Performance of Browntop millet (*Brachiaria ramosa* L.) under varied spacing and fertility levels

ABSTRACT

Aims: Browntop millet is a warm season crop and it can produce heavy seeds compared to other millets. This crop grown on a variety of soils and climates. Brown top millet provide nearly all essential nutrients. Brown top millet referred as miracle or positive crop for the dry and rainfed situations. The Brown top millet is known for its rapid forage production.

Study design: The experiment was laid out in split plot design with three replications.

Place and Duration of Study: An experiment was conducted for two consecutive *Kharif* seasons of 2019 and 2020 at Project Coordinating Unit, AICRP on Small Millets, Bangalore

Methodology: Main plot was having three levels of fertilizer *viz*., F_1(75 % RDF), F_2(100% RDF) and F_3(125 % RDF) and sub plot was accommodated with four different level of spacings *viz*., S_1(22.5 cm X 10 cm), S_2(30 cm X 10 cm), S_3(45 cm X 10 cm) and S_4(60 cm x 10 cm)

Results: Results over years revealed that the plant height, number of tillers, 1000 seed weight, grain yield and straw yield found significantly higher with 125 per cent RDF however, was found on par with 100 per cent RDF. And regarding spacing, 45 cm x 10 cm was found optimum to realize higher yield.

Conclusion: Spacing of 45 cm x 10 cm proved its significant dominance with plant height, number of tillers, 1000 seed weight, grain yield and straw yield as compared to other spacings tested. The nutrient uptake by crop and nutrient availability in soil also showed significantly higher values at 125 per cent RDF followed by 100 per cent RDF and again at the wider spacing level of 45 cm x 10 cm, all these results were further strengthened with higher economic parameters *viz*., gross return, net return and B:C ratio.

Keywords: Economics, Fertility, Grain, Nutrient, Spacing, Yield

1. INTRODUCTION

Browntop millet, which goes by the scientific name *Brachiaria ramosa* (L.) Stapf. is an introduced annual grass that originated in South-East Asia. It is grown in Africa, Arabia, China and Australia [1]. It was introduced to the United States from India in 1915 [2]. It is mainly grown in the South-East for hay, pasture and game bird feed in United States of America. The Browntop millet seed is grown in variety of soils and climates. With extremely rapid growth, Browntop millet can fill narrow growing windows to produce a good quality forage. This crop is restricted to parts in remote areas of Andhra Pradesh, Karnataka, and Tamil Nadu states in southern India [3]. Because of short duration of 75-80 days, it can very well fit into any cropping system. This crop can be used as a cover crop as it can grow fast and cover the soil and also found to grow under shady specially in orchards of coconut, arecanut, mango, cashew etc.

The Browntop millet seed is grown in variety of soils and climatic conditions. The Browntop millet can fill narrow growing windows to produce a good quality forage because of its extremely rapid growth. Under ideal conditions, seed will germinate within 5-6 days and forage will be ready to harvest within two months' time. Like other millets, it is resilient crop and well suited for dryland. It is an annual warm season species that grows one to three feet tall. .The smooth stems have pubescent nodes and may stand erect from decumbent base. It has open, spreading and indeterminate inflorescence with simple axis and staked flower and mature approximately within 75 to 90 days [2].

Brown top millet is renowned for producing more fodder rapidly. It's grown for a number of reasons, including as a cover crop in plantations to prevent soil erosion and as a high-yielding straw crop. The root-knot nematode is suppressed in the soil. This millet can be included in a daily diet; however, farmers must be encouraged to plant this crop in order to help achieve nutrition security. Browntop millet has a similar nutritious profile to other millets, and it is also easier to cultivate. As a result, there is an urgent need to popularize millet [4].

