Forage Res., **41** (3) : pp. 170-175 (2015) **http://forageresearch.in**

RESPONSE OF YIELD, QUALITY AND ECONOMICS OF SINGLE CUT FORAGE SORGHUM GENOTYPES TO DIFFERENT NITROGEN AND PHOSPHORUS LEVELS

SATPAL*, B. S. DUHAN[1], U. N. JOSHI, A. S. GODARA[2], S. ARYA AND NEELAM

Department of Genetics & Plant Breeding
CCS Haryana Agricultural University,
Hisar-125 004 (Haryana), India
**(e-mail : satpal.fpj@gmail.com)*

(Received : 30 September 2015; Accepted : 5 December 2015)

SUMMARY

A field experiment was conducted at Hisar (Haryana), India during the rainy (**kharif**) season of 2014 to study the response of different nitrogen and phosphorus levels on the yield and quality of forage sorghum [*Sorghum bicolor* (L.) Moench] genotypes. The experiment consisted of 20 treatment combinations comprising five single-cut forage sorghum genotypes (SPV 2185, SPV 2191, HC 308, CSV 21F and CSV 30F) and four fertility levels (50 per cent of RDF, 75 per cent of RDF, RDF and 125 per cent of RDF). These treatments were replicated thrice in factorial randomized block design. Recommended dose of fertilizer (RDF) was 80 kg N+40 kg P_2O_5/ha. Among genotypes, SPV 2191 recorded maximum green fodder yield (408.19 q/ ha), which was on a par with HC 308, SPV 2185, CSV 30F and significantly superior over CSV 21F (301.85 q/ha). The dry matter yield (109.89 q/ha) was highest under CSV 30F genotype, which was on a par with HC 308 and SPV 2191 but significantly superior over SPV 2185 and CSV 21F. Highest net returns (Rs. 16077/ ha) and B : C ratio (1.60) were recorded under SPV 2191 which was on a par with all the genotypes except CSV 21F. Among different fertility levels, the application of 125 per cent of RDF (100 kg N and 50 kg P_2O_5/ ha) recorded significantly higher green fodder yield (428.47 q/ha), dry matter yield (113.27 q/ha), leaf area index (5.45) and crude protein yield (11.46 q/ha) than other treatments except application of RDF (80 kg N and 40 kg P_2O_5/ha). The application of 100 kg N and 50 kg P_2O_5 /ha also recorded significantly higher crude protein (10.15%), *in vitro* dry matter digestibility (53.06%) and digestible dry matter (60.38 q/ha), which was significantly superior over rest of the treatments. The maximum net returns (Rs. 17162/ha) and B : C ratio (1.63) were recorded with the application of 125 per cent of RDF which was on a par with the application of RDF.

Key words : Dry matter, forage yield, nitrogen, phosphorus, sorghum

Sorghum [*Sorghum bicolor* (L.) Moench], belonging to family Poaceae, is an important **kharif** season crop which is widely grown to meet the green as well as dry fodder requirement of the livestock. It is fast growing, adaptive to vast environmental condition and provides palatable nutritious fodder to the animals. India supports 512.05 million of livestock, which includes 37.28 per cent cattle, 21.23 per cent buffalo, 12.71 per cent sheep, 26.40 per cent goat and 2.01 per cent pig (DAHD & F, 2012). India supports nearly 20 per cent of the world's livestock being the leader in cattle (16%) and buffalo (5.5%) population. Deficiency in feed and fodder has been identified as one of the major components in achieving the desired level of livestock production. The shortage in dry fodder is 21.8 per cent compared with requirement of 560 million tonnes for the current livestock populations (Rana *et al.*, 2013). Proper and adequate fertilization and suitable genotypes are one among the major factors limiting fodder sorghum production in our country. Identification of good quality sorghum genotypes and development of location specific production technology offer an excellent opportunity to provide fodder for better nutrition to bovine population (Pushpendra and Sumeriya, 2012). It is well established fact that nitrogen and phosphorus play important role in the growth and development of crop plants. Thus,

[1]Department of Soil Science.
[2]Department of Agroforestry.

suitable genotype and proper nutrition are very important to get higher fodder yield. Hence, the present study was undertaken to find out the response of different single cut forage sorghum genotypes to different fertilizer levels.

