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Response of Growth, Yield and Quality Parameters of Foxtail Millet Genotypes to Different Planting Density

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A B S T R A C T

A field trial was conducted to standardize row spacing and suitable genotype of foxtail millet to Southern Transition Zone of Karnataka at College of Agriculture, Shivamogga. Three foxtail millet genotypes *viz.*, Local, HMT-1 and SIA 2644 were grown at four different spacing *viz.*, 30 cm x 10 cm, 20 cm x 10 cm, 20 cm x 5 cm and10 cm x 5 cm. Experiment was laid out in factorial Randomized complete block design with three replications. The pooled results of the experiment shows that Among the different spacing, plants grown at 20 cm x 10 cm recorded significantly higher plant height (100.50 cm), number of leaves (35.14), number of tillers hill^{-1} (14.43), number of productive tillers hill^{-1} (12.19), test weight (3.48 g), panicle length (16.26 cm), panicle weight (4.38 g) and grain yield (2227 kg ha^{-1}), straw yield (4349 kg ha^{-1}) and quality parameters viz., Protein (10.08 %) and fibre (6.33 %), as compared to other planting density. Among the genotypes, SIA 2644 recorded significantly higher growth parameters *viz.*, plant height (86.90 cm), number of leaves (30.64), number of tillers hill^{-1} (11.55), number of productive tillers hill^{-1} (9.76), test weight (3.26 g), panicle length (14.29 cm), panicle weight (3.79 g) and grain yield (1941 kg ha^{-1}), straw yield (3919 kg ha^{-1}) and quality parameters *viz.*, Protein (10.08 %) and fibre (6.33 %), as compared to other genotypes. The combined effect of 20 cm x 10 cm + SIA 2644 was recorded significantly higher growth, yield and quality parameters as compared to other treatments.

Introduction

Millets are a group of highly variable small-seeded grass, widely grown around the world as cereal or grain crops for human food and animal fodder. In recent years, there has been an increasing recognition of the importance of millets as a substitute for major cereal crops. Millets have the potentiality of contributing to increased food production both in developing and developed countries. Millets are known for their climate-resilient features including adaptation to a wide range of ecological conditions, less irrigational requirements, better growth and productivity in low nutrient input conditions, less reliance on synthetic fertilizers, and minimum vulnerability to environmental stresses (Kole *et al.*, 2015). Also, millets are nutritionally superior to other major cereals as they are rich in dietary fibers, resistant starches, vitamins, essential amino acids, storage proteins and other bioactive compounds (Amadou *et al.,* 2013). These attributes have made millets a crop of choice for cultivation in arid and semi-arid regions of the world; however, the less attempt has been made to study the climate-resilient features of millets compared to other major cereals. Among millets, foxtail millet (*Setaria italica*) and its wild progenitor, green foxtail (*S. viridis*) are extensively studied since they are considered as models for studying the traits related to C_4 photosynthesis, stress biology, and bioenergy characteristics (Muthamilarasan and Prasad, 2015). In India, Andhra Pradesh (4,79,000 ha), Karnataka (2,32,000 ha) and Tamilnadu (20,000 ha) are the major foxtail millet growing states contributing about 90 per cent of the total area under cultivation. Andhra Pradesh is a major foxtail millet growing state contributing about 79 per cent of the total area. However, the productivity of foxtail millet found to be very low as compared to that of finger millet due to the lack of suitable genotypes, as well as production packages. Crop production is greatly affected by climatic factors (rainfall and temperature), soil factors and cultural practices (e.g. sowing date, seed rate, plant spacing, sowing methods, weeding and harvesting methods). Among the various management factors contributing to growth and development of foxtail millet, non-monetary inputs like time of sowing, row spacing and selection of variety play vital role in increasing crop productivity. Cultivation of plants with desirable density has positive effect on crop yield components, so that the suitable yield will be achieved by optimum plant density (Ullah *et al.,* 2005). The optimum plant population which exerts near maximum pressure to exploit environmental resources to the fullest extent there by leading to higher yield of crop. However, maintenance of optimum planting density is always a big problem to the farmers and they maintain substandard plant density, results in high weeds infestation, poor radiation use efficiency and low yield, while dense plant population on the other hand may cause lodging, poor light penetration in the canopy, reduce photosynthesis due to shading of lower leaves and drastically reduce the yield (Pradhan and Mishra, 1994). The investigation on this aspect has clearly indicated that the population density in foxtail millet needs to be adjusted as per growth habit of variety, sowing time, prevailing agro climatic conditions. Thus there is a need to work out optimum population density by adjusting inter and intra-row spacing in relation to sowing time and other agronomic factors.

