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YIELD AND ECONOMICS OF SINGLE CUT FORAGE SORGHUM AS INFLUENCED BY ORGANIC AND INORGANIC SOURCES OF NITROGEN UNDER SUMMER SEASON

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SUMMARY

A field experiment was conducted at Forage Section Research Farm, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (Haryana), India during the summer season of 2020 to assess the influence of organic and inorganic sources of nitrogen application on yield and economics of single cut forage sorghum during summer season. The experiment was laid out in randomized block design with nine treatments (inorganic, organic and integrated nitrogen sources) and replicated thrice. Among the different nitrogen sources *viz*. organic, inorganic or combination of both, T_2 [100% RDN (Recommended Dose of Nitrogen) through inorganic source (Urea)] resulted in significantly higher growth at harvest *i.e.* plant height (282.47 cm) and dry matter accumulation/plant (106.73 g) and interns higher yields *i.e.* green fodder yield (45.64 t ha^{-1}) and dry matter yield (11.98 t ha^{-1}); higher quality parameters *i.e.* crude protein yield (1.07 t ha^{-1}), digestible dry matter yield (6.20 t ha^{-1}) of single cut forage sorghum over rest of treatments except T_3 (75% RDN through inorganic source + 25% N through FYM) and T_4 (75% RDN through inorganic source + 25% N through vermicompost). The green fodder, dry matter, crude protein and digestible dry matter yield with 100% RDN through urea was 3.05, 6.58, 9.18 & 4.90 and 1.65, 3.90, 8.39 & 4.73 per cent higher over 75% RDN through inorganic source+25% N through FYM and 75% RDN through inorganic source+25% N through vermicompost, respectively. The maximum net returns (Rs. 19895/ha) and B: C (1.54) were fetched with T_2 followed by T_3 (Rs. 16570/ha and 1.43, respectively) and T_4 (Rs. 11593/ha and 1.26, respectively).

Key words : Forage sorghum, single-cut, FYM, vermicompost, fodder yield and economics

India is home to 535.8 m livestock, with cattle accounting for 37%, goats for 21.23%, and pigs for 20% (Anonymous, 2020). The livestock sector accounts for 4.11% of our country's GDP and 25.6% of its agricultural GDP. High-quality fodder is essential for unlocking the genetic potential of improved cattle breeds; but there is net deficit of green and dry fodder to the tune of 35.6 and 10.9 %, (Anonymous, 2013) because only 4.4% of country's land is used for fodder crops. This gap between demand and supply of fodder can be reduced by adopting high-yielding fodder crops as well as proper agronomic techniques. Sorghum [*Sorghum bicolor* (L.)] is a popular fodder, feed, food, and fuel crop. Single-cut forage sorghum have the ability to yield 400-500 and 100-150 q/ha of high-quality green and dry fodder, respectively (Satpal *et al*., 2020) and in terms of quality, it contains 8-10% crude protein when harvested at 50% flowering stage (Kumar *et al*., 2012). Forage sorghum is grown on 5.6 million ha in India while sorghum is grown on 72,000 ha in Haryana, with an approximate grain yield of 550 kg/ha (Anonymous, 2016). Sorghum is a main fodder crop grown in summer as well as *kharif* season and offer green fodder from May to November. Besides this, it is a salt-tolerant crop also (Devi *et al*., 2018). Sorghum is a high nutrient feeder that removes a huge amount of nutrients from the soil. If the right amounts of nutrients are not applied, the production and quality of the crop decreases greatly.

