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FOLIAR NUTRITION EFFECT ON SINGLE CUT FORAGE SORGHUM VARIETIES UNDER *SUMMER* SEASON

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SUMMARY

The field experiment was conducted at Agronomy Research Area, CCS HAU, Hisar (India) during the *summer* season of 2020. The two factor experiment was laid out in randomized block design with three replication. The experiment consists 14 treatments formed by combination of two single-cut forage sorghum cultivars (HJ 541 & HJ 513) and seven different foliar spray involving S_1: No spray (control) S_2: water spray at 45-50 DAS, S_3: water spray at 25-30 DAS & 45-50 DAS, S_4: urea spray @ 2% at 45-50 DAS, S_5: urea spray @ 2% at 25-30 DAS & 45-50 DAS, S_6: NPK spray (18-18-18) @ 2% at 45-50 DAS, S_7: NPK spray (18-18-18) @ 2% at 25-30 DAS & 45-50 DAS. Among the varieties, HJ 541 recorded highest green fodder yield (GFY), dry fodder yield (DFY), crude protein (CP) content and *In-vitro* dry matter digestibility (IVDMD) of 407.52 q/ha, 99.61 q/ha, 8.90% and 51.64, respectively. Among the foliar nutrition, significantly higher GFY, DFY, CP content and IVDMD of 433.33 q/ha, 111.51 q/ha, 9.27% and 52.40 %, respectively, were recorded with NPK spray (18-18-18) @ 2% at 25-30 DAS & 45-50 DAS. It is concluded that use of single-cut forage sorghum variety, HJ 541 and application of NPK spray (18-18-18) @ 2% at 25-30 DAS & 45-50 DAS was recommended for higher green & dry fodder yield and better quality.

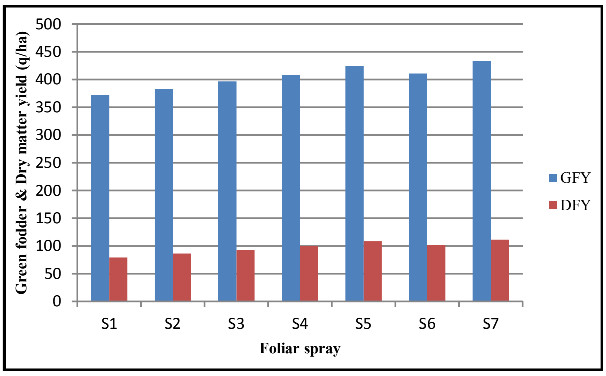
Key words : Single-cut **s**orghum, foliar nutrition, fodder yield, HCN, Crude protein and IVDMD

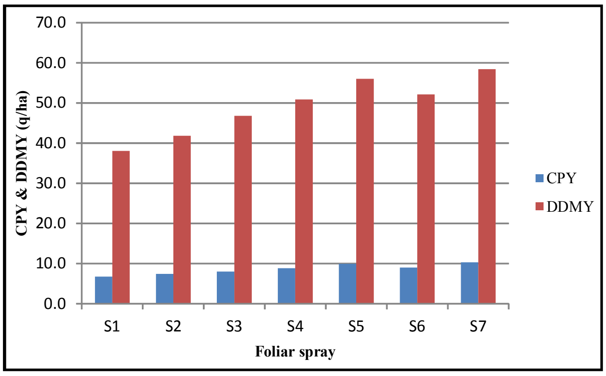
India supports 536.0 million livestock and presently, the country is facing a net deficit of green fodder (36%), dry fodder (11%) and concentrated feeds (44%). Sorghum (*Sorghum bicolour* L.) is a drought resistance fodder crop belonging to the family Poaceae. It is commonly known as jowar, mainly grown for animal feed, grain and ethanol production (Devi *et al*., 2018). Sorghum is cultivated in *kharif* as well as summer season to meet the fodder requirements for livestock and especially valuable for feeding in all region of the world. In India, it is cultivated on about 4.48 million hectares area with the production & productivity of 4.38 million tones and 1051 kg ha^{-1} (Anonymous, 2021). In India, area under fodder sorghum is confined mainly in western U.P., Haryana, Punjab, Rajasthan and Delhi which fulfils over 2/3rd of the fodder demand during *kharif* season (Kushwaha *et al*., 2018). In Haryana, sorghum covers 72,000 ha area with average grain yield of 550 kg/ha (Anonymous, 2016).