Millets especially brown top millet being a low nutrient demanding crop, responds very well for addition of nutrients. Depleted soil nutrient status and cultivation of improved varieties in millets needs balanced nutrients through external source [5}. And the exact requirement of major nutrients and specific optimum plant population *viz*., spacing requirement for Brown top millet is not researched so far [6]. Browntop millet is gaining huge importance off late and hence it is included as one of the mandated small millet crops in AICRP system from 2018-19 for conducting agronomy trials. The productivity of brown top millet can be increased by judicious combination of nutrients especially major nutrients and a perfect plant geometry which plays a major role in Agronomy of any crop. As this crop is of short duration and high canopy growth, the agronomic studies need to explore its potentiality for higher productivity under improved management criteria under different climatic and soil conditions of Bangalore, Karnataka. Hence, the present investigation was planned to find out the nitrogen, phosphorous requirement, optimum spacing and their interactions and finally to work out the economics for the feasibility of these technologies.

2. MATERIALS AND METHODS

A field experiment was conducted from 2019 to 2020 during *Kharif* at AICRP center on Small millets, Bangalore. The experiment was laid out in split plot design with three replications. Main plot was having three levels of fertilizer *viz*., F_1(75 % Recommended Dose of Fertilizer (RDF), F_2(100% RDF) and F_3(125 % RDF) and sub plot was accommodated with four different level of spacing *viz*., S_1(22.5 cm X 10 cm), S_2(30 cm X 10 cm), S_3(45 cm X 10 cm) and S_4(60 cm x 10 cm). The variety used was Dundu korale and the soil type at the location was sandy loam and the experimental site come under semi-arid tropical climatic condition, has 924 MSL, minimum and maximum temperature of 18.2 ^{0}C and 29.8 ^{0}C, respectively, minimum and maximum relative humidity of 50.7 per cent and 87.4 per cent, respectively, received the rainfall of 920 mm and falls under Eastern dry zone of Karnataka.

The initial soil samples were collected for analysis and soil pH (5.84), organic carbon (0.38 %), available nitrogen (220 kg/ha), phosphorous (38.5 kg/ha) and potassium (190.4 kg/ha) were estimated. Well decomposed farmyard manure was applied at 6.25 t/ha for all treatments uniformly and incorporated into the soil. The recommended dose of fertilizer for other small millets is taken as the basis for brown top millet and 40 kg N, 20kg P_2O_5 and 0 kg K_2O ha^{-1} was applied as per the treatment details. Fifty per cent of nitrogen and full dose of phosphorous were applied as a basal dose and remaining fifty percent of nitrogen as per the treatments was applied at 30 DAS. After harvest, plant height, number of productive tillers per plant, days to maturity, grain yield, straw yield and test weight were recorded. By taking into consideration of all costs incurred and returns obtained in the form of grain and straw yield, economics were worked out. The soil samples after the harvest of the crop from each treatment was collected and analyzed for available nutrient status in soil (N, P_2O_5 and K_2O) and physico-chemical properties. The nutrient uptake by crops of each treatment was also worked out. All the observations are statistically analyzed.

3. RESULTS AND DISCUSSION

The results obtained from the present investigation conducted at PC Unit, ICAR-AICRP on Small Millets during *kharif* 2019 and 2020 and discussion is summarized as here under. The pooled data on crop growth, yield, economics, nutrient uptake by crop and nutrient availability in soil during 2018 and 2019 are presented in Table 1, 2, 3 and 4

3.1 Fertilizer levels

The plant height though not varied significantly during *kharif* 2019, the numerically higher values were obtained at higher fertility level of 125 per cent fertility level. Whereas, significantly taller plants were seen at 125 per cent RDF during 2020 as compared to 75 per cent RDF however, the result was found statistically at par with 100 per cent RDF. The pooled mean of both years also revealed that the plant height is more towards higher fertility level. The number of productive tillers during 2019 and 2020 were found significantly more at 125 per cent RDF when compared to 75 per cent RDF and the pooled data of both the years also proved the result of 2020. The test weight (1000 seed weight) did not differ significantly among fertility levels from 75 per cent RDF to 125 per cent RDF. The rate of production and number of tillers in millets are dependent upon nutrient supply. Tillering cereals have considerable capacity to increase the number of tillers per hill under adequate nutrient supply. Number of tillers per hill increased with increase in the fertility level. The increased tiller production with increased fertilizer may be related to the extra nutrients provided by increased dose of fertilizer for the growth of tiller primordia [7, 8 & 9]. These earlier authors also stated that nutrients play a significant role in increasing the plant height and other growth parameters through cytokinin production which in turn affects cell wall elasticity, increase in number of meristematic cells and cell growth.

