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NITROGEN MANAGEMENT IN FORAGE SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH]

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SUMMARY

A field experiment on nitrogen management in forage sorghum [*Sorghum bicolor* (L.) Moench] was carried out at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *kharif* season of 2021 in loamy sand. Nine treatment combinations comprising three levels of nitrogen (75, 100 and 125 %) and three splits (one split at 30 DAS, two splits at 30 and 45 DAS and three splits at 30, 45 and 60 DAS) were laid out in RBD (factorial concept) with four replications. Results revealed that plant height, length of leaves, green and dry forage yield, number of leaves/plant, width of leaves, leaf: stem ratio and crude protein content were significantly the highest with the application of N @ 125%. Whereas, results was obtained for plant height, number of leaves/plant, length of leaves, green and dry forage yield and crude protein content were significantly higher with the application of nitrogen in three splits at 30, 45 and 60 DAS. Nitrogen and phosphorus content and uptake as well as available nitrogen content in soil after harvest of the sorghum were significantly higher with application of 125% N and three splits of nitrogen at 30, 45 and 60 DAS.

Key words: Nitrogen levels, N split, Forage sorghum, green fodder yield, economics

Sorghum [*Sorghum bicolor* (L.) Moench] is the king of cereals. In India, it is most popularly known as Jowar. It is an important feed, food, fodder and ration for cattle, poultry and also for humanity. There is a great need to maintain regular well balanced supply of more nutritious feed and fodder in the state. Fodder is one of the cheapest source of nutrients as they not only meet the requirement of bulk to be fed to the cattle, but also supply desired amount of protein, energy, minerals as well as vitamins to a large extent.

Sorghum forage is a basic feed for livestock and especially valuable for feeding in all regions of the world. Adequate supply of more nutritious feed and fodder by stall feeding, more productive milch herds can be maintained which would accelerate the growth of milk production. Cured sorghum fodder, with a little protein supplement maintains cattle in good condition throughout the winter with little or no grain supplement. Among growth factors, adequate inorganic fertilizers specially, nitrogenous and phosphatic is considered to be of prime importance due to their profound impact on various aspects of growth and development. Hence, for increasing the productivity of the crop, balanced use of fertilizer has played a key role in the modernization of Indian agriculture and in making the country sufficient in fodder production for animals.

Livestock population of India is around 306.7 million and it grows up to 1.2 million animal in year (Anon. 2021-2022). In India, the area under sorghum is approximately 7.38 million hectares with an annual production of 8.71 million tonnes. (Anon. 2021-2022). At present, in India 8.6 million hectare of the cultivated area. Green fodder yield 40 to 50 t/ha. Dry matter yield 10-15 t/ha. Demand of green and dry fodder yield 851.3 million tonnes and 530.5 million tonnes respectively and supply of green and dry fodder yield 590.4 million tonnes and 467.6 million tonnes respectively (Anon. 2020). To satisfy the demand of the current level of livestock production and its annual growth in population, the deficit has to be met from either increasing productivity or increasing land area under fodder cultivation or through import.

Nitrogen is commonly the most limiting nutrient factor for crop production in the majority of the world's agricultural areas and therefore, adoption of good nitrogen management strategies often results in large economic benefits to farmers. Nitrogen fertilizer has contributed more than any other fertilizer towards increasing yield of grain crops, including sorghum. Consequently, nitrogen has become the foremost input in relation to cost and energy requirement in advanced agricultural production systems.

Nitrogen is the most mobile element and required throughout for the growth of the plant.. Better utilization of applied nitrogen can be achieved by splitting the nitrogen as per crops needs. Nitrogen is a major input in sorghum production, affecting both yield and quality through influencing those components which have great contribution in increasing grain yield of sorghum (Wondimu, 2005). Thus, it is very essential to apply nitrogen to *kharif* forage sorghum coincide with the growth period of the forage sorghum crop.

Since, there is paucity of information on a foreside, a field experiment entitled "Nitrogen management in forage sorghum" was planned during *kharif* season of 2021.

MATERIALS AND METHODS

A field experiment entitled, "Nitrogen management in forage sorghum [*Sorghum bicolor* (L.) Moench]" was carried out during *kharif* season of 2021 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat with three levels of nitrogen *i.e.* N_1 : 75% nitrogen N_2 :100% nitrogen and N_3 :125% nitrogen and number of splits are three types *viz;* S_1 : one split at 30 DAS, S_2 : two splits at 30 and 45 DAS and S_3 : three splits at 30, 45 and 60 DAS. The climate of this region is semi-arid and sub-tropical with fairly dry and hot summer. The experimental soil was loamy sand in texture and slightly alkaline in reaction with pH 7.6 and Electrical conductivity was very low showing that the soil was free from salinity hazard. It was moderately fertile being low in organic carbon (0.17 %) and low in available nitrogen (152 kg/ha), medium in available phosphorus (30.22 kg/ha) and high in available potassium (288 kg/ha). The nine treatment combinations consisted of three levels of nitrogen as a main plot treatments and number of splits as sub-plot treatments were evaluated using Randomized block Design with factorial concept with four replications. The seeds were sown keeping 30 cm row spacing using 30 kg seed/ha and the crop was irrigated immediately after sowing. The required cultural practices were followed as per recommended package of practices. The sun dried bundles were weighed and data on green forage yields were recorded. Gross returns were calculated based on green fodder yield of the crop and their prevailing market prices at the time of harvesting.