Sorghum being a short duration, drought tolerant, well adaptive to arid regions is considered promising crop to overcome the fodder shortages. It responds well to high doses of fertilizer due to its excellent growing habit, high potential, better nutritive value and quick regrowth (Kushwaha *et al*., 2018). It produce a tonnage of dry matter having digestible nutrients (50 %), crude protein (8 %), fat (2.5 %) and nitrogen free extracts (45%) (Azam *et al*., 2010). Single cut forage sorghum varieties yields about 400-500 and 100-150 q/ ha of green and dry fodder rich in quality (Satpal *et al*., 2020). Moisture and nutrition affect the succulency, dry matter, crude protein and other quality parameters of fodder. HCN toxicity can be managed through mitigating the moisture stress and nutrient management. Foliar application of NPK could increase crop productivity many folds under moisture stress condition. The current status of nitrogen, phosphorus and potassium use efficiency is very low, which vary from 30-40, 10-20 and 40-50 per cent respectively. Efficacy of foliar fertilization of nitrogen is seven times more than soil application under drought conditions due to less denitrification and leaching losses (Dixon, 2003). The uptake of necessary elements becomes difficult for plants when fertilizers are applied to soil due to the formation of certain soil complexes. Among foliar nutrition options, urea and NPK (18:18:18) are the most easily available and cheapest source of nutrients. Keeping the above facts in view, the present study was conducted for "moisture mitigation in forage sorghum through foliar nutrition during summer season".

MATERIALS AND METHODS

A field experiment was conducted during the *summer* season of 2020, at Research Farm, Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana (India). Hisar is situated at 29°10' N latitude and 75° 46' E longitude at an altitude of 215.2 m above mean sea level. During crop growing period, the weekly highest and lowest mean temperature was recorded 43.2 °C and 17.7 °C in 21st and 15th meteorological standard weeks, respectively. The weekly weather data during the crop period is given in Fig. 1. The experiment was laid out in factorial RBD having two varieties *i.e.* V_1(HJ 541) and V_2 (HJ 513) as factor A and seven spray treatments as factor B {No spray (S_1), water spray at 45-50 DAS (S_2), water spray at 25-30 DAS & 45-50 DAS (S_3), urea spray @ 2% at 45-50 DAS (S_4), urea spray @ 2% at 25-30 DAS & 45-50 DAS (S_5), NPK spray (18-18-18) @ 2% at 45-50 DAS (S_6), NPK spray (18-18-18) @ 2% at 25-30 DAS & 45-50 DAS (S_7)}, it giving rise to 14 treatment combinations which were replicated three times making 42 total plots. A composite sample of soil was collected from the experimental field before sowing and was analyzed for different soil characteristics. The soil was sandy loam in texture, having pH of 7.9, organic carbon content was 0.48% (low), low in available nitrogen (152.8 kg ha^{-1}), medium in available phosphorous (12.5 kg ha^{-1}) and available potassium (244.5 kg ha^{-1}). Two third of nitrogen was applied before sowing ad 1/3rd after first irrigation. The experiment was sown manually with the row spacing of 25 cm as per the treatments during the season of experimentation. Yield attributing parameters were recorded at the time of maturity. Three plants were selected randomly from each treatment to record the observations of yield attributing characters. The weight of harvested green fodder from each plot was taken in situ (kg/plot) and then converted into q ha^{-1}. Random sample of green fodder of 500 g was taken separately from each plot at the time of harvesting, after sun drying it was oven dried till constant weight is achieved, on the basis of





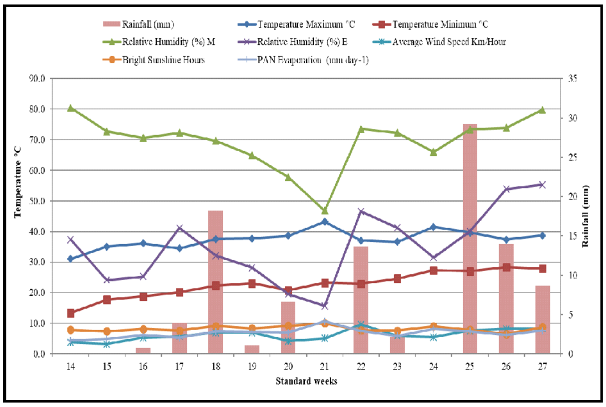


Fig. 1. Mean weekly meteorological data during summer season 2020.

weight of these samples, the green fodder yield converted into dry fodder yield (q/ha). Crude protein and *in vitro* dry matter digestibility (IVDMD) were estimated in dried and grinded samples (2 mm sieve size). 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 samples for estimation of HCN were taken at 30 DAS from the portion of the plant immediately below the uppermost leaf collar and HCN content was determined by the method given by Hogg and Ahlgren (1942). The data were analyzed using appropriate analysis of variance (ANOVA). OPSTAT software was used to carry out statistical analysis (Sheoran *et. al*., 1998).