Materials and Methods

The experiment was conducted to evaluate the performance of foxtail millet (*Setariaitalica* L.) genotypes with different spacing at ZAHRS, University of Agricultural and Horticultural Science, Shivamogga, during *Kharif* 2016 and 2017. The soil of experiment site was on a red sandy clay soil with clay (35.8 %), silt (7.1 %), fine sand (57.1 %). Experiment was laid out in factorial Randomized Complete Block Design (RCBD) with replicated thrice. The plot size of 3.6 m x 3.0 m was used. The sowing was carried out in respective plots in second week of June 2016 and 2017 according to the treatments. Recommended fertilizer was applied in the seed furrows open manually and it was mixed thoroughly in to the soil before sowing. Recommended dose of fertilizer NPK kg ha^{-1} was added to the well prepared area. Urea and single Super phosphate were used as source of nutrients. Optimum plant population was maintained by thinning after 15 days of sowing. All other agronomic practices were kept normal and uniform. Biometric observations like plant height was measured from base of the stem at ground level to the tip of the main shoot having fully opened top leaf and number of fully opened green leaves and number of tillers were recorded from the five healthy plants in each plot at 20, 40, 60 days after sowing and at harvest. Yield parameters like panicle length, panicle weight and test weight was recorded from the five randomly selected plants at the time of harvest. Panicle length was measured from the base of the Panicle to tip of the Panicle and expressed as Panicle length in centimeters (cm). A grain yield and straw yield of foxtail millet was obtained from net plot is computed for hectare and expressed in kilogram hectare^{-1}. Harvest index was determined by dividing the total grain yield by the total biological yield and expressed as % following Donald (1962).

$$\text{Harvest index (HI)} \quad \frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})}$$

Quality parameters

Crude protein content of grain (%)

Nitrogen content in the grain was determined by Kjeldal Method as described by Jackson (1973) and expressed in percentage. The crude protein content was worked out by multiplying the nitrogen percentage with factor 6.25 (Doubetz and Wells, 1968).

Crude protein (%) = N content in grain (%) × 6.25.

Crude fibre content of grain (%)

Crude fibre content was estimated by the acid-alkali digestion method. The residue obtained after digestion was dried in a crucible and its weight was recorded (We). The dried residue was then ashed in a muffle furnace at 600°C for 3 to 4 hours and its weight (Wa) was recorded. The difference between these two weights (We - Wa) was taken as the weight of the crude fibre (Mahadevan 1965).

$$\text{Crude fibre (\%)} \quad \frac{W_e - W_a}{\text{Weight of sample}} \times 100$$

Results and Discussion

Effect of spacing, genotypes and their interaction on growth parameters of foxtail millet

Number of functional leaves per plant is a product of plant height and number of tillers per plant. In the present study 20 cm× 10 cm produced taller plants (100.50 cm) with more number of tillers (14.43) at harvest (Table 1). These results are in conformity with the Kalaraju *et al.,* (2009) in pearl millet. Who has also noticed increased plant height and number of tillers in turns increased the number of leaves. 20 cm× 10 cm produced more number of leaves (35.14 hill^{-1}) at 60 DAS (Table 1) than other spacing. Genotypes exhibited significant difference with respect to plant height from 20 DAS to harvest. Significantly higher plant height of 86.90 cm at harvest and higher number of functional leaves (30.64) was recorded with genotype SIA 2644 as compared with HMT-1 and local(Table 1) due to genetic makeup of genotypes. These results are in confirmity with the findings of Makkhanlal *et al.,* (2007) and Michael *et al.,* (2016) in pearl millet, Misra *et al.,* 1973 in ragi.

