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EFFECT OF NITROGEN ON GROWTH AND YIELD OF SORGHUM FORAGE (*SORGHUM BICOLOR* (L.) MOENCH CV.) UNDER THREE CUTTINGS SYSTEM

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ABSTRACT. A field experiment was conducted on sorghum (*Sorghum bicolor* (L.) Moench cv.) under three cutting system to determine the effect of nitrogen on growth and yield at University of Agriculture Faisalabad, Pakistan, during the season 2010-2011. The experiment was laid out in Randomized Complete Block Design (RCBD), using three replications. There were four levels of nitrogen 0, 50, 75 and 100 kg N/acre in the form of urea. The growth parameters like plant height, number of leaves, leaf area is determined periodically. First reading taken after 20 days of sowing while second and third was taken after 15 days of first cutting. Yield parameter like plant population, fresh and dry weight was determined in three cuttings. Results showed that increasing nitrogen dose increased all growth attributes. Results revealed for first, second and third cuttings showed significant differences at all growth attributes. Thus, the maximum plant height was observed in N4 (100 kg N/acre), having plant height 193.92, 195.24 and 192.79 cm in first, second and third cutting, respectively, which was followed by the treatment N3 (75 kg N/acre), having 179.70 cm in first cutting, while second and third cutting have same plant height 168.62 cm. The exception was the plant population showed non significant behavior in second and third cutting while number of leaves per plant in second cutting only and protein % in third cutting showed non significant difference with nitrogen application.

Key words: Nitrogen; Growth; Green forage; Protein.

REZUMAT. **Efectul azotului asupra creşterii şi a producţiei de sorg pentru furaj (*Sorghum bicolor* (L.) Moench cv.) folosind un sistem de trei cosiri.** La Universitatea de Agricultură Faisalabad, Pakistan, a fost efectuat, în perioada 2010-2011, un experiment pe un teren cu sorg (*Sorghum bicolor* (L.) Moench cv.), folosind un sistem de trei cosiri, pentru a determina efectul azotului asupra creşterii şi a producţiei de sorg. Experimentul s-a efectuat după metoda blocurilor randomizate, cu trei repetiţii. S-au folosit patru niveluri de azot, 0, 50, 75 şi 100 kg N/acru, sub formă de uree. Periodic, au fost măsuraţi parametrii de creştere, cum ar fi

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înălțimea plantei, numărul de frunze, suprafața frunzei. Prima măsurătoare a fost efectuată la 20 de zile de la însămânțare, iar a doua şi a treia la 15 zile de la prima cosire. Parametrii de producție, precum numărul de plante, greutatea plantei proaspete şi uscate, au fost calculați folosind trei cosiri. Rezultatele au arătat că o doză mai mare de azot a dus la sporirea caracteristicilor de creştere. Rezultatele, în cazul primei, celei de-a doua şi a treia cosiri, au relevat diferențe semnificative ale însuşirilor de creştere. Astfel, înălțimea maximă a plantelor a fost observată la N4 (100 kg N/acru), unde s-au înregistrat 193.92, 195.24 si 192.79 cm, respectiv la prima, a doua şi a treia cosire, care a fost urmată de un tratament N3 (75 kg N/acru), cu 179.70 cm la prima cosire, în timp ce la a doua şi a treia cosire s-a înregistrat aceeaşi înălțime a plantelor, 168.62. Excepție a făcut numărul de plante, care nu a avut un comportament diferit la a doua şi a treia cosire, iar numărul de frunze pe plantă la a doua cosire şi concentrația de proteine la a treia cosire nu au prezentat diferențe semnificative după aplicarea azotului.

Cuvinte cheie: azot; creştere; furaj verde; proteine.