RESULTS AND DISCUSSION

Yield parameters

The data related to yield parameters and yield are presented in Table 1. The data indicated that the plant height had no-significant difference between the varieties at harvest. The similar behaviour of these genotypes could be related to the similarity in their inherent genetic make-up or vigour. Similar, findings were also reported by Bhusal (2012) and Satpal *et al*. (2020). Foliar application of nutrients had brought out significant effect on plant height. At harvest, maximum plant height was recorded with S_7 (294.25 cm) which was at par with the treatment S_5 (291.18 cm) and both these treatments were significantly superior over rest of the treatments. This might be attributed to more accumulation of nutrient during early phase of vegetative growth and development which leads to increase in plant height. The beneficial effect of foliar nutrition associated with higher photosynthetic activity and protein synthesis which have promoted cell division and cell elongation that in turn accelerate the vegetative growth (Murlidhar, 2014). Plant height correlates highly with biomass, so it is used for estimating forage yield (Kumbar *et al*., 2020 and Han *et al*., 2019). Between the two varieties, significantly higher number of leaves per plant were recorded with HJ 541 (13.98) as compared to HJ 513 (13.55) at harvest. The differential behaviour of the genotypes in case of no. of leaves per plant had also been explained by Meena *et al*. (2012) and Satpal *et al*. (2016). Maximum number of leaves per plant *i.e*. 15.22 were recorded in the S_7 treatment which remained statistically at par with S_5 but significantly higher over rest of the treatments. However, minimum no. of leaves (11.8) were found in S_1.

Fodder yield

The data (Table 1) depicted that variety HJ 541 recorded significantly higher green fodder yield of 407.52 q ha^{-1} than HJ 513 (400.74 q ha^{-1}). Though the yield difference in green fodder was found to be 1.69% between the varieties. The higher fodder yield of genotype could mainly be attributed to comparatively higher no. of leaves plant^{-1}, dry matter accumulation plant^{-1}, leaf to stem ratio or cumulative effect of other growth contributing characters as well along with them. Corroborative finding were also reported by Singh *et al*. (2016), Tokas *et al*. (2017) and Meena *et al*. (2017). Among foliar nutrition treatments, green fodder yield increased significantly with the water, urea and NPK spray. The highest green fodder yield of 433.33 q ha^{-1} was recorded with S_7 treatment where two sprays of NPK was done, which was found statistically at par with S_5 (424.17 q ha^{-1}), but significantly superior over the treatments where only one spray of NPK/urea/water or two sprays of water or no spray was applied. The green fodder yield of S_7 and S_5 were 5.43 and 3.83 percent higher as compared to S_6 and S_4, respectively. Minimum green

TABLE 1

Effect of foliar nutrition on yield parameters and yield of forage sorghum varieties

Treatments	Plant height (cm)	No. of leaves/ plant	Green fodder yield (q/ha)	Dry fodder yield (q/ha)
Varieties				
V_1 (HJ 541)	277.71	13.98	407.5	99.6
V_2 (HJ 513)	279.75	13.55	400.7	94.6
C. D. (P=0.05)	NS	0.39	5.6	3.3
Foliar Spray				
S_1 : No spray (Control)	261.43	11.8	371.8	79.3
S_2 : Water spray at 45-50 DAS	267.58	12.55	383.3	86.2
S_3 : Water spray at 25-30 DAS & 45-50 DAS	273.98	13.30	396.8	93.0
S_4 : Urea spray @ 2% at 45-50 DAS	280.65	14.13	408.5	99.8
S_5 : Urea spray @ 2% at 25-30 DAS & 45-50 DAS	291.18	15.05	424.2	108.3
S_6 : NPK spray (18-18-18) @ 2% at 45-50 DAS	282.03	14.28	411.0	101.6
S_7 : NPK spray (18-18-18) @ 2% at 25-30 DAS & 45-50 DAS	294.25	15.22	433.3	111.5
C. D. (P=0.05)	4.77	0.72	10.5	6.1

TABLE 2

Effect of foliar nutrition on quality of forage sorghum varieties.