Genotypes had more influence on yield of foxtail millet through higher tillering ability and it is one of the most important desirable factors for increased yield potential in rainfed varieties. Tillering capacity varied with genotypes and its producing ability is dependent on dry matter production and accumulation in main stem during the early stage of the growth (Michael *et al.,* 2016 in pearl millet). In present study also, higher number of tillers was recorded in SIA 2644 (11.55) followed by HMT-1 (10.72) and Local (9.51) at harvest (Table 1).

Table.1 Plant height (cm), Number of leaves hill-1 and Number of tillers hill^{-1} at harvest of foxtail millet as influenced by spacing and genotypes

Treatments	Plant height (cm)			Number of leaves hill^{-1}			Number of tillers hill^{-1}		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Spacing									
S_1:30 cm × 5 cm	83.35	90.85	87.10	31.16	34.58	32.87	11.56	13.02	12.29
S_2:20 cm × 5 cm	75.04	81.79	78.41	24.76	27.48	26.12	8.93	10.06	9.50
S_3:20 cm × 10 cm	96.17	104.82	100.50	33.31	36.97	35.14	13.93	14.94	14.43
S_4:10 cm × 5 cm	63.71	69.44	66.57	21.30	23.64	22.47	5.79	6.52	6.15
F test	*	*	*	*	*	*	*	*	*
S.Em±	1.79	1.30	1.37	0.74	0.79	0.77	0.31	0.32	0.31
C.D.(p=0.05)	5.26	3.81	4.01	2.17	2.33	2.25	0.90	0.94	0.92
Genotypes									
G_1:Local	75.91	82.75	79.33	28.02	31.10	27.74	8.94	10.07	9.51
G_2:HMT-1	79.62	86.78	83.20	29.04	32.24	29.56	10.22	11.23	10.72
G_3:SIA 2644	83.16	90.65	86.90	25.82	28.66	30.64	10.99	12.10	11.55
F test	*	*	*	*	*	*	*	*	*
S.Em±	1.55	1.12	1.18	0.64	0.69	0.66	0.27	0.28	0.27
C.D.(p=0.05)	4.55	3.30	3.47	1.88	2.02	1.95	0.78	0.82	0.80
S×G									
S_1G_1	80.84^{c-f}	88.12^{d}	84.48^{de}	31.92^{c}	35.43^{c}	33.67^{c}	10.89^{d-f}	12.27^{cd}	11.58^{de}
S_1G_2	83.96^{c-e}	91.52^{cd}	87.74^{cd}	33.08^{bc}	36.72^{bc}	34.90^{bc}	11.61^{c-e}	13.07^{b-d}	12.34^{c-e}
S_1G_3	85.24^{cd}	92.91^{cd}	89.08^{cd}	34.92^{a-c}	38.76^{a-c}	36.84^{a-c}	12.19^{cd}	13.73^{bc}	12.96^{b-d}
S_2G_1	71.18^{f-h}	77.58^{fg}	74.38^{fg}	23.20^{d-f}	25.75^{d-f}	24.47^{d-f}	7.06^{g}	7.96^{f}	7.51^{g}
S_2G_2	74.33^{e-g}	81.03^{ef}	77.68^{ef}	24.66^{de}	27.38^{de}	26.02^{de}	9.29^{f}	10.46^{e}	9.87^{f}
S_2G_3	79.60^{d-f}	86.76^{de}	83.18^{de}	26.41^{d}	29.32^{d}	27.86^{d}	10.45^{ef}	11.77^{de}	11.11^{ef}
S_3G_1	90.24^{bc}	98.36^{bc}	94.30^{bc}	36.61^{ab}	40.64^{ab}	38.62^{ab}	12.77^{bc}	14.38^{ab}	13.57^{bc}
S_3G_2	96.25^{ab}	104.92^{ab}	100.59^{ab}	37.21^{a}	41.30^{a}	39.25^{a}	13.93^{ab}	14.57^{ab}	14.25^{ab}
S_3G_3	102.01^{a}	111.19^{a}	106.60^{a}	19.66^{f}	21.82^{f}	20.74^{f}	15.09^{a}	15.87^{a}	15.48^{a}
S_4G_1	61.40^{h}	66.93^{h}	64.16^{h}	20.36^{f}	22.60^{f}	21.48^{f}	5.05^{h}	5.68^{g}	5.36^{h}
S_4G_2	63.92^{h}	69.67^{h}	66.80^{h}	21.23^{ef}	23.56^{ef}	22.39^{ef}	6.06^{gh}	6.82^{fg}	6.44^{gh}
S_4G_3	65.80^{gh}	71.72^{gh}	68.76^{gh}	22.31^{ef}	24.77^{ef}	23.54^{ef}	6.26^{gh}	7.05^{fg}	6.65^{gh}
S.Em±	3.10	2.25	2.37	1.28	1.37	1.33	0.53	0.56	0.54