The nutrient demand of sorghum is comparatively higher than other fodder crops. To meet out this demand, higher doses of inorganic fertilizers are required to realize the fodder potential of cultivars. Although, continuous and indiscriminate use of the high amount of chemical fertilizers had deleterious effects on soil health, leading to declining in

productivity due to the limitation of one or more micronutrients (Nambiar & Abrol, 1989). Integrated nutrient management (INM) is a possible alternative not only for securing high productivity but also against deterioration of soil health (Paikaray *et al*., 2002). Farmyard manure (FYM) and vermicompost are two important organic sources of nutrients in India. Complementary use of chemical fertilisers and organic manures may aid in achieving long-term fodder production by not only increasing the efficiency of applied fertilizers in terms of correcting secondary and micronutrient deficiencies, but also by enhancing the efficiency of applied fertilizers in terms of secondary and micronutrient deficiencies. Organics are environmentally beneficial and sustain productivity, but their restricted supply is a key barrier to their application in agriculture production systems. These difficulties can be addressed by judicious application of manures and fertilisers in a coordinated manner in order to preserve long-term economic crop output in relation to soil fertility. Application of organic sources through vermicompost and farmyard manure improved the available N status compared with the chemical fertilizers (Kumar *et al*., 2005). INM is a flexible technique to reduce the usage of chemical fertilisers while increasing their efficiency and farmers' profits in order to maintain crop yield, soil health and profitability. Keeping the above facts in view, the experiment was conducted to evaluate the effect of organic and inorganic sources of nitrogen application in forage sorghum during the summer season.

MATERIAL AND METHODS

A field experiment was conducted at Forage Section Research Area, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar Haryana (India) during the *summer* season of 2020. Hisar is situated at 29°10' N latitude and 75° 46' E longitude at an altitude of 215.2 m above mean sea level having semi-arid and sub-tropical climate with hot dry summer and severe cold winters and receives 450 mm precipitation per annum. Weekly weather parameters *i.e*. temperature (°C), relative humidity (%) and rainfall (mm) during the season are given Fig 1. The experimental soil was sandy loam with pH 7.7 has 0.48% organic carbon, 140.2 -12.0 - 240.5 kg/ha of available N-P-K at the start of study in plough layer. Nine treatment *viz*. T_1: Control, T_2: 100% RDN (Recommended Dose of Nitrogen) through inorganic source, T_3: 75% RDN through inorganic source+25% RDN through FYM, T_4: 75% RDN through inorganic source+25% RDN through vermicompost , T_5: 50% RDN through inorganic source +50% RDN through FYM , T_6: 50% RDN through inorganic source +50% RDN through vermicompost , T_7: 100% RDN through FYM, T_8: 100% RDN through vermicompost, T_9: 50% RDN through FYM+50% RDN through vermicompost were replicated thrice in the experiment. Single cut variety of forage sorghum 'HJ 541' was used in the experiment. The experiment was sown manually with the row spacing of 25 cm on April 5, 2020. RDF (Recommended Dose of Nitrogen) used was 75 kg nitrogen + 15 kg P_2O_5 per ha. All the other standard agronomic practices were followed uniformly in all the treatments as per the package of practices for *kharif* crops of CCS Haryana Agricultural University, Hisar, India (Anonymous, 2017). 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

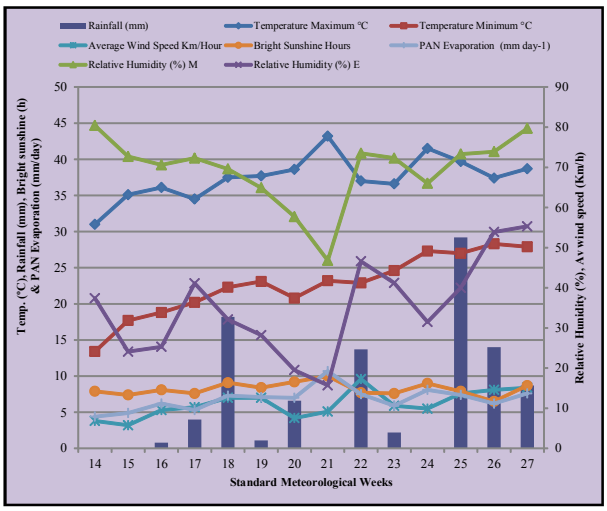

Fig. 1. Weekly weather parameters during the study period at the experimental site.