INTRODUCTION

Sorghum is a drought resistance fodder crop belonging to the family Gramineae / Poaceae grow in Pakistan. Sorghum forage is the basic feed for live stock and especially valuable for feeding in all regions of the world. Cured sorghum fodder, with a little protein supplement, maintains cattle in good condition throughout the winter with little or no gain supplement. Sorghum fodder contains 70% carbohydrates, minerals, crude fat and nitrogen free extract (Chaudhry, 1994). Green forage demands for rapidly expanding livestock industry is increasing day by day in Pakistan. Livestock has a great contribution in the economy of Pakistan having 11.5% share in total GDP (Govt. of Pakistan, 2011). It ranks 4th among the cereals wheat, rice and maize. In some parts of the world regions it is also consumed as staple food grain and is used for a variety of products like alcohol, edible oil, sugar and waxes etc. It has a great potential of adaptation to adverse climatic conditions. Although sorghum is grown intensively in Pakistan but its yield is very low (Ashraf *et al.,* 1995). Plant populations and nitrogen fertilizers need to be reduced as much as possible so that ravage is minimized and resource use efficiency is maximized. Reducing plant densities and N fertilizer rates may affect yield and nutritive value of forage sorghum and corn when grown in limited irrigation situations (Marsalis *et al*., 2009)**.** Average forage yield in Pakistan is low. The increasing feed requirements of the expanding livestock population necessitate the introduction of sorghum hybrid into the farming systems in irrigated areas. In such areas, these crops could be established after harvesting of winter cereals, allowing cropping systems with two crops per year (Iptas *et al.,* 1997). Among the kharif forage crops, multicut hybrid sorghum is an important one that possesses a wide range of ecological adaptability

because of its xerophytic characteristics (Iptas *et al*., 1997).

Multicut sorghum is capable of producing high-quality forage in mid to late summer when cool-season perennials have low production (Undersander *et al*., 1990). Forage sorghum hybrid grass is an important livestock feed, often used to produced silage, hay or pasture during summer when adequate supply of moisture is available for the production of other crops (Fribourg, 1995). Timing and placement of N fertilizer have a major effect on the efficiency of N management systems. Nitrogen should be applied to a crop at times that avoids periods of significant loss and provide adequate N when needed. Studies with grain sorghum have shown that fertilizer knifed-in at planting has increase yields relative to broadcast application (Sweeney, 1989; Khosla *et al*., 2000). For producing sorghum hybrids for forage, nitrogen should be applied in a split application with one half of the N applied at planting and the remaining one half applied after the first cut (OMAF, 2002).

Multicut sorghum forage should be fertilized more like an intensively managed perennial grass than a corn crop with N fertilizer being applied before planting and after each cut in a multicut system (Ketterings *et al*., 2004). In irrigated areas, N fertilizer is very important and is the main factor affecting the DM yield of sorghum cultivars; N fertilizers are easily soluble and leach able in most of the soils, and increase the forage yield of sorghum varieties (Rahman *et al.,* 2001). Multiple applications throughout the season have been suggested for optimum forage production of grass species (Lauriault *et al*., 2002). Studies of the yield response of forage multicut sorghum hybrids developed for areas with shorter growing seasons to additions of fertilizer N have not been previously reported.

In Pakistan, a little information is available on the interactive effects of nitrogen on the quality and fodder yield of multicut sorghum. The present study was therefore planned with the object to determine the effects of different nitrogen levels for obtaining maximum fodder yield of sorghum under three cutting irrigated condition of Faisalabad.

MATERIALS AND METHODS

The experiment was conducted on the Agronomic farm at University of Agriculture Faisalabad, during the season 2010-2011, using randomized complete block design with three replications. The soil of the area is clay loam having alkaline pH in nature. The average rain fall of this area is 95 to 210 mm and average summer temperature is 45 ^{0}C. The net plot size is 3 m x 6 m. the experiment was comprised of four levels of nitrogen 0, 50, 75, 100 kg N/acre. Recommended dose of nitrogen is 100 kg/ha while of phosphorus is 60 kg/ha. Half dose of nitrogen and full dose of nitrogen were applied at the time of sowing while remaining half is applied at first irrigation. Urea as a source of nitrogen is used in the experiment. The area of experiment was divided into 12