Table.2 Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index of foxtail millet as influenced by spacing and genotypes

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Spacing									
S_1:30 cm × 5 cm	1632	2024	1953	3966	4007	3986	0.32	0.34	0.33
S_2:20 cm × 5 cm	1676	1803	1740	3632	3641	3637	0.32	0.33	0.32
S_3:20 cm × 10 cm	2146	2308	2227	4268	4430	4349	0.33	0.34	0.34
S_4:10 cm × 5 cm	1562	1679	1621	3410	3442	3426	0.31	0.33	0.32
F test	*	*	*	*	*	*	NS	NS	NS
S.Em±	32.18	35.91	27.44	37.75	40.38	32.26	0.006	0.006	0.006
C.D.(p=0.05)	94.37	105.31	80.49	110.71	118.44	94.63	-	-	-
Genotypes									
G_1:Local	1762	1894	1828	3741	3787	3764	0.32	0.33	0.33
G_2:HMT-1	1818	1955	1886	3844	3888	3866	0.32	0.33	0.33
G_3:SIA 2644	1871	2012	1941	3871	3966	3919	0.32	0.34	0.33
F test	*	*	*	*	*	*	NS	NS	NS
S.Em±	27.87	31.10	23.77	32.69	34.97	27.94	0.005	0.005	0.005
C.D.(p=0.05)	81.73	91.20	69.71	95.87	102.57	81.95	-	-	-
S×G									
S_1G_1	1827^{c-e}	1965^{c-e}	1896^{cd}	3856^{de}	3930^{c}	3893^{d}	0.32^{a}	0.33^{a}	0.33^{a}
S_1G_2	1872^{cd}	2013^{cd}	1943^{c}	3969^{cd}	4006^{c}	3987^{cd}	0.32^{a}	0.33^{a}	0.33^{a}
S_1G_3	1948^{bc}	2095^{bc}	2022^{bc}	4072^{bc}	4085^{c}	4079^{c}	0.32^{a}	0.34^{a}	0.33^{a}
S_2G_1	1641^{fg}	1765^{fg}	1703^{ef}	3562^{fg}	3583^{de}	3572^{e-g}	0.32^{a}	0.33^{a}	0.32^{a}
S_2G_2	1675^{e-g}	1801^{e-g}	1738^{e}	3635^{fg}	3638^{de}	3636^{ef}	0.32^{a}	0.33^{a}	0.32^{a}
S_2G_3	1713^{d-f}	1842^{d-f}	1778^{de}	3700^{ef}	3702^{d}	3701^{e}	0.32^{a}	0.33^{a}	0.32^{a}
S_3G_1	2079^{ab}	2235^{ab}	2157^{ab}	4202^{ab}	4314^{b}	4258^{b}	0.33^{a}	0.34^{a}	0.33^{a}
S_3G_2	2148^{a}	2310^{a}	2229^{a}	4261^{ab}	4435^{ab}	4348^{ab}	0.33^{a}	0.34^{a}	0.34^{a}
S_3G_3	2212^{a}	2378^{a}	2295^{a}	4340^{a}	4542^{a}	4441^{a}	0.34^{a}	0.34^{a}	0.34^{a}
S_4G_1	1499^{g}	1612^{g}	1556^{f}	3283^{h}	3321^{f}	3302^{h}	0.31^{a}	0.33^{a}	0.32^{a}
S_4G_2	1575^{fg}	1694^{fg}	1635^{ef}	3434^{gh}	3473^{ef}	3454^{gh}	0.31^{a}	0.33^{a}	0.32^{a}
S_4G_3	1611^{fg}	1732^{fg}	1671^{ef}	3511^{fg}	3533^{d-f}	3522^{fg}	0.31^{a}	0.33^{a}	0.32^{a}
S.Em±	55.73	62.19	47.53	65.38	69.94	55.88	0.010	0.010	0.010