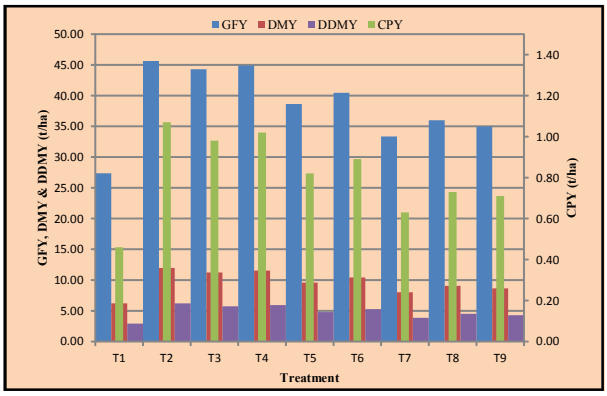

Fig. 2. Green fodder yield (GFY), dry matter yield (DMY), crude protein yield (CPY) and digestible dry matter yield (DDMY) of different treatments.

each plot was taken in situ (kg/plot) and then converted into q/ha. 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 weight of these samples, the green fodder yield converted into dry fodder yield (q/ha). The data were analyzed using appropriate analysis of variance (ANOVA). Data were analyzed by using OPSTAT software available at CCS Haryana Agricultural University website (Sheoran *et al*., 1998). The results are presented at five per cent level of significance (p=0.05) for making comparison between treatments.

RESULTS AND DISCUSSION

Growth parameters

Perusal of the data from Table 1 revealed that at harvest the number of plants per meter row length did not show any significant difference among organic and inorganic sources of nitrogen application treatments. At harvest, maximum plant height of 282.47 cm was recorded with T_2 treatment [100% RDN (Recommended Dose of Nitrogen) through inorganic source] which was on a par with T_3 and T_4. Similar trend was also observed in leaf to stem ratio. The maximum LS ratio recorded with 100% RDN was on a par with the treatments wherein 25% RDN was replaced with either FYM or vermicompost but significantly superior over other treatments at harvest. This clearly indicated that proper nutrient supply is essential to maintain good fodder quality. The increase in LS ratio was due to more availability of nutrients in the treatment where 100% RDN was supplied through inorganic source. The results are in conformity with Kaur and Satpal (2019). Maximum dry matter accumulation per plant was also recorded with the application of 100% RDN through urea (T_2) and was at par with T_3 and T_4 but significantly higher over rests of the treatments. At harvest, the dry matter accumulation in T_2, T_3 and T_4 treatments were 18.48, 15.19 and 17.58 per cent higher over T_1, respectively. The first pre-requisite for high yield was a production of higher total dry matter per unit area. The amount of dry matter produced depends on photosynthesis which in turn depends on large and efficient assimilating area. The results are in conformity with Hugar *et al.* (2010).

Yield

The data presented in Table 2 revealed that highest green fodder yield (45.64 t/ha) was recorded in T_2 and it was at par with T_3 and T_4. The green fodder yield of T_2 was 3.05 and 1.65 per cent higher as compared to T_3 and T_4; however, it was 66.81% higher over control. Minimum green fodder yield (27.36 t/ha) recorded with T_1 was significantly lower to all other treatments in which RDN was applied either through inorganic or organic on combination of inorganic + organic source. Among different treatments, dry matter yield followed the same trend of green fodder yield. The highest dry matter yield of 11.98 t/ha was recorded with T_2 treatment, which was on a par with T_3 (11.24 t/ha) and T_4 (11.53 t/ha). The dry matter yield of T_3 and T_4 were 17.45 and 10.65 percent higher as compared to T_5 and T_6,

TABLE 1

Effect of organic and inorganic sources of nitrogen application on number of growth parameters of fodder sorghum

