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YIELD, GROWTH AND PROXIMATE ANALYSIS OF MULTI-CUT FODDER SORGHUM GENOTYPES WITH DIFFERENT DOSES OF NITROGEN

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SUMMARY

A field experiment was conducted on multi-cut fodder sorghum [*Sorghum bicolor* (L.) Moench] to determine the effect of nitrogen on yield, growth and proximate analysis at Punjab Agricultural University, Ludhiana, Punjab during the *Kharif* season 2018. The experiment was laid out in Randomized Complete Block Design (RCBD), using three replications. The results showed that increasing nitrogen dose increased all yield and growth attributes. All the parameters studied showed significant differences in first, second and third cuts. The genotype SPH 1840 due to higher GFY revealed significantly higher gross returns (Rs 93745), net returns (Rs 52913) and B:C ratio (2.29). Therefore, it could be inferred that 125% RDF for each cut found optimum and economical which recorded higher green forage, DMY, higher quality parameters, net returns and B : C ratio.

Keywords : Growth, genotypes**,** multi-cut sorghum, nitrogen levels, quality

In general, forage is the main feed for ruminants with a daily consumption rate reaches 70% of the total ration. Besides of this huge amount, forage also plays a role as the main nutrition source for ruminants, therefore its availability is absolutely necessary. Forages should be maintained in ruminant diets because the production costs for forages are lower than for concentrate and more environment friendly, so it is more suitable for the development of sustainable livestock industry. Forage in diets helps maintain rumen function, reduces the risk of acidosis, and improves intake (Sari *et al.,* 2015). To overcome those conditions, forage with high biomass production and more adaptive to marginal land such as sorghum is needed to be developed. Sorghum [*Sorghum bicolor* (L.) Moench] is one of important crops and ranks at the fifth world's widest spread after wheat, rice, maize, and barley (Dahir *et al.,* 2015). Sorghum is one of cereal crops consisting of forage and grains which potential to be used for fodder.

The green fodder availability from single cut sorghum is seasonal while multi-cut sorghum helps to supply green fodder throughout the year. Multi-cut forage having shorter cutting interval of 40-45 days, requires adequate nutrients in available form to produce sufficient foliage in a limited period of time (Sanmugapriya and Kalpana, 2017). There are several factors, which affect the productivity and quality of forage oat. Nitrogen is a one of the major components to influence the forage growth, yield and quality. Moreover, nitrogen is the most important nutrient for plant growth and is the most limiting nutrient in our soils and sufficient amount of it will promote shoot elongation, tillering and regeneration after defoliation thereby affects the yield and quality of fodder crop. Sorghum exhausts more nutrients than other forage crops and being cereal crop, it requires higher amount of nitrogen. However, higher level of nitrogen application may increase prussic acid contents of forage sorghum and ultimately poisoning to animals but nitrogen application is essential requisite to utilize the available soil and environmental resources effectively (Crawford *et al.,* 2018).

In addition to quantity, quality of feed also is a matter of concern because good quality feed provides better nutrition to the livestock and intern also affect quality of by-products. Sorghum feed quality is mainly determined by TSS%, CP% and IVDMD%. Forage shortage during the scarcity period can be reduced by the introducing the high yielding cultivars. Different sorghum cultivars vary in fodder yield as well as quality of fodder. The introduction of high yielding crop varieties is the most suitable option to fulfil forage shortage. Therefore, the present research work was framed to study the effect of different genotypes and nitrogen levels on fodder multi cut sorghum growth, productivity and quality.

MATERIAL AND METHODS

The field experiment was conducted during *kharif* season of 2018 at forage research farm of Punjab