Table.3 Yield components of foxtail millet as influenced by spacing and genotypes

Treatments	Productive tillers hill^{-1}			Panicle length (cm)			Panicle weight (g)			Test weight (g)		
	2016	**2017**	**Pooled**	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**
Spacing												
S_1:30 cm × 5 cm	9.83	10.94	10.38	13.85	15.10	14.47	3.75	3.92	3.83	3.22	3.35	3.28
S_2:20 cm × 5 cm	7.59	8.45	8.02	12.11	13.20	12.65	3.21	3.35	3.28	3.04	3.17	3.10
S_3:20 cm × 10 cm	11.84	12.55	12.19	15.56	16.96	16.26	4.28	4.47	4.38	3.41	3.55	3.48
S_4:10 cm × 5 cm	4.92	5.47	5.20	10.31	11.23	10.77	2.84	2.96	2.90	2.84	2.95	2.89
F test	*	*	*	*	*	*	*	*	*	*	*	*
S.Em±	0.26	0.27	0.27	0.29	0.29	0.29	0.10	0.10	0.10	0.10	0.10	0.10
C.D.(p=0.05)	0.77	0.79	0.78	0.85	0.85	0.85	0.28	0.28	0.28	0.28	0.28	0.28
Genotypes												
G_1:Local	7.60	8.46	8.03	12.22	13.32	12.77	3.35	3.50	3.42	3.06	3.19	3.12
G_2:HMT-1	8.69	9.43	9.06	12.97	14.14	13.56	3.50	3.66	3.58	3.13	3.25	3.19
G_3:SIA 2644	9.35	10.17	9.76	13.68	14.91	14.29	3.71	3.87	3.79	3.19	3.32	3.26
F test	*	*	*	*	*	*	*	*	*	*	*	*
S.Em±	0.23	0.23	0.23	0.25	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08
C.D.(p=0.05)	0.66	0.69	0.67	0.74	0.74	0.74	0.24	0.24	0.24	0.24	0.24	0.24
S×G												
S_1G_1	9.26^{d-f}	10.31^{cd}	9.78^{de}	13.06^{cd}	14.23^{cd}	13.65^{c-e}	3.62^{c-e}	3.78^{cd}	3.70^{c-e}	3.17^{a-c}	3.30^{a-d}	3.23^{a-d}
S_1G_2	9.87^{c-e}	10.98^{b-d}	10.42^{c-e}	14.01^{bc}	15.27^{bc}	14.64^{b-d}	3.74^{cd}	3.91^{cd}	3.82^{cd}	3.21^{a-c}	3.34^{a-d}	3.27^{a-d}
S_1G_3	10.36^{cd}	11.53^{bc}	10.94^{b-d}	14.49^{bc}	15.79^{b}	15.14^{bc}	3.89^{b-d}	4.07^{b-d}	3.98^{b-d}	3.28^{a-c}	3.41^{a-d}	3.35^{a-d}
S_2G_1	6.01^{g}	6.68^{f}	6.34^{g}	11.05^{ef}	12.04^{ef}	11.55^{fg}	3.07^{fg}	3.21^{ef}	3.14^{fg}	2.97^{a-c}	3.09^{a-d}	3.03^{a-d}
S_2G_2	7.89^{f}	8.78^{e}	8.34^{f}	12.33^{de}	13.44^{de}	12.88^{ef}	3.12^{e-g}	3.26^{ef}	3.19^{e-g}	3.05^{a-c}	3.17^{a-d}	3.11^{a-d}
S_2G_3	8.88^{ef}	9.88^{de}	9.38^{ef}	12.94^{cd}	14.10^{cd}	13.52^{de}	3.43^{d-f}	3.58^{de}	3.51^{d-f}	3.11^{a-c}	3.23^{a-d}	3.17^{a-d}
S_3G_1	10.85^{bc}	12.08^{ab}	11.47^{bc}	14.87^{ab}	16.20^{b}	15.53^{b}	4.02^{a-c}	4.20^{bc}	4.11^{a-c}	3.35^{ab}	3.48^{a-c}	3.42^{a-c}
S_3G_2	11.84^{ab}	12.24^{ab}	12.04^{ab}	15.44^{ab}	16.83^{ab}	16.13^{ab}	4.3^{ab}	4.49^{ab}	4.40^{ab}	3.41^{a}	3.55^{ab}	3.48^{ab}
S_3G_3	12.83^{a}	13.33^{a}	13.08^{a}	16.39^{a}	17.86^{a}	17.12^{a}	4.52^{a}	4.72^{a}	4.62^{a}	3.47^{a}	3.61^{a}	3.54^{a}
S_4G_1	4.29^{h}	4.77^{g}	4.53^{h}	9.91^{f}	10.80^{f}	10.36^{g}	2.68^{g}	2.80^{f}	2.74^{g}	2.76^{c}	2.87^{d}	2.82^{d}
S_4G_2	5.15^{gh}	5.73^{fg}	5.44^{gh}	10.12^{f}	11.03^{f}	10.58^{g}	2.85^{g}	2.98^{f}	2.91^{g}	2.84^{bc}	2.95^{cd}	2.90^{cd}
S_4G_3	5.32^{gh}	5.92^{fg}	5.62^{gh}	10.89^{ef}	11.87^{f}	11.38^{fg}	2.98^{fg}	3.11^{ef}	3.05^{fg}	2.91^{a-c}	3.03^{b-d}	2.97^{b-d}
S.Em±	0.45	0.47	0.46	0.50	0.50	0.50	0.17	0.17	0.17	0.17	0.17	0.17

