             | 159               | 0.27              |
| CD (P=0.05)                       | NS                     | 1.87                         | 63                       | 0.44                  | 99             | 462               | 0.78              |
| Nitrogen Scheduling               |                        |                              |                          |                       |                |                   |
| N₁: 50% at sowing as basal + 50% at 30 DAS | 14.40                  | 59.33                        | 1358                     | 27.74                 | 1459           | 9715              | 13.18             |
| N₂: 50% at sowing as basal + 25% at 30 DAS + 25% at boot leaf stage | 14.22                  | 59.67                        | 1494                     | 28.01                 | 1613           | 11811             | 12.05             |
| N₃: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage | 14.28                  | 50.32                        | 1397                     | 27.07                 | 1230           | 10370             | 10.71             |
| N₄: 25% at sowing as basal + 50% at 30 DAS + 15% at boot leaf stage + 10% at grain filling stage | 14.57                  | 51.33                        | 1432                     | 27.11                 | 1338           | 10963             | 10.85             |
| N₅: 25% at sowing as basal + 45% at 30 DAS + 5% foliar spray at 45 DAS + 15 % at boot leaf stage + 10% at grain filling stage | 14.61                  | 56.17                        | 1361                     | 27.31                 | 1350           | 10167             | 11.76             |
| SEm+                              | 0.16                   | 1.02                         | 34                       | 0.24                  | 54             | 252               | 0.42              |
| CD (P=0.05)                       | NS                     | 2.97                         | 99                       | 0.70                  | 157            | 730               | 1.23              |
### Table 2: Effect of nitrogen scheduling and cultivars on nitrogen content in plant and soil fertility status after harvest of sorghum.

| Treatments               | Nitrogen content (%) | Available N (kg/ha) | Organic Carbon (%) |
|--------------------------|----------------------|---------------------|--------------------|
|                          | At 30 DAS            | At boot leaf stage  | At grain filling stage |
| **Cultivars**            |                      |                     |                    |
| V1: CSH 16              | 2.073                | 1.946               | 1.827              | 248.37 | 0.64 |
| V2: CSV 20              | 2.041                | 1.926               | 1.806              | 252.16 | 0.63 |
| SEm±                     | 0.005                | 0.006               | 0.005              | 1.31   | 0.01 |
| CD (P=0.05)             | 0.016                | 0.017               | 0.014              | 3.78   | NS   |
| **Nitrogen Scheduling** |                      |                     |                    |
| N1: 50% at sowing as basal + 50% at 30 DAS | 1.942 | 1.844 | 1.727 | 245.68 | 0.61 |
| N2: 50% at sowing as basal + 25% at 30 DAS + 25% at boot leaf stage | 2.094 | 1.957 | 1.836 | 242.84 | 0.61 |
| N3: 25% at sowing as basal + 50% at 30 DAS + 25% at boot leaf stage | 2.083 | 1.958 | 1.838 | 250.89 | 0.63 |
| N4: 25% at sowing as basal + 50% at 30 DAS + 15% at boot leaf stage + 10% at grain filling stage | 2.086 | 1.961 | 1.841 | 254.52 | 0.65 |
| N5: 25% at sowing as basal + 45% at 30 DAS + 5% foliar spray at 45 DAS + 15% at boot leaf stage + 10% at grain filling stage | 2.080 | 1.959 | 1.839 | 257.38 | 0.68 |
| SEm±                     | 0.009                | 0.009               | 0.008              | 2.06   | 0.01 |
| CD (P=0.05)             | 0.025                | 0.027               | 0.023              | 5.98   | 0.03 |
30 DAS + 25 per cent at boot leaf stage produced higher grain and stover yield of sorghum.

REFERENCES

Choudhary, R., Singh, D. and Nepalia, V. (2013). Productivity and economics of quality protein maize (Zea mays) as influenced by nitrogen levels, its scheduling and sulphur application. Indian Journal of Agronomy. 58: 340-343.

DAC, (2013). Agriculture Statistics at a Glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Dixit, A.K., Singh, O.P., Kachroo, D. and Bali, A.S. (2005). Response of promising rainy season sorghum (Sorghum bicolor L.) genotypes to nitrogen and phosphorus fertilization. Indian Journal of Agronomy. 50: 206-209.

Harikrishana, B.L., Dasog, G.S. and Patil, P.L. (2005). Uptake of N, P and K, nitrogen use efficiency and available N, P and K in soils at different growth stages of maize crop. Karnataka Journal of Agricultural Sciences. 18(2): 375-382.

Kharub, A.S. and Chander, S. (2010). Effect of nitrogen scheduling on wheat (Triticum aestivum L.) yield, nutrient uptake and quality under alternate tillage practices. Indian Journal of Agricultural Science. 80:29-32.

Kumar, S., Pandey, A.C. and Mardi, G. (2008). Evaluation of high yielding genotypes of sorghum [Sorghum bicolor (L.) Moench] under rainfed condition in east Singhbhum, Jharkhand. International Journal of Tropical Agriculture. 26: 427-429.

Kushwaha, B.B. and Thakur, N.S. (2006). Response of sorghum (Sorghum bicolor L.) genotypes to fertility levels under rainfed conditions. Extended summaries in National symposium on conservation Agriculture and Environment held at BHU, Varanasi, Oct. 26-28, pp. 248.

Lindner, R.C. (1944). Rapid analytical method for some of the common substances of plant and soil. Plant Physiology. 19: 76-84.

Mahajan, G., Kumar, S., Kumar, M., Kumar, R. and Yadav, M.K. (2010). Effect of cultivars and nitrogen scheduling on yield, nutrient uptake and quality of late sown wheat (Triticum aestivum L.). Environment and Ecology. 28: 1989-1900.

Panwar, D., Singh, P., Sumeriya, H.K., Jat, N. and Verma, S.N. (2015). Response of sorghum [Sorghum bicolor (L.) Moench] genotypes to different fertility levels on yield and nutrient content. Progressive Research. 10: 164-166.

Singh, D. (2010). Impact of scheduling on nitrogen on productivity of single cross maize (Zea mays) hybrids. Indian Journal of Agricultural Sciences. 80: 649-651.

Sumeriya, H.K. and Singh, P. (2008). Effect of geometry and fertility levels on yield attributes, protein content and yield of promising sorghum [Sorghum bicolor (L.) Moench] genotypes under rainfed condition. International Journal of Tropical Agriculture. 26: 403-408.

Sumeriya, H.K., Singh, P. and Mali, A.L. (2005). Effect of fertility level on growth and productivity of sorghum [Sorghum bicolor (L.) Moench]. Crop Research. 30: 6-9.