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Response of fodder sorghum to irrigation scheduling and nitrogen levels

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ABSTRACT

Irrigation scheduling is a useful technique that improves water use efficiency and increases crop yield. Nitrogen plays a significant role in the growth and development of crop plants. A field experiment was conducted at Central Research Farm (Gayeshpur), Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during March to May 2011 to find out the effect of different irrigation scheduling I_1 (without irrigation), I_2 (irrigation at 20 DAS), I_3 (irrigation at 40 DAS) and I_4 (irrigation at 20 and 40 DAS) and nitrogen levels N_1 (no nitrogen), N_2 (60 kg/ha), N_3 (90 kg/ha) and N_4 (120 kg/ha) along with 40 kg/ha each of P_2O_5 and K_2O on growth, yield and water use efficiency of fodder sorghum. Irrigation and nitrogen had favourable effects on growth and yield of the crop. The results showed that two irrigations at different stages (I_4) responded positively as compared to other treatments. However magnitude of water use efficiency attained the highest level (99.75 kg/ha/mm) under without irrigation treatment (I_1). Irrespective of growth stages a continuous increasing trend with increase in nitrogen level was recorded for leaf area index (LAI). Similar trend was also recorded for plant height, green fodder yield, dry matter yield and water use efficiency.

Keywords: Irrigation; nitrogen; sorghum; water use efficiency

INTRODUCTION

Sorghum, *Sorghum bicolor* (L) Moench is a food, fodder and fuel crop in many regions of the world. In India fodder sorghum is an important crop that is highly palatable and digestible as far as its nutritional quality is concerned and it can be grown in any season. The present fodder production does not meet the fodder requirement in terms of both quantity and quality. The availability of fodder resources is around 60 per cent of the requirement and area under fodder crops in India is only 8.6 million ha (Damame et al 2013). Water is considered to be the most precious and heavily scrutinized natural resource by many researchers. To make the better use of irrigation water irrigation scheduling may play an important role because it can

increase irrigation efficiency and water use efficiency. Moosavi et al (2011) reported that irrigation intervals had significant effect on yield components, forage yield and qualitative traits of sorghum. Moisture stress at critical stages definitely affects growth, yield components, nutrient uptake and yield of crop. Nitrogen is an essential primary nutrient for profuse plant growth and plays a pivotal role in fodder productivity. Optimization of nitrogen level is an important aspect. Thus suitable irrigation schedule and proper nutrition are very important to get higher fodder yield. The present study was undertaken to find out growth behaviour, yield and water use efficiency of fodder sorghum under different irrigation scheduling and nitrogen levels.

MATERIAL and METHODS

Field experimentation was carried out during March to May 2011 at the Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (latitude 22° 58' N, longitude 88° 31' E and 9.75 m amsl). The soil of the experimental site is sandy loam in texture. The climate is sub-humid tropic and average annual rainfall is about 1650 mm (131.9 mm during study period). The experiment consisted of four irrigation scheduling viz I_1 (without irrigation), I_2 (irrigation at 20 DAS), I_3 (irrigation at 40 DAS) and I_4 (irrigation at 20 and 40 DAS) and four nitrogen levels N_1 (no nitrogen), N_2 (60 kg/ha), N_3 (90 kg/ha) and N_4 (120 kg/ha) along with 40 kg each of P_2O_5 and K_2O/ha. The treatments were tested in a split-plot design with three replications. Irrigation scheduling was assigned to the main plots and nitrogen levels to the sub-plots. Sorghum genotype PC 23 was sown at a spacing of 30 cm between rows with seed rate of 22.5 kg/ha. Crop was harvested at 60 DAS. Data were recorded on plant height (cm) at harvest, leaf area index (LAI) at 15, 30, 45 DAS and at harvest, green fodder yield (q/ha) and dry matter yield (q/ha). Crude protein concentration was worked out by multiplying the Kjeldhal's N value (Jackson 1973) with 6.25. Crude protein yield (q/ha) was calculated by multiplying crude protein concentration with dry matter yield. Seasonal consumptive use of water by the crop for the entire growing season was estimated from the total soil moisture depletion by soil moisture determination (Reddy 2007). Water use efficiency (kg/ha/mm) was determined by dividing the harvested green fodder yield with total consumptive use of water by the crop. The data were statistically analyzed using analysis of variance for split-plot design as outlined by Gomez and Gomez (1984).