Table.4 Quality parameters of foxtail millet as influenced by spacing and genotypes

Treatments	Protein per cent			Fibre per cent		
	2016	2017	Pooled	2016	2017	Pooled
Spacing						
S_1:30 cm × 5 cm	8.36	9.09	8.73	5.82	6.05	5.94
S_2:20 cm × 5 cm	7.49	8.14	7.82	5.47	5.69	5.58
S_3:20 cm × 10 cm	9.83	10.33	10.08	6.21	6.46	6.33
S_4:10 cm × 5 cm	6.28	6.82	6.55	4.74	4.93	4.83
F test	*	*	*			
S.Em±	0.29	0.29	0.29	0.11	0.11	0.11
C.D.(p=0.05)	0.85	0.85	0.85	0.33	0.33	0.33
Genotypes						
G_1:Local	7.54	8.19	7.86	5.36	5.57	5.47
G_2:HMT-1	7.88	8.48	8.18	5.59	5.81	5.70
G_3:SIA 2644	8.55	9.12	8.84	5.73	5.96	5.84
F test	*	*	*			
S.Em±	0.25	0.25	0.25	0.10	0.10	0.10
C.D.(p=0.05)	0.74	0.74	0.74	0.28	0.29	0.29
S×G						
S_1G_1	7.91^{b-e}	8.60^{b-d}	8.26^{b-e}	5.72^{b-d}	5.95^{b-d}	5.83^{b-d}
S_1G_2	8.38^{b-e}	9.11^{b-d}	8.74^{b-e}	5.81^{a-d}	6.04^{a-d}	5.92^{a-d}
S_1G_3	8.80^{b-d}	9.56^{a-c}	9.18^{b-d}	5.94^{a-c}	6.18^{a-c}	6.06^{a-c}
S_2G_1	7.26^{d-g}	7.89^{de}	7.57^{d-f}	5.24^{d-f}	5.45^{d-f}	5.34^{d-f}
S_2G_2	7.58^{c-g}	8.24^{cd}	7.91^{c-e}	5.53^{c-e}	5.75^{c-e}	5.64^{c-e}
S_2G_3	7.64^{c-f}	8.30^{cd}	7.97^{c-e}	5.65^{b-d}	5.87^{b-d}	5.76^{b-d}
S_3G_1	9.08^{bc}	9.86^{a-c}	9.47^{a-c}	6.07^{a-c}	6.31^{a-c}	6.19^{a-c}
S_3G_2	9.52^{ab}	10.02^{ab}	9.77^{ab}	6.20^{ab}	6.45^{ab}	6.32^{ab}
S_3G_3	10.88^{a}	11.12^{a}	11.00^{a}	6.36^{a}	6.61^{a}	6.48^{a}
S_4G_1	5.90^{g}	6.42^{e}	6.16^{f}	4.42^{g}	4.59^{g}	4.51^{g}
S_4G_2	6.04^{fg}	6.56^{e}	6.30^{f}	4.83^{fg}	5.02^{fg}	4.92^{fg}
S_4G_3	6.89^{e-g}	7.49^{de}	7.19^{ef}	4.97^{e-g}	5.17^{e-g}	5.07^{e-g}
S.Em±	0.50	0.50	0.50	0.19	0.20	0.20