At both the years i.e., 2019 and 2020, significantly higher grain yield was recorded at 125 per cent RDF (1483 and 1591 kg/ha, respectively) compared to 75 per cent RDF however, was found on par with 100 per cent RDF (1399 and 1526 kg/ha) and again the same result was obtained at the pooled data of both the years. Significantly higher straw yield was recorded at 125 per cent RDF compared to 75 per cent RDF and 100 per cent RDF during 2019 and 2020 but the pooled results exhibited that significantly result at 125 per cent RDF compared to 75 per cent RDF but was closely followed by crop applied with 100 per cent RDF.

Higher response for economics *viz*., higher gross return (Rs.51923, Rs.55694 and Rs.53808/ha, respectively), net return (Rs.35004, Rs.37627 and Rs.36316 /ha, respectively) and B:C ratio (3.08, 3.10 and 3.09, respectively) were again observed at 125 per cent in 2019, 2020 and pooled mean of two years but it was closely followed by 100 per cent RDF application. However, lower values in all these economic indices were noted at 75 per cent RDF.

Among different fertility levels during 2019, 2020 and pooled mean of two years, application of 125 per cent RDF resulted in significantly higher uptake of Nitrogen (33.92, 35. 51 and 34.72 kg/ha respectively), Phosphorous (17.77, 18.40 and 18.40 kg/ha, respectively) and Potassium (51.77, 52.92 and 52.69 kg/ha, respectively)

3.2 Spacing levels

Significantly higher plant height was recorded with S_1 (22.5 cm x 10 cm) during 2019 while plant height did not vary during 2020 and pooled data confirmed the results of year 2020. Significantly higher number of tillers was recorded with S_4 (60 cm x 10 cm) during 2019 and 2020 and also pooled results of two years. Significantly taller plants were observed at wider spacings, whereas, shorter plants were seen at closer spacing [10, 11, 12 & 13]. All these previous researchers stated that increased plant height, tillers number might be due to wider spacing with higher fertility levels resulted in less competition between plants for solar radiation, space and increased supply of nutrients and efficient utilization helps in better growth. Accordingly, the number of tillers per plant was varied significantly among varied spacings. Test weight (1000 seed weight) was also found significantly higher with wider spacings as compared to closer spacings in both years.

Crop exhibited significant response for yield under varied spacing levels. Significantly higher grain yield was recorded with S_3(45 cm x 10 cm)(1540 and 1687 kg/ha)followed by S_2(30 cm x 10 cm) (1411and 1529 kg/ha)during 2019 and 2020, respectively and the pooled mean of both years also confirmed the higher performance of crop under wider spacing S_3(1681 kg/ha)followed by S_4(60cm x 10 cm)(1541 kg/ha) [13, 14 & 15] found out that significant response of crop at optimum population of crops. Significantly higher straw yield was recorded with S_1 (2627 and 2611 kg/ha) however, it is statistically on par with S_2(2538 and 2514 kg/ha) during 2019 and 2020 but pooled data showed significantly higher straw yield was recorded with S_1 (2619 kg/ha) followed by S_2(2468 kg/ha).

Spacings also had influence on economics of crop. Among different spacing levels, wider spacing of 45 cm x 10 cm was found having higher gross return (Rs.53888, Rs.59057 and Rs.56473 /ha), net return (Rs.38761, Rs.42528 and Rs.40645 /ha) and B:C ratio (3.56, 3.57 and 3.56) in 2019, 2020 and in a pooled mean of both years as compared to other spacings [15]. However, the closer spacing was found with lowest values for all economic parameters.