MATERIALS AND METHODS

The field experiment was conducted during rainy (**kharif**) season of 2014 at Forage Section Research Area, CCS Haryana Agricultural University, Hisar, Haryana, India (29°10' N or 75°46' E, at an average elevation of 215.2 m above mean sea level). The site has semi-arid and sub-tropical climate with hot dry summer and severe cold winter. Average annual rainfall is about 450 mm, 75 per cent of which is received in three months, from July to September during south-west monsoon. July and August are the wettest months. The crop received 103.8 mm rainfall during the crop duration. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction (pH 7.7), low in available nitrogen (180.40 kg/ha), medium in available phosphorus (14.10 kg/ha) and potassium (275.70 kg/ha) with moderate water holding capacity. The experiment consisted of 20 treatment combinations comprising five single-cut forage sorghum genotypes (SPV 2185, SPV 2191, HC 308, CSV 21F and CSV 30F) and four fertility levels viz., 50 per cent of recommended dose of fertilizer (RDF), 75 per cent of RDF, RDF (80 kg N+40 kg P_2O_5/ ha) and 125 per cent of RDF. These treatments were tested in factorial randomized block design with three replications. As per treatment, full dose of phosphorus and half of the nitrogen was applied at the time of sowing and rest half of the nitrogen was applied 30 days after sowing. The P_2O_5 and N nutrients were supplied through DAP and urea fertilizers as per treatments. The sorghum genotypes as per treatment were sown manually on 7th August 2014 in opened furrows at 25 cm apart using seed rate of 40 kg/ha. All the other standard agronomic practices for the cultivation of forage sorghum were followed uniformly in all the treatments. Leaf area index was recorded with the instrument SS1 SunScan (Canopy Analysis System, AT Delta-T Devices Ltd., Cambridge CB25 0EJ, UK). All the genotypes were harvested just after 50 per cent flowering. The harvested green fodder from each plot was weighed in situ in kg/plot and then converted into q/ha. A random sample of 500 g was taken from each plot at the time of green fodder harvest, chopped well and put into paper bag. These bags were aerated by making small holes all over. The samples were first sun dried for 15 days and then transferred in an electric hot air oven for drying at a temperature of 60±5 ^{o}C till constant weight was achieved. On the basis of these samples, the green fodder yield was converted into dry matter yield (q/ha). Crude protein and *in vitro* dry matter digestibility (IVDMD) were estimated in dried and grinded samples (2 mm sieve size), collected at 50 per cent flowering stage. The crude protein content was calculated by multiplying the nitrogen percentage with 6.25 by conventional micro-Kjeldhal method (AOAC, 1995). IVDMD was determined by method of Barnes *et al.* (1971). Crude protein yield and digestible dry matter (q/ha) were calculated by multiplication of crude protein content and IVDMD with dry matter yield (q/ha), respectively. The sample for analysis of HCN was taken at 30 DAS from the portion of the tiller immediately below the uppermost leaf collar and HCN content was determined by the method given by Hogg and Ahlgren (1942). The amount of HCN on fresh weight basis was calculated by calibrating the absorbance with HCN (5-40 x 10^{-3} g/l) in water as standard. The content of total soluble solids (TSS) was determined using refractometer. Economics was worked out on the basis of prevailing market prices of inputs and outputs in the local market. The experimental data were analyzed by the application of factorial randomized block design using OPSTAT software available on CCS Haryana Agricultural University home page (Sheoran, 2015). The results were presented at 5 per cent level of significance (P=0.05) for making comparison among treatments.

RESULTS AND DISCUSSION

Genotypes

Data presented in Table 1 reveal that the green fodder yield (408.18 q/ha) was highest under genotype SPV 2191, which was on a par with HC 308, SPV 2185 and CSV 30F but significantly superior over CSV 21F. The green fodder yield of SPV 2191 was 9.29, 9.53 and 10.4 per cent higher over HC 308, SPV 2185 and CSV 30F, respectively. The green fodder yield of SPV 2191 was 35.22 per cent higher over CSV 21F. The dry matter yield (109.89 q/ha) was highest under CSV 30F, which was on a par with HC 308 and SPV 2191 but significantly superior over SPV 2185 and CSV 21F. The dry matter yield of CSV 30F was 11.23 and 13.91 per cent higher over HC 308 and SPV 2191, respectively. The dry matter yield of CSV 30F was 14.57 and 25.18 per cent higher over SPV 2185 and CSV 21F, respectively. The lowest green fodder yield and dry matter yield was obtained in case of genotype SPV 21F. The plant height of sorghum genotype CSV 30F was 312.33 cm, which was significantly higher over rest of the genotypes. In case of leaf : stem ratio, no significant difference was observed among all the genotypes. Data presented in Table 2 reveal that the genotype CSV 30F took maximum number of days for flowering i. e. 84.30 days, whereas the genotypes HC 308 and CSV 21F completed their duration of 50 per cent flowering after a period of 73 days after sowing. The maximum leaf area index was recorded with the genotype SPV 2191 (5.37), which was significantly superior over the other genotypes.