Plant height of foxtail millet increased significantly with the combined effect of 20 cm × 10 cm + SIA 2644 (106.60 at harvest) (Table 1) and number of tillers hill^{-1} (15.48 at harvest), number of leaves hill^{-1} which was at par with 20 cm × 10 cm + HMT-1, 20 cm ×

10 cm + local, 30 cm × 5 cm + SIA 2644 as compared to 10 cm × 5 cm + SIA 2644 (Table 1). The improvement in plant height was due to interaction effect of spacing and genotype on proper establishment of crop.

Effect of spacing, genotypes and their interaction on yield and yield components of foxtail millet

The results revealed that grain yield and straw yield was significantly influenced by different spacing. Among the four spacings, plants grown with 20 cm× 10 cm spacing recorded significantly higher grain yield and straw yield (2,227 and 4,349 kg ha^{-1}, respectively) followed by 30 cm × 5 cm (1,953 kg $ha^{-1}$and 3,986 kg ha^{-1}, respectively) and low grain and straw yield was observed in 10 cm× 5 cm (1,621 and 3,426 kg ha^{-1}, respectively) (Table 2). Harvest index recorded non-significant with different spacing. The higher grain yield in 20 cm × 10 cm may be attributed to higher yield components *viz.*, number of productive tillers (12.19 $hill^{-1}$ at harvest), panicle length, panicle weight and test weight (16.26 cm, 4.38 g and 3.48 g, respectively) (Table 3) Further, (Anon., 1976) in millets have also reported a functional relationship in grain yield with various yield attributes of foxtail millet. Among three genotypes SIA 2644 recorded significantly higher grain yield and straw yield (1941.34, 3918.57 kg ha^{-1}, respectively) followed by HMT-1 (1886.09 and 3866.15 kg ha^{-1}, respectively) and local (1827.95 and 3763.66 kg ha^{-1}, respectively) (Table 2). This increase in grain yield of SIA 2644 may be due to increase in yield parameters like number of productive tillers (9.76 $hill^{-1}$) at harvest, panicle weight (3.79 g), panicle length (14.29 cm) and test weight (3.26 g) followed by HMT-1 and Local (Table 3).

The results of this present investigation are in conformation with the findings of Khafi *et al.*, (2000) in pearl millet. The low yield in other varieties is due to decreased yield attributes. The grain yield of foxtail millet due to interaction effects of spacing and genotype were found significant and significantly higher grain and straw yield (2295 and 4441 kg ha^{-1}, respectively) was recorded with the interaction of 20 cm × 10 cm + SIA 2644 which was found to be on par with 20 cm × 10 cm + HMT-1 and 20 cm × 10 cm + local (Table 2). The increase in grain yield in 20 cm × 10 cm + SIA 2644 and a positive relationship between spacing and genotype existed for higher grain yield mainly because it recorded higher yield parameters such as higher productive tillers (13.08) (Table 3) at harvest, panicle length (17.12 cm), panicle weight (4.62 g) and test weight (3.54 g) than other interaction effects (Table 3). The harvest index was significantly higher (0.34) with the interaction of 20 cm × 10 cm + SIA 2644 which was followed by 20 cm × 10 cm+ HMT-1 and on par with 30 cm × 5 cm + SIA 2644 (0.33). The lower harvest index was recorded due to interaction of10 cm × 5 cm + Local (0.32) (Table 2). The increase in stover yield with closer spacing was mainly due to vertically expansion of plants with higher growth and dry matter production resulted in higher stover yield.