4. CONCLUSION

Among different spacings tested during 2019, S_2 resulted in significantly higher uptake of Nitrogen and Phosphorous (32.88 and 17.35 kg/ha, respectively) but significantly higher uptake of Potassium was recorded with S_1(52.02 kg/ha) however, during 2019 and pooled mean of two years, significantly higher uptake of Nitrogen (35.65 and 34.11 kg/ha, respectively) and Phosphorous (18.01 and 17.66 kg/ha, respectively) was obtained but significantly higher uptake of Potassium was recorded with S_1(52.08 and 52.08 kg/ha).

The application of 125% RDF and 45 cm x10 cm spacing gave significantly higher grain yield, straw yield and economics as compared to 75% RDF during 2019, 2020 and also pooled mean of two years, however the result was found on par with 100%. Hence, recommended dose of fertilizers (40-20 kg N-P_2O_5/ha) and a sowing at a spacing of 45 cm x 10 cm were found most optimum practices for higher productivity and profitability of Brown top millet under eastern dry zone.

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Table 1: Effect of different fertility and planting geometry on growth and yield parameters of Browntop millet

	Grain yield (kg/ha)			Straw yield (kg/ha)			Plant height (cm) at harvest			No. of productive tillers/plant			1000 seed weight (g)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Fertilizer levels (F)															
F1: 75 % RDF	1206	1306	1323	1909	2127	1980	89.9	88.0	87	15.5	16.0	15.8	3.03	3.04	3.04
F2: 100% RDF	1399	1526	1554	2406	2424	2483	98.7	104.8	102	17.8	20.3	19.0	3.05	3.03	3.04
F3: 125 % RDF	1483	1591	1609	2563	2604	2587	99.3	108.3	104	19.3	20.0	19.6	3.01	3.01	3.01
SE.m ±	33.03	37.60	38	48.0	50.1	37.12	4.1	2.01	2.99	0.25	0.1	0.1	0.01	0.04	0.01
CD =P(0.05)	96.87	110.28	111	140	147	108.1	12.2	6.02	9.13	0.68	0.3	0.3	NS	NS	NS
Spacing levels (S)															
S1: 22.5 cm X 10 cm (S1)	1247	1336	1299	2627	2611	2619	105.6	102.3.2	103.21	10.0	10.7	10.3	2.96	2.99	2.98
S2: 30 cm X 10 cm (S2)	1411	1529	1460	2538	2514	2468	97.1	102.24	100.50	16.0	17.3	16.7	3.04	3.02	3.03
S3: 45 cm X 10 cm (S3)	1540	1687	1681	2219	2427	2356	97.9	99.72	98.52	20.7	22.3	21.5	3.07	3.08	3.08
S4: 60 cm x 10 cm (S4)	1254	1345	1541	1839	1988	1958	93.70	94.25	93.51	23.3	24.7	24.0	3.05	3.01	3.02
SE.m ±	38.14	43.40	44	55.2	58.0	43.12	2.13	1.91	2.03	0.30	0.1	0.1	0.02	0.01	0.01

CD =P(0.05)	111.9	127.81	129	163	171	125.08	6.58	6.02	6.25	0.91	0.3	0.3	NS	NS	NS
Fertilizer levels and Spacing levels (F x S)															
SE.m(±)	66.08	75	76	96.12	101	74.03	2.0	1.6	3.0	0.44	0.30	0.3	0.01	0.03	0.02
CD =P(0.05)	NS	NS	NS	280.5	NS	216.56	NS	NS	NS	NS	1.12	1.09	NS	NS	NS

Table 2: Effect of different fertility and planting geometry on economics of Browntop millet

