Forage Res., **47** (2) : pp. 222-226 (2021) **http://forageresearch.in**

MORPHOLOGICAL CHARACTERIZATION AND FORAGE YIELD OF SORGHUM AS INFLUENCED BY VARYING ESTABLISHMENT METHODS AND FERTILIZATION

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(Received : 13 July 2021; Accepted : 15 September 2021)

SUMMARY

Field experiments were conducted during *kharif* season of 2019 and 2020 at Research farm of CCSHAU Regional Research Station, Rohtak. The objective of the experiment was to evaluate the performance of forage sorghum under different establishment methods and doses of fertilization. The soil of the experimental field was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in Split plot design with four establishment methods *viz*. S_1: Happy seeder + full wheat residue, S_2: Zero Tillage with 50 % wheat residue, S_3: Conventional Tillage + sowing with drill and S_4: Conventional Tillage + seed broadcasting (Rotavator) in main plot and three fertilizer doses viz. F_1: 100 % RDF (75 kg N/ha + 15 kg P_2O_5/ha), F_2: 125 % RDF and F_3: 150% RDF replicated thrice. Overall results depicted that in the year 2019 among different establishment methods significantly higher green fodder yield was obtained with conventional tillage + sowing with seed drill sowing method as compared to Happy seeder + full wheat residue and Zero Tillage with 50 % wheat residue sowing method and at par with treatment Conventional tillage + seed broadcasting followed by rotavator sowing method. Similar trend in 2019 was observed in case of dry fodder yield. In the year 2020 sorghum sown with happy seeder + full wheat residue yielded 475.97 q / ha green fodder yield which was 7.51 % and 6.07 % higher than conventional tillage + seed broadcasting and zero tillage with 50 % residue (wheat stubbles) sowing method, respectively. Sorghum sown with happy seeder + full wheat residue yielded 131.73 q / ha dry fodder yield in 2020 which was 7.98 % , 6.89 % and 5.41 % higher than conventional tillage + seed broadcasting, zero tillage with 50 % residue (wheat stubbles) and conventional tillage + sowing with seed drill sowing method, respectively. In 2019 application of 150 % recommended dose of fertilizer in sorghum recorded significantly higher green fodder and dry fodder yield than 125 % RDF and RDF. In the year 2020 application of 150 % RDF being at par with 125 % RDF recorded significantly higher dry fodder and green fodder yield than RDF.

Key words : Conventional tillage, forage sorghum, happy seeder, RDF and zero tillage

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the five top cereal crops in the world which is originated in Africa. It is an important staple food for more than 300 million people and feed for cattle in Africa and Asia. Sorghum is cultivated in tropical, subtropical and even in the temperate regions of the world extending throughout the six continents. Fodder of sorghum has more than 50% digestible nutrients with 8% protein, 2.5% fat and about 45% nitrogen free extract. It is extremely drought tolerant, making it an excellent choice for arid and dry areas. It is a multi-purpose crop grown for grain, forage and ethanol production. It's fast growing habit, high yield regeneration potential, better digestibility, palatability and drought tolerance makes it good choice of fodder for farmers on which the livestock industry depends.

Under good management practices, single cut forage sorghum yields about 400-500 and 100-150 q/ ha of green and dry fodder rich in quality. However, fodder yield can be further increased with improved agro-technology (Satpal *et al*., 2020). Among various management practices, optimum level of fertilizer and methods of sowing are of great importance to achieve maximum potential of fodder sorghum. Nitrogen application assumes greater importance regarding the yield and quality of fodder. It is one of the most yield limiting plant nutrients under most agro ecological conditions and its efficient use is important for the economic sustainability of cropping systems. In fodder

crops it is the most important input for forage production as the maximum vegetative growth is desired within a short period of time. On the global scene regarding plant nutrients and their importance, nitrogen is considered the most limiting factor for plant growth after water (Sadras, 2005). Sorghum has a significant role in livestock production, particularly in tropical zone where feed stuffs could not meet animal requirements due to many factors such as poor soil fertility and drought (Pholsen and Suksri, 2007). Sowing method could also significantly affect the forage yield of fodder crop like sorghum. Photo accumulation rate and radiation use efficiency at different growth stages could be corrected by appropriate planting geometry and rows should be in the North-South direction which is the wind direction with maximum radiation interception (Beheshti *et. al.*, 2003). Thus keeping in views the above facts for further confirmation, the present experiments were carried out to identify best feasible growing technique of forage sorghum under different fertility levels.