plots (3 x 6 m) each. The crop was sown during the last week of April and irrigation applied just after sowing and then irrigation was done after 12-15 days. After a month plants in an area 1 m^2 in each plot were counted to determine the plant height. LAI was determining after 15, 30 and 45 days from sowing. All other agronomic practices were kept uniform for all the treatments. The experiment was carried out using a randomized complete block design RCBD with three replications. Data were statistically analyzed according to SAS. Differences among means were compared using LSD at 5% probability level (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Generally, all treatments like, plant height, plant population, number of leaves, fresh weight, dry weight plant^{-1}, protein contents and ash % increasing steadily with progressive increase of growth. Increasing dose of nitrogen resulted increased all growth attributed.

The effect of different doses of nitrogen on plant height for three cutting was presented in *Table 1.* The results revealed that plant height showed significant difference in all three cuttings at (P=0.05) by increasing nitrogen dose. Maximum plant height was observed in N4 (100 kg N/acre), having plant height 193.92, 195.24, 192.79 cm in first, second and third cutting, respectively, which was followed by the treatment N3 (75 kg N/acre), having 179.70 cm in first cutting, while second and third cutting have same plant height 168.62 cm. The plant height increased by increasing nitrogen levels is might be due to increased the number of nodes and inter nodal distance. Similar results were found by Eltelib (2004). Plant density is an important factor in forage production as it influences both fodder quality and quantity special in cereal forage.

The effect of nitrogen on plant population was also found significant differences, presented in *Table 1.* Results revealed in first cutting showed that plant population showed significant difference while in second and third cutting results showed non significant difference among treatments. Data regarding plant population N4 (100 kg N/acre) have maximum 45.33 while second and third cutting showed non significant effect. This finding was in agree with Abuswar and Mohammed (1997) who reported that nitrogen fertilization had significant effect on plant density and number of green leaves of fodder sorghum. Bebawi (1987) found that tiller density of multicut has significant effect on harvesting. On the other hand Bebawi (1987) revealed that nitrogen application had no effect on plant population.

The effect of nitrogen on number of leaves presented in *Table 1.* Data showed significant differences among treatments. In first and third cuttings results are highly significant while in second cutting results showed non significant behavior among treatments.

Table 1 - Effect of nitrogen fertilization on plant height, plant population and number of leaves plant^{-1} for three cutting on sorghum fodder

Treatments, N kg/acre	Plant height, cm			Plant population			Number of leaves plant^{-1}		
N1 (0)	155.58d	145.22d	144.61d	36.33b	37.66	38.66	8.40c	10.08	9.75b
N2 (50)	165.49c	158.47c	156.61c	38.33b	40.33	39.33	9.06b	11.88	11.55a
N3 (75)	179.70b	168.62b	168.62b	40.66b	43.33	41.66	9.31b	9.11	8.78c
N4 (100)	193.92a	195.24a	192.79a	45.33a	48.00	43.66	10.30a	10.45	10.11b
LSD	4.17	6.78	6.72	4.43	NS	NS	0.64	NS	0.43

Table 2 - Effect of nitrogen fertilization on the fresh weight, dry weight plant^{-1}, ash % and protein % for three cutting of sorghum fodder

Treatments, N kg/acre	Fresh weight plant^{-1}			Dry weight plant^{-1}			Ash, %			Protein, %		
N1 (0)	160.9d	160.9d	160.9d	52.9b	69.2c	66.2b	6.1ab	5.8c	6.0	7.5d	8.8c	7.9c
N2 (50)	190.7c	190.7c	190.7c	67.9a	84.1b	82.9b	6.3a	6.4a	6.1	8.6c	8.9c	10.7b
N3 (75)	220.4b	220.4b	220.4b	67.7a	90.7b	91.0b	6.0b	6.1b	6.1	10.6b	11.0b	11.0b
N4 (100)	243.1a	243.1a	243.1a	74.6a	115.0a	93.3a	6.3a	6.1b	5.9	12.0a	12.4a	12.5a
LSD	21.9	21.9	21.9	14.7	8.8	15.7	0.2	0.23	NS	1.0	1.3	1.0