Treatment details	Gross returns (Rs./ha)			Cost of cultivation			(Net returns (Rs./ha)			B:C ratio		
	2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
Fertilizer levels (F)												
F1: 75 % RDF	42228	45719	43973	14648	16147	15397	27580	29572	28576	2.89	2.84	2.87
F2: 100% RDF	48974	53419	51196	15040	16550	15795	33934	36869	35402	3.26	3.23	3.25
F3: 125 % RDF	51923	55694	53808	16918	18067	17492	35004	37627	36316	3.08	3.10	3.09
Spacing levels (S)												
S1: 22.5 cm X 10cm	43633	46772	45203	15887	17083	16485	27746	29689	28718	2.75	2.74	2.74
S2: 30 cm X 10 cm	49408	53527	51468	14982	16462	15722	34426	37064	35746	3.29	3.25	3.27
S3: 45 cm X 10 cm	53888	59057	56473	15127	16528	15828	38761	42528	40645	3.56	3.57	3.57
S4: 60 cm x 10 cm	43902	47087	45494	16145	17611	16878	27756	29476	28616	2.71	2.67	2.70
S 4	49875	51380	50628	17865	19268	18567	32010	32112	32061	2.79	2.67	2.73

Table 3. Effect of different fertility and planting geometry on nutrient availability in soil

Treatment details	pH	EC (dSm^{-1})	OC (%)	Available Nutrients (kg/ha)		
				N	P	K
Fertilizer levels (F)						
F1: 75 % RDF	5.83	0.32	0.38	279.83	45.71	152.29
F2: 100% RDF	5.82	0.31	0.38	286.48	51.83	164.80
F3: 125 % RDF	5.85	0.35	0.38	316.14	51.18	168.24
SE.m ±	0.09	0.02	0.01	5.78	1.37	4.12
CD =P(0.05)	NS	NS	NS	18.24	4.23	12.69
Spacing levels (S)						
S 1: 22.5 cm X 10 cm	5.84	0.31	0.37	284.86	44.82	162.38
S 2: 30 cm X 10 cm	5.85	0.333	0.38	285.80	49.46	166.79
S 3: 45 cm X 10 cm	5.85	0.35	0.39	280.14	46.29	153.60
S 4: 60 cm x 10 cm	5.86	0.34	0.39	303.20	52.10	170.18
SE.m ±	0.01	0.02	0.01	5.65	1.53	4.34
CD =P(0.05)	NS	NS	NS	17.23	4.68	13.10
Fertilizer levels and Spacing levels (F x S)						
SE.m ±	0.02	0.03	0.02	6.96	2.26	6.86
CD =P(0.05)	NS	NS	NS	21.24	6.94	20.86

Table 4: Effect of different fertility and planting geometry on nutrient uptake by crop

Treatment details	Total N uptake (kg/ha)			Total P uptake (kg /ha)			Total K uptake (kg/ha)		
	2019	2020	pooled	2019	2020	pooled	2019	2020	pooled
Fertilizer levels (F)									
F1: 75 % RDF	26.53	29.09	27.81	13.66	15.06	14.47	38.94	43.24	40.67
F2: 100% RDF	32.16	33.63	32.90	16.88	17.32	17.70	49.34	49.44	50.61
F3: 125 % RDF	33.92	35.51	34.72	17.77	18.40	18.40	51.77	52.92	52.69
SE.m ±	0.07	0.06	0.06	0.04	0.03	0.03	0.14	0.10	0.11
CD =P(0.05)	0.20	0.18	0.18	0.12	0.09	0.09	0.42	0.29	0.32
Spacing levels (S)									
S1: 22.5 cm X 10 cm	31.35	32.37	31.85	17.06	17.36	17.25	52.02	52.08	52.08
S2: 30 cm X 10 cm	32.88	34.20	33.54	17.35	17.74	17.24	51.04	51.07	49.98
S3: 45 cm X 10 cm	32.56	35.65	34.11	16.45	18.01	17.66	45.79	50.10	48.81
S4: 60 cm x 10 cm	26.71	28.74	27.73	13.54	14.60	15.28	37.86	40.89	41.10
SE.m ±	0.08	0.07	0.07	0.05	0.04	0.04	0.16	0.11	0.13
CD =P(0.05)	0.23	0.21	0.21	0.14	0.11	0.11	0.48	0.33	0.37
Fertilizer levels and Spacing levels (F x S)									
SE.m ±	0.14	0.12	0.13	0.08	0.06	0.06	0.28	0.20	0.22
CD =P(0.05)	0.40	0.36	0.37	0.24	0.19	0.19	0.84	0.57	0.65