MATERIALS AND METHODS

Field experiments were carried out during *kharif* season of 2019 and 2020 at Research farm of Chaudhary Charan Singh Haryana Agricultural University Regional Research Station, Rohtak. The goal of this experiment was to investigate the effect of four different establishment methods and fertilization on growth and yield parameters of fodder sorghum. The experiment was laid out in split plot design with four sowing methods *viz*. Happy seeder + Residue (Wheat stubble), Zero Tillage - Residue (Removal), Conventional Tillage – Drill Conventional Tillage - Broadcasting (Rotavator) in main plot and three fertilizer dose viz. 100 % RDF (75 kg N/ha + 15 kg P_2O_5/ha), 125 % RDF and 150% RDF replicated thrice. The climate of Rohtak (28°40' N latitude and 76° 13' E longitude) is classified as subtropical monsoon, mild and dry winter, hot summer and sub-humid which is mainly dry with very hot summer and cold winter except during monsoon season when moist air of oceanic origin penetrates into the district. The hot weather season starts from mid March to last week of the June followed by the South West monsoon which lasts up to September. The transition period from September to November forms the post monsoon season. The normal annual rainfall in Rohtak district is about 592 mm spread over 23 days. The South West monsoon sets in the last week of June and withdraws towards the end of September and contributes about 84% of the annual rainfall. July and August are the wettest months. 16% of the annual rainfall occurs during the non monsoon months in the wake of thunder storms and western disturbances. The Soil nitrogen and phosphorus status before sowing was 132.13 kg N and 18.25 kg P_2O_5 ha^{-1} respectively before sowing. Experimental field was prepared thoroughly by two ploughings and one planking followed by pre-sowing irrigation. Fodder sorghum variety 'HJ 541' was sown after wheat crop on 23rd June 2019 and 28th June 2020 and harvested on 22nd September 2019 and 26th September 2020. As per the treatment full dose of phosphorus and half dose of nitrogen were applied as basal dose at the time of sowing and remaining half dose of nitrogen was top dressed. The other agronomic practices from sowing to till the crop harvesting like irrigation, insect-pests control and weed control measures were done as per recommended package of practices of Chaudhary Charan Singh Haryana Agricultural University, Hisar. Data on five randomly selected plants from each method of sowing in each replication were recorded on different quantitative characters *viz*. Plant height (cm), number of leaves per plant, leaf length (cm), leaf breadth (cm), green fodder yield (q/ha) and dry fodder yield (q/ha) in all the three fertility treatments (Table 1 and 2). The crop was harvested at 50 per cent flowering stage.

RESULTS AND DISCUSSION

Effect on Sorghum growth

The critical analysis of periodic data presented in Table 1 revealed that establishment method plays a crucial role in the productivity of fodder sorghum as it effects the germination, stand establishment and plant population. Varying sowing method significantly influence leaf length and breadth of fodder sorghum in both the years of experimentation. Leaf length in the year 2019 was found highest in Conventional tillage + sowing with seed drill method (S_3) followed by Conventional tillage + seed broadcasting followed by rotavator (S_4). While in the year 2020 highest value of leaf length was recorded in treatment S_4 which was at par with S_3. In the year 2019, leaf breadth was recorded highest in Conventional tillage + sowing with seed drill method (S_3) while in the year 2020 leaf breadth was recorded highest in treatment S_4 (Conventional tillage + seed broadcasting followed by rotavator). The

TABLE 1
Effect of different method of sowing and fertility levels on sorghum growth