Treatments	HCN (ppm)	Crude protein (%)	IVDMD (%)	CPY (q/ha)	DDMY (q/ha)
Varieties					
V_1 (HJ 541)	72.34	8.90	51.64	8.87	51.44
V_2 (HJ 513)	76.49	8.78	49.29	8.30	46.62
C. D. (P=0.05)	1.62	N.S.	1.27	-	-
Foliar Spray					
S_1 : No spray (Control)	81.62	8.51	48.00	6.74	38.04
S_2 : Water spray at 45-50 DAS	79.07	8.62	48.55	7.43	41.84
S_3 : Water spray at 25-30 DAS & 45-50 DAS	66.91	8.62	50.32	8.02	46.81
S_4 : Urea spray @ 2% at 45-50 DAS	79.47	8.84	50.95	8.83	50.87
S_5 : Urea spray @ 2% at 25-30 DAS & 45-50 DAS	68.34	9.17	51.73	9.93	56.01
S_6 : NPK spray (18-18-18) @ 2% at 45-50 DAS	78.93	8.84	51.3	8.98	52.12
S_7 : NPK spray (18-18-18) @ 2% at 25-30 DAS & 45-50 DAS	66.57	9.27	52.4	10.34	58.43
C. D. (P=0.05)	0.53	2.37	3.02	-	-

fodder yield (371.83 q ha^{-1}) was recorded with S_1 and it was significantly lower to all other treatments in which water or nutrients were sprayed once or twice. Similar trend was also observed in case of dry fodder yield. The treatments having two sprays of water/ urea/NPK performed better as compared to one foliar spray. Water soluble fertilizer of N:P:K 19:19:19 contains high quality macro and essential nutrients and chloride free ingredients. Application of this by fertigation or through foliar spray may lead to instant uptake of nutrients by the plants resulting in significant and quick improvement in crop growth and development (SPIC Triumph, 2019). Foliar application of nutrients along with their soil application increase the yield and besides improving the quality of cereal crops (Gokul & Senthilkumar, 2019 and Lagad *et al.*, 2020).

Fodder quality

The data in relation to crude protein (CP) content (%) revealed that numerically higher CP content of 8.90 % was recorded with HJ 541variety, but the difference was non-significant between the varieties (Table 2). Among varieties, maximum IVDMD content was estimated in HJ 541 (51.64%) which was significantly higher over HJ 513. HCN content ranged from 72.34 ppm to 76.49 ppm, however, it was below the critical limit (200 ppm). Satpal *et al.* (2020) also reported that out of HJ 541 and HJ 513, the former variety exhibited significantly higher crude protein content and IVDMD and lower HCN content. Maximum CPY was recorded with HJ 541 (8.87 q ha^{-1}) which was 6.9% higher over HJ 513. Maximum DDMY was also estimated with HJ 541 which was 10.3% higher over HJ 513. The higher crude protein was due to higher dry matter yield of the variety as compared to other variety (Manjanagouda *et al.*, 2016). The higher value of nutritional constituents and lower value of anti-nutritional constituents in HJ 541 indicated that this variety was suitable to the semi-arid agro-climatic conditions of Haryana. The application of foliar nutrition significantly influenced the CP content of sorghum varieties, whereas, water spray alone could not have affected the CP content (Table 2). The maximum CP content was recorded in S_7 (9.27%), which was closely followed by S_6, S_5 and S_4. However, S_7 and S_5 were significantly superior over S_3, S_2 and S_1. In context of foliar nutrition, foliar application of urea or NPK (one or two spray) exhibited significantly higher IVDMD value in comparison to control or one water spray. This might be due to the improved absorption of NPK nutrients through the foliar application and mitigation of abiotic stress associated with the prevailed agro-climatic conditions of semi-arid zone. Maximum CPY and DDMY were also recorded with S_7 (10.34 and 58.43 q ha^{-1}) which was 53.4% and 53.6 % higher over control, respectively. Foliar application of NPK at 25-30 DAS & 45-50 DAS (S_7) had significantly lower value of HCN content (66.57 ppm) which was at par with S_5 and S_3 where two sprays of urea or water were applied. These results are in agreement with the findings of Damame *et al.* (2017) and Lagad *et al.* (2020).

CONCLUSION

Based on one year study, it was concluded that the use of single-cut forage sorghum variety, HJ 541 and foliar application of NPK (18-18-18) spray

@ 2% at 25-30 DAS & 45-50 DAS was recommended for higher green & dry fodder yield and better quality. The higher value of nutritional constituents (CP and IVDMD) and lower value of anti-nutritional constituent (HCN) in HJ 541 indicate that this variety was suitable to the semi-arid agro-climatic conditions of Haryana.

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