Treatments	No. of plants/m row length	Plant height (cm)	Leaf to stem ratio	Dry matter accumulation/ plant
T_1 : Control	10.73	193.93	0.203	94.79
T_2 : 100% RDN (Recommended Dose of Nitrogen) through inorganic source	12.20	282.47	0.267	112.31
T_3 : 75% RDN through inorganic source+25% RDN through FYM	11.00	277.13	0.257	109.19
T_4 : 75% RDN through inorganic source+25% RDN through vermicompost	11.00	279.13	0.260	111.45
T_5 : 50% RDN through inorganic source +50% RDN through FYM	10.33	265.20	0.237	106.15
T_6 : 50% RDN through inorganic source +50% RDN through vermicompost	11.40	269.73	0.243	106.73
T_7 : 100% RDN through FYM	10.67	260.00	0.223	104.45
T_8 : 100% RDN through vermicompost	10.33	265.60	0.243	105.61
T_9 : 50% RDN through FYM+50% RDN through vermicompost	10.47	262.73	0.233	105.40
S. Em ±	0.38	3.56	0.004	1.77
CD at 5%	NS	10.77	0.011	5.35

TABLE 2
Effect of organic and inorganic sources of nitrogen application on fodder yield of sorghum

Treatments	Green fodder yield (t/ha)	Dry matter yield (t/ha)	Crude protein yield (t/ha)	Digestible dry matter yield (t/ha)
T_1 : Control	27.36	6.22	0.46	2.92
T_2 : 100% RDN (Recommended Dose of Nitrogen) through inorganic source	45.64	11.98	1.07	6.20
T_3 : 75% RDN through inorganic source+25% RDN through FYM	44.29	11.24	0.98	5.72
T_4 : 75% RDN through inorganic source+25% RDN through vermicompost	44.90	11.53	1.02	5.92
T_5 : 50% RDN through inorganic source +50% RDN through FYM	38.64	9.57	0.82	4.78
T_6 : 50% RDN through inorganic source +50% RDN through vermicompost	40.45	10.42	0.89	5.27
T_7 : 100% RDN through FYM	33.36	8.01	0.63	3.86
T_8 : 100% RDN through vermicompost	36.00	9.04	0.73	4.50
T_9 : 50% RDN through FYM+50% RDN through vermicompost	34.98	8.65	0.71	4.28
S. Em ±	1.41	0.36	0.03	0.19
CD at 5%	4.27	1.07	0.10	0.59

TABLE 3
Economics of different treatments as influenced organic and inorganic sources of nitrogen application in forage sorghum

Treatments	Economics			
	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net return (Rs./ha)	B : C
T_1 : Control	35972	34196	-1776	0.95
T_2 : 100% RDN (Recommended Dose of Nitrogen) through inorganic source	37159	57054	19895	1.54
T_3 : 75% RDN through inorganic source+25% RDN through FYM	38787	55357	16570	1.43
T_4 : 75% RDN through inorganic source+25% RDN through vermicompost	44538	56131	11593	1.26
T_5 : 50% RDN through inorganic source +50% RDN through FYM	40400	48304	7904	1.20
T_6 : 50% RDN through inorganic source +50% RDN through vermicompost	51901	50565	-1336	0.97
T_7 : 100% RDN through FYM	43920	41696	-2224	0.95
T_8 : 100% RDN through vermicompost	66647	45000	-21647	0.68
T_9 : 50% RDN through FYM+50% RDN through vermicompost	55143	43720	-11423	0.79