RESULTS and DISCUSSION

Plant height was significantly influenced by irrigation and nitrogen levels. Plants attained maximum height (198.51 cm) in I_4 where two irrigations at 20 and 40 DAS were applied (Table 1). It was followed by I_3 ie irrigation at 40 DAS

(192.19 cm) against minimum plant height of 185.73 cm in I_1 (no irrigation). The results revealed that irrigation applied at two stages increased plant height significantly. In case of skipping of either of these irrigations plant height was reduced. Among the nitrogen levels significantly maximum plant height (196.99 cm) was recorded in N_4 (120 kg/ha). The higher nutrient status under this treatment could be due to greater availability of nutrients in a suitable soil environment as well as their better extraction by roots and therefore translocation within plant system (Rana et al 2013). As the crop age increased from 15 to 60 DAS (harvest) the LAI also increased (Fig 1, Fig 2). Throughout the growing period the highest value of LAI (0.67-3.70) was obtained under I_4 treatment as compared to I_1, I_2 and I_3 (Fig 1). Considerable increase in LAI under I_4 was possibly due to increased rate of cell division and cell size enlargement under availability of more soil water (Nandan and Prasad 1988). Significant increase in LAI was recorded with each increment of nitrogen level from 0 to 120 kg/ha (Fig 2). Variation in the magnitude of LAI under different irrigation and nitrogen levels was wide as optimum irrigation and nitrogen level benefited growth and development.

Irrespective of different treatments green fodder yield, dry matter yield and crude protein yield were significantly influenced by both irrigation scheduling and nitrogen levels (Table 1). Maximum green fodder yield (228.53 q/ha) was obtained under I_4 and it was significantly declined by 13.40, 12.43 and 4.57 per cent respectively under I_1, I_2 and I_3 treatments. Dry matter yield also followed the same trend. Better utilization of soil nutrients, higher photosynthetic rate as well as enhanced translocation of photosynthates under non-water stressed environment were responsible for achieving the highest yield under I_4 (irrigation at 20 and 40 DAS). Application of 120 kg N/ha recorded significantly highest fodder yield over all other treatments. Similar results were also reported by Duhan (2013) who reported significant effect of nitrogen and phosphorus application on green fodder yield of sorghum. Crude protein yield also followed the same trend (Table 1). The differences in crude protein yield among the treatments were largely due to the variations in dry matter production (Rana et al 2013).

In the present study water use efficiency (WUE) of 99.75, 96.42, 86.59 and 86.53 kg/ha/mm was obtained for the I_1, I_3, I_4 and I_2 irrigation levels respectively irrespective of irrigation (Table 1). It was found that relative increase in fodder yield was less than the relative increase in water use. Due to this reason water use efficiency was highest under I_1. Unproductive loss of water through evaporation and drainage might be responsible for lower water use efficiency in irrigated plot. With increase in nitrogen levels WUE also increased. This increased value of water use efficiency might be ascribed to higher green fodder yield

Table 1. Effect of irrigation scheduling and nitrogen levels on different attributes of fodder sorghum

Treatment	Plant height (cm)	Green fodder yield (q/ha)	Dry matter yield (q/ha)	Crude protein yield (q/ha)	Consumptive use of water (mm)	Water use efficiency (kg/ha/mm)
Irrigation schedule						
I1 (no irrigation)	185.73	197.90	44.55	2.65	198.39	99.75
I2 (20 DAS)	190.76	200.13	49.45	2.95	231.29	86.53
I3 (40 DAS)	192.19	218.08	51.56	3.08	226.18	96.42
I4 (20 & 40 DAS)	198.51	228.53	54.76	3.29	263.92	86.59
SEm±	0.80	4.39	0.57	0.06	-	-
LSD (p= 0.05)	2.77	15.20	1.08	0.22	-	-
Nitrogen level (kg/ha)						
N1 (0)	187.20	171.39	47.25	2.80	221.84	77.26
N2 (60)	190.48	210.00	49.42	2.95	229.69	91.43
N3 (90)	192.53	226.61	50.99	3.05	232.72	97.38
N4 (120)	196.99	236.63	52.66	3.16	235.53	100.47
SEm±	1.77	3.97	0.42	0.07	-	-
LSD (p= 0.05)	5.18	11.58	1.21	0.19	-	-