Agricultural University, Ludhiana (Punjab). The study area was situated at 30°54′N latitude and 75°48′E longitude with an altitude of 247 meters above the mean sea level. The weekly metereological data of the Ludhiana has been given in Table 1. The soil of the experimental field was sandy loam in texture, 0.40% organic carbon, low in available nitrogen 208 kg/ha, medium in available phosphorus 18.8 kg/ha and high in available potassium 255 kg/ha with pH of 7.8. The experiment consisted of 9 treatment combinations comprising three multi-cut forage sorghum genotypes (SPH 1840, UPMC 503 and CSH 24MF) and three fertility levels *viz*. 75, 100 and 125 per cent of recommended dose of fertilizer (RDF). These treatments were tested in factorial randomized complete block design (RCBD) and replicated thrice. The crop was sown on 18 May 2018 in opened furrows at 25 cm apart using seed rate of 40 kg/ha. The recommended dose of fertilizer (100%) for forage sorghum is 100 kg N, 20 kg P_2O_5 and 25 kg K_2O (in potassium deficient soils) per hectare. Half dose of nitrogen and full dose of phosphorus were applied as basal according to treatment levels. Remaining half dose of nitrogen was top-dressed after first irrigation 30 days after sowing (DAS). The crop received uniform irrigation as per requirement. All the other standard agronomic practices for the

TABLE 1
The weekly meteorological data (*Kharif* 2018)

Standard Week	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)
	Max	Min	AM	PM	
19	38.4	23.2	55	23	3.6
20	38.4	23.3	51	23	0.0
21	42.1	23.7	33	9	0.0
22	39.1`	24.1	47	22	19.0
23	38.7	27.2	66	40	37.8
24	37.8	23.1	61	37	66.8
25	38.3	26.3	61	36	0.0
26	37.6	27.2	64	41	141.8
27	33.9	26.0	85	62	52.8
28	35.5	28.1	79	58	64.0
29	33.4	25.9	84	77	167.8
30	33.9	26.6	85	65	91.4
31	34.3	26.6	83	64	376.6
32	32.7	26.5	86	72	53.8
33	33.9	26.8	84	69	13.0
34	34.2	27.3	83	68	0.0
35	34.1	27.3	84	67	74.0
36	33.4	26.1	88	64	20.0
37	33.4	25.2	86	60	0.0
38	31.1	22.3	86	61	146.8
39	29.9	21.3	93	65	68.2
40	32.5	20.5	93	47	0.0
41	30.8	18.6	85	40	0.0
42	31.7	16.0	88	33	0.0

cultivation of forage sorghum were followed uniformly in all the treatments. After the harvest, the plant samples were first sun dried and then dried in hot air oven completely to obtain a constant weight. The dried samples were finely meshed by grounding with Willy grinder and are used for the quality parameters estimation. Among quality traits crude protein (CP), hydrocyanic acid (HCN) and *in-vitro* dry matter digestibility (IVDMD) were estimated by the method proposed by Kjeldhal's method (AOAC, 1970), Hogg and Ahlgren (1942) and Telly and Terry (1963), respectively. Yield and yield related parameters were recorded. Data on forage yield, HCN content, *in-vitro* dry matter digestibility (IVDMD) and crude protein (CP) were analysed by using OPSTAT software.

RESULTS AND DISCUSSION

The effect of different doses of nitrogen on green fodder yield (GFY) for three cuttings was presented in Table 2. The results revealed that except for the third cut, the green fodder yield showed non-significant differences for first and second cut by increasing nitrogen dose. Maximum GFY was observed at 125% RDF, having GFY 60.8 t/ha, 25.6 t/h and 10.0 t/ha in first, second and third cut respectively, which was followed by 100% RDF treatment, having 54.5 t/ha in first cut while second and third cut have 22.0 t/ha and 9.9 t/ha. Similarly, the dry fodder yield (DFY) was significantly influenced by different doses of nitrogen during first and second cut but not in the third cut of forage sorghum. Higher DFY was recorded with the fertilizer dose of 125% during first, second and third cuts (Table 2) which might be due to the fact that nitrogen plays a key role in accumulation of photosynthates. These findings are in conformity with those of Singh *et al.* (2016). The genotype SPH 1840 in comparison to other two genotypes showed significant higher GFY and DMY of 64.9 t/ha and 16.0 t/ha in the first cut respectively followed by CSH 24 MF with 56.9 t/ha and 13.3 t/ha respectively. In second and third cuts also SPH 1840 showed significantly higher GFY and DFY than UPMC 503 and CSH 24 MF. Forage yield is a function of genetic as well as environmental factors which plays a vital role in plant growth and development. The different genetic makeup of three genotypes under study showed difference in their yield potential. The non-significant interactive effects of genotype and fertilizer were observed in green and dry fodder yield in first and second cuts in comparison to third cut.