RESULTS AND DISCUSSION

Effect of nitrogen levels

Data presented in Table 1, 2 and 3 indicated that application of 125% nitrogen (N_3) recorded significantly the highest plant height at 60 DAS (111.53 cm), number of leaves per plant (11.30), leaf length (68.54 cm), leaf width (5.73cm), plant height at harvest (190.1 cm), leaf stem ratio (0.36) and green forage yield (287.8 q/ha) whereas, significantly the lowest were recorded with 75% nitrogen (N_1). The increase in the plant height might be due to the positive effect of nitrogen element on plant growth that leads to progressive increase in inter nodal length and consequently plant height. Similar results were reported by Nirmal *et al.* (2016). This has served consequences one of them is increase in size of cell which is expressed morphologically through increase in plant height. Gupta *et al.* (2010) also reported same type of results. Significantly the higher number of leaves per plant might be due to the higher plant height and due to favourable growth of forage sorghum by the application of higher dose of nitrogen. The increase in leaf stem ratio with increasing levels of nitrogen was mainly due to rapid expansion of dark green foliage which could intercept and utilize the incident solar

TABLE 1
Plant height of forage sorghum as influenced by levels and split applications of nitrogen

Treatment	Plant height (cm)	
	60 DAS	At harvest
Levels of nitrogen (N)		
N_1 : 75% N	89.9	142.7
N_2 : 100% N	99.7	164.8
N_3 : 125% N	111.5	190.1
S. Em±	2.82	4.33
C. D. (P = 0.05)	8.24	12.63
Number of splits (S)		
S_1 : One split at 30 DAS	90.9	146.4
S_2 : Two splits at 30 and 45 DAS	101.9	170.3
S_3 : Three splits at 30, 45 and 60 DAS	108.3	180.9
S. Em±	2.82	4.33
C. D. (P = 0.05)	8.24	12.63
Interaction (N × S)		
C. D. (P = 0.05)	NS	NS
C. V. %	9.75	9.04

TABLE 2
Number of leaves, leaf length and width of leaves at harvest of forage sorghum as influenced by levels and split applications of nitrogen

Treatment	No. of leaves/ plant	Length of leaves (cm)	Width of leaves (cm)
Levels of nitrogen (N)			
N_1 : 75% N	10.02	55.08	5.10
N_2 : 100% N	10.83	59.08	5.38
N_3 : 125% N	11.30	68.54	5.73
S. Em±	0.24	1.84	0.16
C. D. (P = 0.05)	0.68	5.36	0.46
Number of splits (S)			
S_1 : One split at 30 DAS	10.22	55.98	5.37
S_2 : Two splits at 30 and 45 DAS	10.72	62.70	5.53
S_3 : Three splits at 30, 45 and 60 DAS	11.22	64.03	5.31
S. Em ±	0.24	1.84	0.16
C. D. (P = 0.05)	0.68	5.36	NS
Interaction (N × S)			
C. D. (P = 0.05)	NS	NS	NS
C.V. %	7.63	10.46	10.18

TABLE 3
Days to 50% flowering and leaf : stem ratio of forage sorghum as influenced by levels and split applications of nitrogen

Treatment	Days to 50% flowering	Leaf : stem ratio yield	Green forage (q/ha)
Levels of nitrogen (N)			
N_1 : 75% N	62.64	0.24	235.5
N_2 : 100% N	63.46	0.31	262.8
N_3 : 125% N	62.98	0.36	287.8
S. Em±	1.46	0.02	7.8
C. D. (P = 0.05)	NS	0.05	22.9
Number of splits (S)			
S_1 : One split at 30 DAS	61.73	0.27	243.1
S_2 : Two splits at 30 and 45 DAS	63.83	0.31	266.9
S_3 : Three splits at 30, 45 and 60 DAS	63.53	0.33	276.2
S. Em±	1.46	0.02	7.8
C. D. (P = 0.05)	NS	NS	22.9
Interaction (N × S)			
C. D. (P = 0.05)	NS	NS	NS
C. V. %	8.04	21.46	10.36

radiation in the production of photosynthates and eventually resulting in higher meristematic activity and increased leaf : stem ratio of fodder sorghum. This might be also due to favourable influence of nitrogen on cell division and cell elongation, which could have produced more functional leaves for a longer period of time. Ram and Singh (2001) also reported same type of results. Effects of nitrogen on cell division and elongation, formation of nucleotides and co-enzymes which resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates which results in higher green forage yield.