respectively. Minimum dry matter yield (6.22 t/ha) was recorded with control which was significantly lower than all other treatments. Maximum crude protein and digestible dry matter yields (1.07 and 6.20 t/ha, respectively) were estimated with the application of 100% RDN through urea (T_2) which were on a par with 75% RDN through urea+25% RDN through FYM (T_3), 75% RDN through urea+25% RDN through vermicompost (T_4). The CPY and DDMY of T_2 was 9.18 & 8.39, 4.90 & 4.73 and 132.61 & 112.32 per cent higher over T_3, T_4 and control, respectively. Duhan (2013) also reported that the fodder yield with the application of 100% N through FYM was 38.6% higher over control. Gangaiah *et al*. (2021) also reported that vermicompost (10 t/ha) proved best nutrient source for organic forage sorghum production with least fodder productivity penalty (12.14%) over inorganic fertilizers (64.88 t/ha). So to grow forage sorghum either with 100% RDN through inorganic source or replacement of only 25% of the total RDN through vermicompost or FYM is equally effective in realizing the fodder yield of single cut sorghum and if the

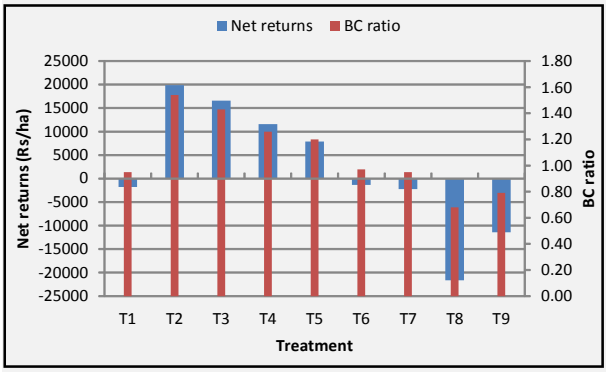

Fig. 3. Net returns and BC ratio of different treatments.

replacement of RDN is more than 25 % *i.e*. 50% or more, the N requirement could not be met out at the pace at which it was required. Satpal *et al*., (2010) also reported similar results in wheat wherein the maximum straw yield was obtained with 100% RDN through inorganic source but it was on a par with 75% RDN through inorganic source+ 25% RDN through organic source. The GFY, DMY, CPY and DDMY are graphically represented in Fig. 2.

ECONOMICS

Among different treatments, the highest cost of cultivation of Rs. 66647/ha was incurred with the application of 100% RDN through vermicompost (T_8) followed by 50% RDN through FYM+50% RDN through vermicompost (T_9) because of higher cost of vermicompost (Rs. 4/kg); whereas, lowest cost of cultivation was noticed with the control (Rs. 35972/ ha). The green fodder was sold at the rate of Rs. 1250/t and the yield levels of different treatments influenced the gross returns. Maximum gross returns (Rs. 57054/ha) were realized with the application of RDN through inorganic fertilizer (T_2) followed by T_4 (Rs. 56131/ha). Lowest gross returns were realized with control (Rs. 34196/ha). The higher net returns (Rs.19895/ha) were realized in T_2 followed by T_4 (Rs. 56131/ha). The net returns realized with control (T_1) being the lowest and were in negative also. Application of 100% RDN through inorganic source could add Rs. 21671/ha to the forage sorghum cultivation in terms of net returns. The higher BC ratio (1.54) was fetched with the application of T_2 followed by T_3 (1.43). The lowest BC ratio (0.68) was fetched with 100% RDN through vermicompost (T_8) which was 40 per cent lower than the control (T_1). These results are in conformity with the findings of Satpal *et al*. (2020), and Singh and Sumeriya (2010). The net returns and BC ratio are graphically represented in Fig. 3.

CONCLUSION

Based on research findings, it was concluded that among different nitrogen management options integrated use of inorganic and organic sources of nitrogen (75% nitrogen through urea and 25% nitrogen through vermicompost or FYM) can be a better substitute to sole application of inorganic sources (100% nitrogen through inorganic sources) to high fodder yield. Highest net returns and B: C of forage sorghum could be fetched with the application of 100% recommended dose of nitrogen through urea. It was also concluded that vermicompost proved to be a better alternative nitrogen source than FYM in terms of growth, yield, and quality of forage sorghum.

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