The genotype SPH 1840 recorded significantly higher plant height of 166.5 cm in first cut, 111.7 cm in

TABLE 2

Fodder yield of multi-cut fodder sorghum genotypes with different doses of nitrogen

Treatments	Green fodder yield (t/ha)			Dry matter yield (t/ha)		
	First cut	Second cut	Third cut	First cut	Second cut	Third cut
Genotypes						
SPH 1840	64.9	29.0	10.3	16.0	4.0	1.8
UPMC 503	43.2	16.7	7.9	12.2	2.8	1.3
CSH 24MF	56.9	22.9	11.0	13.3	3.7	1.9
C. D. (P=0.05)	8.6	2.1	0.9	2.0	0.4	0.2
Fertilizer levels						
75% RDF	49.7	21.0	9.3	12.5	3.1	1.5
100% RDF	54.5	22.0	9.9	13.4	3.5	1.7
125% RDF	60.8	25.6	10.0	15.6	3.8	1.7
C. D. (P=0.05)	8.6	2.1	NS	2.0	0.4	NS
CD (E x F)	NS	NS	1.6	NS	NS	0.3
CV (%)	15.7	9.2	9.4	14.6	11.2	9.7

TABLE 3

Plant height and leaf stem ratio of multi-cut fodder sorghum genotypes with different doses of nitrogen

Treatments	Plant height (cm)			L : S ratio		
	First cut	Second cut	Third cut	First cut	Second cut	Third cut
Genotypes						
SPH 1840	166.5	111.7	78.8	0.57	0.51	0.94
UPMC 503	125.2	90.0	64.8	0.50	0.47	0.89
CSH 24MF	129.1	111.2	69.8	0.78	0.60	1.22
C. D. (P=0.05)	15.7	18.1	6.7	0.08	0.09	0.05
Fertilizer levels						
75% RDF	129.9	104.6	70.2	0.49	0.48	0.97
100% RDF	134.0	104.6	72.4	0.66	0.52	1.04
125% RDF	156.9	103.7	70.8	0.71	0.58	1.04
C. D. (P=0.05)	15.7	NS	NS	0.08	NS	0.05
CD (E x F)	NS	NS	11.6	0.15	NS	0.08
CV (%)	11.2	17.4	9.4	13.6	16.2	4.8

second cut and 78.8 cm in third cut followed by the genotype CSH 24 MF (Table 3). However, leaf stem ratio of the genotype CSH 24 MF was found to be significantly higher followed by SPH 1840. The higher plant height and leaf stem ratio were noted with the 125% RDF treatment in comparison to 100 and 75% RDF treatments. The higher plant height with higher levels of nitrogen was mainly attributed to more availability of nitrogen to the crop which resulted in more vegetative growth and higher in protoplasmic constituents. The present findings are in agreement with those of Shivprasad and Singh (2017). Further, increase in leaf stem ratio with increase in nitrogen levels might be due to rapid expansion of green foliage which intercept and utilize the incident solar radiation in the production of photosynthates and eventually resulting in more meristematic activity and increased leaf stem ratio of fodder sorghum. This might also be due to favourable influence of nitrogen on cell division and cell elongation, producing more functional leaves for a longer period of time. The leaf stem ratio of 0.71, 0.58 and 1.04 in first, second and third cuts were recorded, respectively, at 125% RDF. Moreover, observed increase in growth parameters i.e. plant height and leaf stem ratio reflected on yield as forage yield is the function of growth parameters. The increase dose of fertilizer resulted in luxuriant vegetative growth and ultimately the higher GFY (Table 2 and 3). Similar results were also obtained by Shanti *et al.* (2017). Moreover, for plant height interactive effect of genotype and fertilizer level was found to be non-significant in first and second cuts whereas for leaf stem ratio the first and third cuts showed non significance between genotype and fertilizer interaction.