Treatment	Leaf length (cm)		Leaf breadth (cm)		No. of tillers/m row length	
	2019	2020	2019	2020	2019	2020
Method of sowing						
Happy seeder + full wheat residue	75.09	74.12	7.51	7.56	9.67	8.97
Zero tillage with 50 % residue wheat stubbles	75.91	74.09	7.59	7.56	10.17	10.93
Conventional tillage + sowing with seed drill	80.78	74.92	8.08	7.64	11.05	12.16
Conventional tillage + seed broadcasting followed by rotavator	77.97	75.02	7.80	7.66	10.67	11.34
CD at 5%	1.21	0.87	0.56	0.72	1.23	0.92
Fertility levels						
RDF	73.81	71.18	7.38	7.26	9.97	10.22
125 % of RDF	77.41	74.41	7.74	7.59	10.26	11.25
150% of RDF	81.09	78.04	8.11	7.96	10.94	11.08
CD at 5%	1.98	1.36	0.64	0.32	0.98	0.67

difference in leaf breadth in treatment S_3 and S_4 were, however, non significant. Similarly no. of tillers/mrl of sorghum were recorded highest in Conventional tillage + sowing with seed drill method which was at par with treatment S_2 and S_4 in 2019 and with treatment S_4 in the year 2020. These results confirm findings of Afzal *et al*. (2013).

The data (Table 1) pertaining to effect of different fertility levels on sorghum growth revealed that among three fertility treatments highest value of leaf length and breadth of sorghum were recorded with application of 150 % RDF which was significantly higher than other two treatments (RDF and 125 % RDF). However, the leaf breadth recorded in treatment F_2 (125 % of RDF) and F_3 (150 % of RDF) in the year 2019 was statistically at par with each other. Similarly with increase in fertility level from RDF to 150 % RDF there was significant increase in no of tillers/mrl of sorghum in both the years except for 2019 where the difference in value of no of tillers/mrl in treatment F_2 and F_3 were not significant. Significant increase in growth with 150% RDN in drill sowing might be attributed to efficient utilization of nutrients and availability of sufficient amount of light and water etc. in a comparatively larger net area for off shoot production (Awan *et al*., 2011). Bahrani and Ghenateghestani, 2004 also reported that varying nitrogen level with different plant densities gave significant results in forage sorghum.

Afzal *et al*. (2013) reported maximum improvement in forage yield and quality with drill sowing at 30 cm apart rows as compared to broadcast method. Similarly, Rashid *et al.* [8], reported that pattern of 30 cm spaced sorghum gave maximum yield and was the proficient practice for the utilization of available resources and to exploit soil potential. Afzal *et al.* (2013) reported maximum improvement in forage yield and quality with drill sowing at 30 cm apart rows as compared to broadcast method. Similarly, Rashid *et al.* [8], reported that pattern of 30 cm spaced sorghum gave maximum yield and was the proficient practice for the utilization of available resources and to exploit soil potential.

Varying method of sowing fail to influence days taken to 50% flowering of fodder sorghum in both the years. In the year 2019 significantly taller plants were recorded in Conventional tillage + sowing with seed drill method (S_3) which was at par with Conventional tillage + seed broadcasting followed by rotavator sowing method (S_4). In the year 2020 there was not significant effect of method of sowing on plant height of sorghum. Sowing sorghum with Conventional tillage + sowing with seed drill method (S_3) recorded significantly higher no of leaves /plant of fodder sorghum as compared to other methods. The data (Table 2) regarding sorghum phenology revealed among varying fertility treatment significantly lower no of days to 50 % flowering were observed in RDF as compared to other two levels in both the years. With increase in fertility level from RDF to 150 % RDF there was significant increase in plant height of fodder sorghum. The difference in plant height of fodder sorghum in the treatment F_2 and F_3 in the year 2019 was however non significant. Treatment F_2 (125% RDF) being at par with treatment F_3 (150 % RDF) recorded significantly higher no of leaves /plant of fodder sorghum as compared to other treatments in the year 2019. With increase in fertility levels from

TABLE 2
Effect of different method of sowing and fertility levels on sorghum phenology, plant height and no of leaves /plant