Data presented in Table 2 reveal that HCN content ranged from 76.12 to 170.37 µg/g fresh weight basis. Minimum HCN content was observed in HC 308 (76.12 µg/g) followed by CSV 30F (106.37 µg/g) and SPV 2191 (116.87 µg/g). The crude protein (%) ranged from 8.86 to 9.52. The maximum crude protein (%) was observed in HC 308 and lowest in CSV 30F. The maximum crude protein (%) was observed in HC 308 (9.52), which was on a par with SPV 21F and SPV 2185 but significantly superior over SPV 2191 and CSV 30F. IVDMD (%) ranged from 47.14 to 54.19. The maximum IVDMD (%) was observed in CSV 30F, which was significantly superior over rest of the varieties. The crude protein yield (q/ha) was non-significant under all the varieties. The crude protein yield (q/ha) ranged from 8.59 to 9.89. The maximum crude protein yield (q/ha) was observed in CSV 30F and minimum in CSV 21F. The digestible dry matter (q/ha) ranged from 41.76 to 59.91 among genotypes. The maximum digestible dry matter (q/ha) was observed in CSV 30F, which was significantly superior over rest of the genotypes. The minimum digestible dry matter (q/ha) was observed in CSV 21F. The maximum TSS (%) (9.57) was observed in genotype HC 308, which was on a par with SPV 2191 (9.13) and CSV 21F (9.04) but significantly superior over CSV 30F and SPV 2185. The difference yielded by sorghum cultivars might be the result of variation in their genetic make-up (Hanuman *et al.*, 2008).

Fertility Levels

Data presented in Table 1 reveal that green fodder yield (GFY) and dry matter yield (DMY) increased with the increase in fertility levels from 50 per cent of RDF to 125 per cent of RDF. The maximum GFY was observed with the application of 125 per cent of RDF (428.47 q/ha), which was found on a par with the application of RDF (396.34 q/ha) but significantly superior from the application of 75 per cent of RDF (349.10 q/ha) and 50 per cent of RDF (286.79 q/ha).

TABLE 1
Growth, yield attributes and yield of sorghum genotypes for single cut fodder at different fertility levels

Treatment	Tillers/mrl at harvest	Plant height (cm) at harvest	LAI at harvest	L : S ratio at harvest	Days to 50% flowering	Green fodder yield (q/ha)	Dry matter yield (q/ha)
Genotypes							
SPV 2185	14.08	246.25	4.86	0.311	80.30	372.65	95.91
SPV 2191	14.33	271.75	5.37	0.312	80.80	408.19	96.47
HC 308	14.58	269.33	5.05	0.284	72.90	373.48	98.79
CSV 21F	14.17	271.00	4.81	0.302	72.60	301.85	87.78
CSV 30F	12.50	312.33	5.00	0.292	84.30	369.71	109.89
S. Em±	0.63	7.43	0.10	0.01	0.60	16.76	4.79
C. D. (P=0.05)	NS	21.36	0.29	NS	1.90	48.16	13.77
Fertility levels							
50% RDF (40 kg N+20 kg P_2O_5/ha)	12.87	262.67	4.44	0.294	77.60	286.79	77.86
75% RDF (60 kg N+30 kg P_2O_5/ha)	14.40	277.67	4.94	0.298	78.20	349.10	93.91
RDF (80 kg N+40 kg P_2O_5/ha)	14.73	283.53	5.23	0.303	78.30	396.34	106.04
125% RDF (100 kg N+50 kg P_2O_5/ha)	13.73	272.67	5.45	0.306	78.70	428.47	113.27
S. Em±	0.56	6.65	0.09	0.009	0.60	14.99	4.28
C. D. (P=0.05)	NS	NS	0.26	NS	NS	43.08	12.31

Tillers/mrl–Tillers per metre row length, LAI–Leaf area index, L : S ratio–Leaf : stem ratio. NS–Not Significant.