Data regarding number of leaves in first have maximum number of leaves 10.30 by applying nitrogen at the 100 kg N/acre while in third cutting maximum number of leaves were 11.55 by applying nitrogen N2 at the rate of 50 kg N/acre which was followed by N4 (100 kg N/acre) having number of leaves 10.11. Resultantly number of leaves was increased by increasing nitrogen levels. These results were in contrast with Abuswar and Mohmmed (1997), also Abuswar (1981) found that no significant difference was manifested in leaf numbers. Addition of nitrogen has little effect on number of leaves per plant (Mustafa and Abdemaged 1982).

The effect of nitrogen application on the fresh weight plant^{-1} was presented in *Table 2*. Results revealed that nitrogen application had significant differences among treatments in all three cuttings. By increasing nitrogen levels fresh weight plant^{-1} was also increased. In first cutting maximum fresh weight per plant were 243.1 by applying nitrogen N4 (100 kg N/acre) which was followed by 220.4 having nitrogen applied at the rate of N3 (75 N kg/acre). While second and third cutting have maximum fresh weight per plant 380.2 and 270.3, respectively. The variation in green forage yield among nitrogen levels can be attributed to the more availability of nutrient with the increase in nitrogen fertilizer rate. Similar results were found by Ayub *et al.* (2002), Awan (1999), Devi (2002), Ammaji and Suryanarayana (2003). Same is the case in dry weight plant^{-1} was also showed significant differences among treatments.

Data presented in *Table 2* about dry weight plant^{-1} showed significant difference in three cuttings. Maximum dry weight per plant (74.6, 115.0 and 93.8) was observed in N4 which is 100 kg N/acre in first, second and third cutting, respectively. The variation in dry matter yield among nitrogen levels can be attributed to the differences in uptake and availability of nutrients of crop plants. Application of urea increased the fresh and dry weight of multicut sorghum, and this result was in agreement with Khair and Salih (2007) and Eltelib (2004).

The effect of nitrogen application on ash % contents show significant effect on sorghum forage presented in *Table 2*. Data regarding ash % contents in first cutting showed significant effect. Nitrogen application at the rate of 100 kg N/acre have maximum (6.3) ash % contents which was followed by N2 which is 50 kg N/acre also have 6.3 ash % contents. While in second cutting nitrogen at the rate of N2 (50 kg N/acre) showed (6.4) maximum ash contents which was followed by the treatment N3 (75 kg N/acre) and N4 (100 kg N/acre) have 6.1 ash % contents, while third cutting showed non significant effect regarding ash % contents. These results are in line with Safdar (1997) and Tariq (1998) who reported that ash contents have no effect by increasing nitrogen levels. Protein contents are one of the most important parameter affecting the nutritional value of forage crops.

The data presented in *Table 2* showed that effect of nitrogen on crude protein content % was highly significant. The highest value of crude protein (12.0 %) was observed in N 4 (100 kg N/acre) that was followed by N3 (75 kg N/acre) with crude protein content was 10.6%. While the minimum crude protein (7.5%) was observed in N1 (0 kg N/acre). While in third cutting protein content was high as compared to rest of other cuttings which is 12.5 at N4 (100 kg N/acre). Significant differences for crude protein contents among the sorghum cultivar reported by Lukipudis (1984), Neylon *et al.* (2002), Kanwar *et al.* (1992), Reddy *et al.* (2003) who reported that nitrogen significantly improved the crude protein content %.

CONCLUSIONS

In multicut sorghum nitrogen at the rate of 100 kg N per acre performed comparatively better in all three cuttings. A more exploring study with smaller levels of nitrogen and different sorghum cultivars is recommended.

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