A perusal of data on net return as influenced by different levels of nitrogen are exhibited in Table 4 revealed that the highest net return (Rs. 56342/ha) was accrued with application of 125% nitrogen, followed by level of 100% nitrogen with net return of (Rs. 50369/ha) whereas, significantly the lowest net return (Rs. 43348/ha) was recorded with 75% nitrogen (N_1). Higher benefit: cost ratio 2.87 was accrued with application of 125% nitrogen, followed by level of 100% nitrogen with benefit: cost ratio of 2.76 whereas, significantly lowest benefit: cost ratio 2.58 recorded with 75% nitrogen (N_1).

Number of splits

An appraisal of the data presented in Table 1, 2 and 3 showed that significantly the highest plant height at 60 DAS and harvest (108.31 cm and 180.9 cm respectively) of *kharif* forage sorghum was recorded by splitting the nitrogen in three splits at 30, 45 and 60 DAS and which was at par with two splits at 30 and 45 DAS. Increase in the plant height might be due to cell elongation, cell enlargement and more chlorophyll synthesis in the presence of sufficient nitrogen at higher levels resulting in better plant growth and ultimately resulted in higher yield of forage sorghum. Significantly the maximum number of leaves per plant (11.22) of *kharif* forage sorghum was recorded by splitting the nitrogen in three splits at 30, 45 and 60 DAS and which was at par with two splits at 30 and 45 DAS whereas, significantly the minimum number of leaves per plant at harvest (10.22) recorded with one split at 30 DAS. The increase in number of leaves per plant was due to the accelerated meristematic activity, photosynthetic activity and vegetative growth. Significantly the higher green forage yield (276.2 q/ha) of *kharif* forage sorghum was recorded by splitting the nitrogen in three splits at 30, 45 and 60 DAS but which was at par with two splits at 30 and 45 DAS whereas, significantly lower green forage yield (243.1 q/ha) recorded with one split at 30 DAS.

An appraisal of the data presented in Table 4 indicated that significantly the maximum net return (Rs. 53911/ha) of *kharif* forage sorghum was recorded by splitting the nitrogen in three splits at 30, 45 and 60 DAS followed by two splits at 30 and 45 DAS with net return of (Rs. 51479/ha) whereas, significantly the lowest net return (Rs. 44699/ha) was recorded with one split at 30 DAS.

TABLE 4
Effect of levels and split applications of nitrogen on economics of forage sorghum

Treatment	Green forage yield (q/ha)	Gross return (Rs./ha)	Total cost of cultivation (Rs./ha)	Net return (Rs./ha)	B:C ratio
Levels of nitrogen (N)					
N_1 : 75% N	235.5	70650	27302	43348	2.58
N_2 : 100% N	262.8	78840	28471	50369	2.76
N_3 : 125% N	287.8	86340	29998	56342	2.87
Number of splits (S)					
S_1 : One split at 30 DAS	243.1	72930	28231	44699	2.58
S_2 : Two splits at 30 and 45 DAS	266.9	80070	28591	51479	2.80
S_3 : Three splits at 30, 45 and 60 DAS	276.2	82860	28949	53911	2.86

TABLE 5
Different treatment combinations as influenced by levels and split applications of nitrogen

Treatment	Treatment combination	Green forage yield (q/ha)	Total cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BCR
T_1	N_1S_1	212.5	26943	63750	36807	2.36
T_2	N_1S_2	241.2	27302	72360	45058	2.65
T_3	N_1S_3	252.7	27661	75810	48149	2.74
T_4	N_2S_1	249.2	28112	74760	46648	2.65
T_5	N_2S_2	269.0	28472	80700	52228	2.83
T_6	N_2S_3	270.2	28830	81060	52230	2.81
T_7	N_3S_1	267.5	29639	80250	50611	2.70
T_8	N_3S_2	290.5	29998	87150	57152	2.90
T_9	N_3S_3	305.5	30356	91650	61294	3.01

An appraisal of the data presented in Table 4 indicated that significantly the maximum benefit : cost ratio 2.86 of *kharif* forage sorghum was recorded by splitting the nitrogen in three splits at 30, 45 and 60 DAS followed by two splits at 30 and 45 DAS with benefit : cost ratio (2.80) whereas, significantly the lowest benefit : cost ratio 2.58 was recorded with one split at 30 DAS.

CONCLUSION

Based on the results of one year experimentation, it indicated that for getting higher green forage yield with better forage quality, sorghum should be fertilized with 125% N in two equal splits at 30 and 45 DAS.

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