TABLE 2
Quality of sorghum genotypes for single cut fodder at different fertility levels

Treatment	HCN (µg/g) of fresh weight	Crude protein (%)	IVDMD (%)	Crude protein yield (q/ha)	Digestible dry Matter (q/ha)	TSS (%)
Genotypes						
SPV 2185	170.38	9.30	48.55	8.93	46.55	7.99
SPV 2191	116.88	9.24	50.45	8.97	48.92	9.13
HC 308	76.13	9.52	51.20	9.47	50.75	9.57
CSV 21F	134.88	9.46	47.14	8.59	41.76	9.04
CSV 30F	106.38	8.86	54.19	9.89	59.91	8.71
S. Em±	0.58	0.08	0.12	0.48	2.36	0.30
C. D. (P=0.05)	1.66	0.23	0.36	NS	6.79	0.85
Fertility levels						
50% RDF (40 kg N+20 kg P_2O_5/ha)	88.40	8.36	48.10	6.53	37.59	8.69
75% RDF (60 kg N+30 kg P_2O_5/ha)	113.10	8.79	49.22	8.28	46.42	8.89
RDF (80 kg N+40 kg P_2O_5/ha)	132.10	9.80	50.84	10.41	53.93	9.83
125% RDF (100 kg N+50 kg P_2O_5/ha)	150.10	10.15	53.06	11.46	60.38	8.15
S. Em±	0.52	0.07	0.11	0.43	2.11	0.26
C. D. (P=0.05)	1.48	0.21	0.32	1.23	6.07	0.76

IVDMD–*In vitro* dry matter digestibility, TSS–Total soluble solids. NS–Not Significant.

The GFY of 125 per cent of RDF was 22.73 and 49.40 per cent higher over 75 per cent of RDF and 50 per cent of RDF, respectively. The maximum DMY was observed with the application of 125 per cent of RDF (113.27 q/ha), which was found on a par with the application of RDF (106.04 q/ha) but significantly superior over the application of 75 per cent of RDF (93.91 q/ha) and 50 per cent of RDF (77.86 q/ha). Under the present investigation, preponderant effect of increasing rate of nitrogen level on the growth of the crop was due to the improvement in nutritional environment of the plants. This is very well evinced from estimates of nutrient status of plants, which showed that nitrogen application not only increased its concentration but also had synergistic effect on other indispensable nutrients. Thus, this assumption was due to its greater availability in soil environments as well as its better extraction by roots and thereafter, translocation within plant system. Superiority of nitrogen levels appeared to have resulted on account of improved crop growth and better productivity favoured by improved nitrogen nutrition. The improvement in synthesis of amino acids and protein and growth promoting substances, which seemed to have enhanced meristematic activity and increased cell division and enlargement and their elongation resulting in higher plant height and dry matter accumulation per plant (Singh *et al.*, 2015). The abundant supply of nitrogen may have increased protoplasmic constituents and accelerated the process of cell division and elongation, which resulted in luxuriant vegetative growth in terms of plant height thereby higher biomass and dry matter yield. Besides, phosphorus involved in energy transfer may have significantly increased the tiller number especially at early crop growth stage thereby resulting in higher tonnage. These results corroborate the findings of Singh *et al.* (1997), Bali *et al.* (2003) and Malik and Paynter (2010). At harvest no significant difference was observed among different fertilizer treatments with respect to number of tillers per metre row length, plant height (cm), leaf : stem ratio (L : S ratio) and number of days to 50 per cent flowering (Table 1). Highest leaf area index (LAI) was recorded with the application of 125 per cent of RDF (5.45), which was on a par with RDF (5.23) and significantly superior over 75 per cent of RDF (4.94) and 50 per cent of RDF (4.44). Increase in LAI could be attributed to the encouragement of more green surface of leaves, which resulted in assimilation of photosynthates that would ultimately result in good performance of the crop in LAI (Han *et al.*, 1985; Ihtisham-ul-Haq and Aman-Ullah Jan, 2001).

HCN content increased with increasing fertility levels and became higher at 125 per cent RDF (150.10 µg/g). HCN content increased from 88.4 to 150.10 µg/g of fresh weight with increasing fertilizer levels, from 50 per cent of RDF to 125 per cent of RDF (40 kg N+20 kg P_2O_5 to 100 kg N+50 kg P_2O_5/ha). It was mainly due to increase in nitrogen absorption by plants which was used for the synthesis of HCN. Arora *et al.*