Treatment	Days to 50% flowering (DAS)		Plant height (cm)		No of leaves/ plant	
	2019	2020	2019	2020	2019	2020
Methods of sowing						
Happy seeder + full wheat residue	85.00	84.66	262.7	256.22	13.21	12.67
Zero tillage with 50 % residue (wheat stubbles)	86.33	84.33	265.3	251.89	13.91	13.12
Conventional tillage + sowing with seed drill	84.66	83.33	280.9	253.22	15.46	14.84
Conventional tillage + seed broadcasting followed by rotavator	84.33	85.66	271.9	252.44	14.34	13.77
CD at 5%	NS	NS	10.0	NS	1.04	0.93
Fertility levels						
RDF	83.33	82.33	258.6	242.00	13.95	12.24
125 % of RDF	85.33	84.66	270.1	253.00	14.23	13.61
150% of RDF	86.66	86.33	281.9	265.33	14.51	14.95
CD at 5%	0.96	0.84	15.0	5.41	0.65	0.89

RDF to 150 % RDF there was significant increase in no of leaves /plant of fodder sorghum in the year 2020. Increase in number of leaves and leaf area per plant with nitrogen application has also been reported by Nawaz (2017).

Effect on fodder yield

The perusal of data (Table 3) on the effect of different method of sowing and fertility levels on fodder sorghum yield showed that among different sowing methods in both the year of experimentation significantly higher green fodder yield was obtained in conventional tillage + sowing with seed drill as compared to other sowing methods. The difference in green fodder yield in the year 2019 in treatments conventional tillage + sowing with seed drill and conventional tillage + seed broadcasting followed by rotavator was not significant. Sowing sorghum with happy seeder + full wheat residue sowing method being at par with conventional tillage + sowing with seed drill sowing method recorded significantly higher dry fodder yield. Lower fodder yield in Zero tillage sowing method might be due to poor plant population in zero tillage plots as no tillage reduced the plant stand and delayed the plant emergence. These results confirm findings of Zimmer *et al.* (2000).Afzal *et.al* (2013) reported maximum improvement in forage yield and

TABLE 3
Effect of different method of sowing and fertility levels on sorghum yield

Treatment	Green fodder yield (q/ha)		Dry fodder yield (q/ha)		Per day productivity for GFY (q/ha)		Per day productivity for DFY (q/ha)	
	2019	2020	2019	2020	2019	2020	2019	2020
Methods of sowing								
Happy seeder + full wheat residue	455.9	475.97	119.7	131.73	5.36	5.47	1.41	1.51
Zero tillage with 50 % residue wheat stubbles	462.9	448.71	122.4	123.23	5.45	5.16	1.44	1.42
Conventional tillage + sowing with seed drill	478.7	455.05	127.8	124.96	5.63	5.23	1.50	1.44
Conventional tillage+ seed broadcasting followed by rotavator	468.8	442.71	124.4	121.99	5.52	5.09	1.46	1.40
CD at 5%	10.6	22.14	3.3	7.01	-	-	-	-
Fertility levels								
RDF	451.1	449.43	118.7	119.49	5.31	5.17	1.40	1.37
125 % of RDF	466.3	455.60	122.0	126.07	5.49	5.24	1.44	1.45
150% of RDF	482.3	461.80	130.0	130.88	5.67	5.31	1.53	1.50
CD at 5%	15.4	8.74	5.9	4.93	-	-	-	-

quality with drill sowing at 30 cm apart rows as compared to broadcasting method. With increase in fertility level from RDF to 150 % RDF there was significant increase in green fodder and dry fodder yield of sorghum in the years 2019. While, in the year 2020 significantly higher green and dry fodder yield was obtained with 150 % RDF and 125 % RDF over RDF.

CONCLUSION

Sorghum sown with conventional tillage + sowing with seed drill sowing method resulted in significantly higher green fodder and dry fodder yield in the year 2019 and sowing sorghum with happy seeder + full wheat residue being at par with conventional tillage + sowing with seed drill sowing method recorded significantly higher green fodder and dry fodder yield in the year 2020. With increase in fertility level, there was significant increase in green and dry fodder yield of sorghum.

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