The nitrogen application in third cut had resulted in significant increase in crude protein (CP) content as presented in Table 4. The increase in CP with increment in nitrogen dose was due to increased absorption of nitrogen since it is well established fact that nitrogen is the main constituent of amino acids, ultimately increased CP content of plants. These results are in harmony with the published work of Kaur *et al.* (2018). The CP content was noted to be maximum in first (7.0%) and second (7.5%) cuts in SPH 1840 followed by CSH 24 MF whereas in third cut CP with value of 7.8% was maximum in CSH 24 MF followed by 7.6% in SPH 1840. The more CP content in third cut in comparison to other two cuts could attribute to the fact that vegetative growth in third cut in comparison to first and second cuts was lesser and all the nutrients especially nitrogen could be used for amino acids synthesis thereby, observed CP content was the outcome. The significant variation for CP content had been seen among all three genotypes under the influence of different doses of nitrogen. The interactive effect for crude protein content was recorded to be significant in all three cuttings.

In first and third cuts, there was significant variation in IVDMD whereas in second cut the difference noticed was non-significant among the genotypes i.e. SPH 1840, UPMC 503 and CSH 24MF under different doses of nitrogen treatment (Table 4). However, the overall mean of three cuts showed higher IVDMD of UPMC 503 (46.3%) in comparison to SPH 1840 (43.3%) and UPMC 503 (43.7%). With the increase in nitrogen application to forage sorghum increase in IVDMD was recorded in all the three cuts. The maximum IVDMD values are found in second cut compared to first and third cut. In comparison to

TABLE 4
Quality of multi-cut fodder sorghum genotypes with different doses of nitrogen

Treatments	Crude protein content (%)			IVDMD (%)		
	First cut	Second cut	Third cut	First cut	Second cut	Third cut
Genotypes						
SPH 1840	7.0	7.5	7.6	37.0	49.0	44.0
UPMC 503	5.6	6.4	5.9	38.2	50.1	50.5
CSH 24MF	6.9	7.0	7.8	39.9	47.5	43.6
C. D. (P=0.05)	0.4	0.5	0.6	2.2	NS	3.1
Fertilizer levels						
75% RDF	6.4	6.9	7.6	37.3	49.1	43.0
100% RDF	6.5	7.0	6.2	36.7	48.6	46.7
125% RDF	6.6	7.0	7.5	41.1	49.0	48.2
C. D. (P=0.05)	NS	NS	0.6	2.2	NS	3.1
CD (E x F)	0.6	0.9	1.1	NS	NS	5.4
CV (%)	5.5	7.5	9.0	5.8	5.6	6.8

other two cuts, the significant interactive effect was seen for IVDMD. Anup and Vijaykumar (2000) had reported that the increase in GFY will results in increase in quality of forage sorghum and the important quality parameters CP and IVDMD exhibited strong positive correlation. In the present investigation, the CP and IVDMD had showed almost same trend in the three cuts and also as the increase in GFY resulted in better quality of fodder sorghum by increase in the content of CP and IVDMD.

The higher significant gross returns (Rs 86759), net returns (Rs 45089) and B:C ratio (2.08) were obtained with 125% RDF as compared to 100% and 75% RDF application to fodder sorghum (Table 5). Among the genotypes, significantly higher gross returns (Rs 93745), net returns (Rs 52913) and B:C ratio (2.29) were obtained in SPH 1840. This was mainly due to higher GFY and less cost of production.

TABLE 5
Economics of multi-cut fodder sorghum genotypes with different doses of nitrogen

Treatments	Gross returns (Rs/ha)	Net returns (Rs/ha)	B : C ratio
Genotypes			
SPH 1840	93745	52913	2.29
UPMC 503	60976	20145	1.49
CSH 24MF	81705	40873	2.00
C. D. (P=0.05)	8215	8215	0.20
Fertilizer levels			
75% RDF	71941	31948	1.80
100% RDF	77727	36895	1.90
125% RDF	86759	45089	2.08
CD (p=0.05)	8215	8215	0.20
CD (E x F)	NS	NS	NS
CV (%)	10.4	21.6	10.4

CONCLUSION

From above results it can be concluded that 125% RDF for each cut was optimum and economical. The green forage, DMY, quality parameters, net returns and B:C ratio were noticed to be more with 125% RDF compared to other nitrogen treatments. Among all genotypes tested, genotype SPH 1840 proved superior with regard to fodder yield, quality and net returns.

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