(1971) also observed increase in HCN content with high level of nitrogen fertilizer and low phosphorus content. Hydrocyanic acid content is heritable and subjected to modification through selection and breeding, as well as by climate, stage of maturity, stunting of plant, type of soil and fertilizer (Khatri *et al.*, 1997). Nitrogen application is considered essential for growth and regrowth during growing season. However, higher level of nitrogen application may increase HCN content of forage sorghum (Aziz-Abdel and Abdel-Gwad, 2008). Crude protein (%) and IVDMD (%) gradually increases with increase in fertility levels up to 125 per cent RDF. The increase in crude protein percentage and IVDMD with increase in fertilizer levels was mainly due to increase in L : S ratio, both protein and IVDMD were positively correlated with L : S ratio and also observed increase in crude protein and IVDMD percentage with increase in nitrogenous fertilizer levels (Joshi *et al.*, 2009). The increase in protein content with the increase in fertilizer levels may be the result of enhancement in amino acid formation due to fertilization (Mahmud *et al.*, 2003). Increase in crude protein yield and DDM with increasing levels of fertilizer was mainly due to increase in dry matter yield, crude protein percentage and IVDMD. The crude protein yield (q/ha) gradually increases with increase in fertility levels up to 125 per cent RDF. A progressive increase in crude protein and dry matter was observed with the increase in N and P levels (Mahmud *et al.*, 2003). The significant increase was observed in digestible dry matter (q/ha) with increase in fertilizer levels from the application of 50 per cent of RDF (37.59 q/ha) to 125 per cent of RDF (60.38 q/ha). The highest DDM recorded with the application of 125 per cent of RDF level might be due to its higher dry matter yield. Similar results were also obtained by Midha *et al.* (2014). The maximum TSS (%) was observed with the application of RDF (9.83) which was significantly superior over rest of the treatments.

Economics

The economic analysis (Table 3) indicated that among genotypes, highest gross returns (Rs. 42451/ha), net returns (Rs. 16077/ha) and B : C ratio (1.60) were recorded under SPV 2191 which was on a par with all the genotypes except CSV 21F. However, the cost of cultivation was same for all the genotypes. Among fertility levels, the maximum gross returns (Rs. 44561/ha), net returns (Rs. 17162/ha) and B : C ratio (1.63) were recorded with the application of 125 per cent of RDF (100 kg N and 50 kg P_2O_5 /ha) which was on a par with the application of RDF (80 kg N and 40 kg P_2O_5 /ha) except rest of the treatments.

TABLE 3

Economics of sorghum genotypes for single cut fodder at different fertility levels during **kharif** 2014

Treatment	Gross returns (Rs./ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	B : C ratio
Genotypes				
SPV 2185	38755	26374	12381	1.47
SPV 2191	42451	26374	16077	1.60
HC 308	38842	26374	12468	1.47
CSV 21F	31393	26374	5018	1.18
CSV 30F	38450	26374	12076	1.45
S. Em±	1742.78	-	1742.79	0.07
C. D. (P=0.05)	4990.79	-	5008.77	0.19
Fertility levels				
50% RDF (40 kg N+20 kg P_2O_5/ha)	29826	25350	4476	1.18
75% RDF (60 kg N+30 kg P_2O_5/ha)	36307	26033	10274	1.39
RDF (80 kg N+40 kg P_2O_5/ha)	41220	26716	14504	1.54
125% RDF (100 kg N + 50 kg P_2O_5/ha)	44561	27399	17162	1.63
S. Em±	1558.79	-	1558.80	0.06
C. D. (P=0.05)	4463.89	-	4479.98	0.17

B : C–Benefit : cost ratio.

CONCLUSION

Based on the results, it can be concluded that among genotypes, SPV 2191 recorded maximum green fodder yield (408.19 q/ha), whereas the dry matter yield (109.89 q/ha) was highest under CSV 30F genotype. Among fertilizer levels, the maximum green fodder yield and dry matter yield was recorded with the application of 125 per cent of RDF (100 kg N and 50 kg P_2O_5 /ha) which was on a par with RDF (80 kg N and 40 kg P_2O_5 /ha). Thus, the application of RDF is the most suitable fertilization practice to achieve the maximum yield levels of green fodder and dry matter. With increasing doses of fertilizers (50% of RDF to 125% of RDF) the HCN content increased from 88.40 to 150.10 µg/g of the fresh weight, respectively. The HCN content at all the treatments was less than the critical limit (200 µg/g of the fresh weight) at 30 days after sowing.

REFERENCES

AOAC. 1995 : *Official Methods of Analysis, 16th edn.* Association of Official Analytical Chemists, Arlington, U. S. A. ID No. 984.13.

Arora, S. K., R. S. Paroda, and Y. P. Luthra. 1971 : Forage sorghum – Its chemistry. *Indian J. Genet. Plant Breed.,* **37** : 175-183.