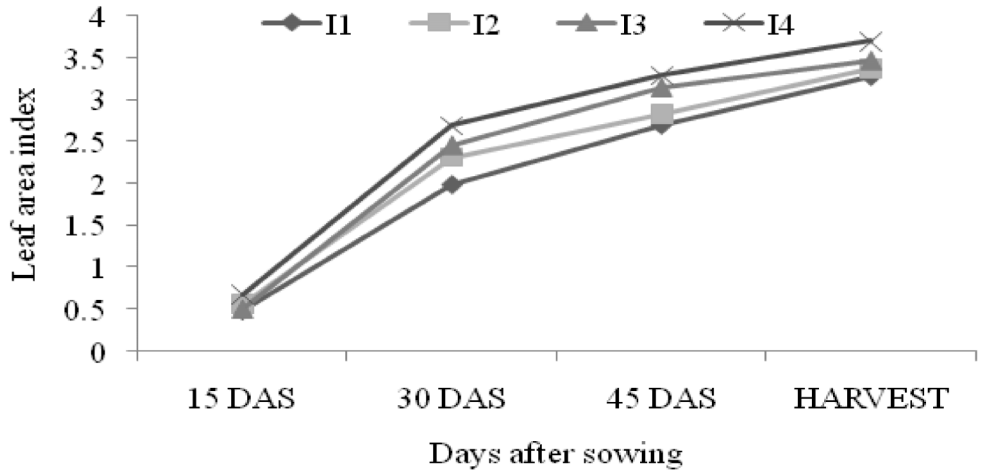

Fig 1. Temporal variations in leaf area index under different irrigation levels

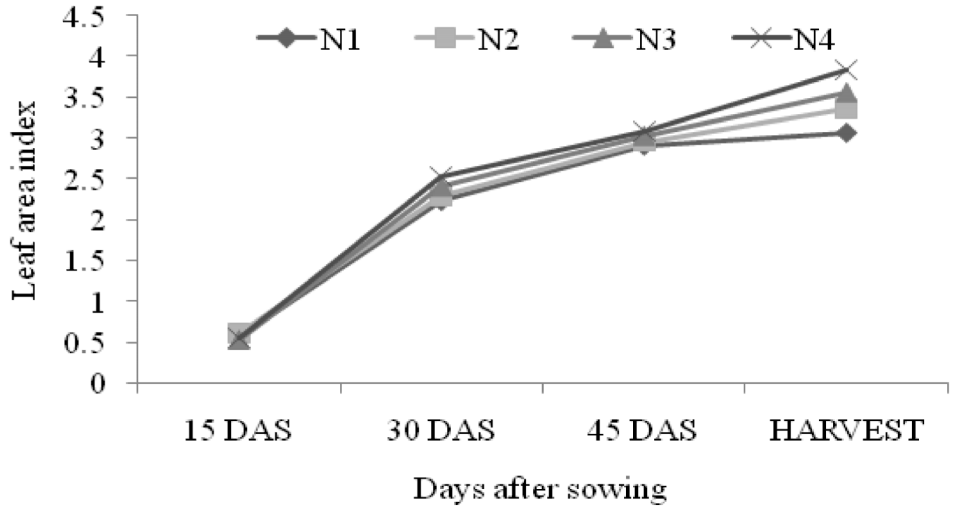

Fig 2. Temporal variations in leaf area index under different nitrogen levels

coupled with more proportionate increase in green fodder yield as compared to consumptive use of water.

CONCLUSION

From the above findings it can be concluded that application of nitrogen is essential for production of more green fodder and dry matter in sorghum with excellent crude protein content. The nitrogen application at the rate of 120 kg/ha along with 40 kg/ha each of phosphorus and potassium were recommended for general cultivation as it produced the highest yield with desirable fodder quality of sorghum. The highest water use efficiency was observed with no irrigation. However the maximum yield was found where two irrigations (20 and 40 DAS) were given. If water is limiting factor the farmers should go for fodder sorghum without irrigation. However for maximum yield irrigation at 20 and 40 DAS is recommended.

REFERENCES

Damame SV, Bhingarde RN and Pathan SH 2013. Effect of different nitrogen levels on nutritional quality and nitrate nitrogen accumulation in forage pearlmillet genotypes grown under rainfed conditions. Forage Research **39:** 93-95.

Duhan BS 2013. Effect of integrated nutrient management on yield and nutrients uptake by sorghum (*Sorghum bicolor* L). Forage Research **39:** 156-158.

Gomez KA and Gomez AA 1984. Statistical procedures for agricultural research (2nd edn). A Wiley Inter Science Publication, J Wiley and Sons, New York.

Jackson MI 1973. Soil chemical analysis. Prentice Hall of India Pvt Ltd, New Delhi, India.

Moosavi GRS, Seghatoleslami MJ, Javadi H and Ansari-nia E 2011. Effect of irrigation intervals and planting patterns on yield and qualitative traits of forage sorghum. Advances in Environmental Biology **5:** 3363-3368.

Nandan R and Prasad UK 1988. Effect of irrigation and nitrogen on growth and seed yield of French bean (*Phaseolus vulgaris*). Indian Journal of Agronomy **43:** 550-554.

Rana DS, Singh B, Gupta K and Dhaka AK 2013. Performance of single cut forage sorghum genotypes to different fertility levels. Forage Research **39:** 96-98.

Reddy SR 2007. Irrigation agronomy. Kalyani Publishers, Ludhiana, Punjab, India.

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