Aziz-Abdel, T. K., and M. A. S. Abdel-Gwad. 2008 : Yield and quality of tunis grass as affected by plant height at cutting and N fertilizer. *Anim. Agric. Sci*. (Cairo), **53** : 157-169.

Bali, A. S., M. A. Wani, and M. H. Shah. 2003 : Growth and grain yield of oat (*Avena sativa* L.) as influenced by varying row spacing and fertility levels. *SKUAST J. Res*., **5** : 217-221.

Barnes, R. F., L. D. Muller, L. F. Bauman, and V. F. Colenbrander. 1971 : *In vitro* dry matter disappearance of brown midrib mutants of maize (*Zea mays* L.). *J. Anim. Sci*., **33** : 881-884.

DAHD & F. 2012 : *19th Livestock Census, 2012.* Department of Animal Husbandry, Dairying and Fisheries, Government of India. http:// dahd.nic.in/dahd/ WriteReadData/Livestock.pdf.

Han, H. J., M. S. Han, and S. B. Alia. 1985 : Effect of soil moisture levels on growth and dry matter accumulation of sorghum and maize. *J. Korean Soc. Grassland Sci*., **5** : 143-151.

Hanuman, S., S. Pushpendra, and H. K. Sumeriya. 2008 : Effect of fertility levels on fodder yield and HCN content of fodder sorghum genotypes. *Int. J. Trop. Agric*., **26** : 417-420.

Hogg, P. G., and H. L. Ahlgren. 1942 : A rapid method of determining hydrocyanic acid content of single plant of Sudan grass. *J. Am. Soc. Agron*., **43** : 199-200.

Ihtisham-ul-Haq, and Aman-Ullah Jan, 2001 : Effect of different nitrogen levels and time of irrigation on the fodder yield of sorghum (*Sorghum bicolor* L.). *Online J. Biol. Sci.*, **1** : 348-349.

Joshi, U. N., R. N. Arora, D. S. Phogat, B. S. Jhorar, R. Avtar, and R. S. Sheoran. 2009 : Current status of crude protein and *in vitro* dry matter digestibility in forage crops. In : *Emerging Trends in Forage Research & Livestock Production,* S. K. Pahuja, U. N. Joshi, B. S. Jhorar, and R. S. Sheoran (eds.). Published by Indian Society of Forage Research, Hisar, India. pp. 146-153.

Khatri, A., I. A. Khan, S. H. Siddiqui, M. Ahmed, and K. A. Saddiqui. 1997 : *In vitro* culture of indigenous and exerted banana clones for maximizing multiplication. *Pak. J. Bot*., **29** : 143-150.

Mahmud, Khalid, Ahmad, Ijaz, and Ayub Muhammad. 2003 : Effect of nitrogen and phosphorus on the fodder yield and quality of two sorghum cultivars (*Sorghum bicolor* L.). *Int. J. Agri. Biol*., **5** : 61-63.

Malik, R. K., and B. Paynter. 2010 : Influence of N fertilization on yield and quality of oats hey and grain in Western Australia. Worked on Grass of Soil Science, Soil Solution for Acquiring World, 1-6 August. pp. 187-189.

Midha, L. K., Satyawan Arya, and U. N. Joshi. 2014 : Response of forage sweet sorghum genotypes under different nitrogen levels. *Forage Res*., **40** : 116-118.

Pushpendra Singh, and H. K. Sumeriya. 2012 : Effect of nitrogen on yield, economics and quality of fodder sorghum genotypes. *Ann. Pl. Soil Res*., **14** : 133-135.

Rana, D. S., B. Singh, K. Gupta, A. K. Dhaka, and S. K. Pahuja. 2013 : Effect of fertility levels on growth, yield and quality of multi-cut forage sorghum (*Sorghum bicolor* L.) genotypes. *Forage Res*., **39** : 36-38.

Sheoran, O. P. 2015 : Statistical analysis software at the website of CCS Haryana Agricultural University Hisar. *www.hau.ernet.in*.

Singh, Bahadur, M. K. Kaushik, and H. K. Sumeriya. 2015 : Production of fodder sorghum as influenced by nitrogen levels and seed rates during summer season in southern Rajasthan. *Ann. Agri-Bio Res.*, **20** : 30-32.

Singh, J., D. S. Rana, and R. K. Joon. 1997 : Effect of sowing time, cutting management and phosphorus levels on growth, fodder and grain yield of oats. *Forage Res*., **23** : 115-117.