Effect of spacing, genotypes and their interaction on quality parameters of foxtail millet

Plants grown at spacing of 20 cm× 10 cm recorded significantly higher quality parameters of foxtail millet *viz.*,protein content (10.08 %), fiber content (6.33 %) followed by 30 cm × 5 cm (8.73 and 5.94 %, respectively) compared to other spacing (Table 4). Among genotypes, SIA 2644 recorded significantly higher protein content, fiber content (8.84 and 5.84 %, respectively) followed by HMT-1 (8.18 and 5.70 %, respectively) and local (7.86 and 5.47 %, respectively) (Table 4). Among the interactions SIA 2644 with maintaining spacing 20 cm × 10 cm recorded significantly higher protein content, fiber content (11.00 % and 6.48 %, respectively), and it was found to be on par with 20 cm × 10 cm with HMT-1, 20 cm × 10 cm with local as compared to other treatments (Table 4).

References

Anonymous, 1976, Annual progress report, Dryland and Agriculture project, GKVK, Bengaluru.

Donald CM.1962. Competition among crop and pasture plants. Adv. Agron. 15: 1-114.

Doubetz S. and Wells S A. 1968. Relation of barley varieties to nitrogen fertilization. J Agric Sci Cambridge. 70(1): 253-256.

Gurunadha Rao Y, Anjanapa M. and Ramireddy S. 1990. Effect of fertility levels and spacing on grain yield of Setaria under rainfed conditions. Andhra Agric J. 37(1): 94-95.

Kalaraju K, Kumar NS, Nagaraja N. and Ningappa KB. 2009. Effect of methods of planting on growth and yield of finger millet genotypes under organic farming. Res Crops.10: 20-24.

Mahadevan SA. 1965. Laboratory Manual for Nutrition Research, pp. 56-58.

MakkhanLal, Bora KK, Ramesh Verma and Yadav PC. 2007, Effect of in situ moisture conservation on productivity of pearlmillet in arid regions of Rajasthan under farmer's conditions. Ann Arid Zone. 46(1): 91-93.

Michael O, Ishaya K, Joseph A. 2016, Effects of intra-row spacing of pearl millet (*Pennisetum glaucum* L.) and cropping systems on growth and yields of soybean-pearl millet intercrop, in the Southern Guinea Savanna Nigeria. Int J Bio Sci. 44:78-99.

Misra A, Patra SS and Patnaik RN. 1973. Response of ragi (*Eleusine coracana* L.) to spacings and nitrogen. Indian J Agron.18: 264-268.

Moobe, Martha, K. Nyang, Basweti, Getabu, Mwangi and Ondicho, 2014, Effect of plant density on growth and grain yield of finger mille (*Eleusine coracana*) under high potential conditions of southwest Kenya. J Agric Sci. 10(5): 261-268.

Pradhan L. and Mishra SN. 1994. Effect of cutting management, row spacing and levels of nitrogen on fodder yield and quality of oat (*Avena sativa* L.). Indian J Agron. 39(2): 233-236.

Shinggu SA, Mahadi MA, Mukhtar and Asala SW. 2009. Influence of Spacing and Seed Rate on Weed Suppression in Finger Millet (*Eleucine carocana* L. Gaertn). J Sci Res. 4(4): 267-270.

Tekle, 2014, Determination of inter row spacing and seed rate on productivity of finger millet [*Eleusine coracana* (l.) Gaertn.], at Jinka, Southern Ethiopia. Int J Res Agri Sci. 1(3):2348-3997.

Ullah MJ, Karim M, Mia MS, Shamsuddoha M. and Begum NJ. 2005, Effect of nitrogen row spacing and potassium uptake pattern of foxtail millet. Karnataka J Agric Sci. 18(4): 896-902.

Kole C, Muthamilarasan M, Henry R, Edwards D, Sharma R, Abberton M. 2015. Application of genomics-assisted breeding for generation of climate resilient crops: progress and prospects. Front Plant Sci. 6:563.

Amadou I, Gounga ME, Le GW. 2013. Millets: nutritional composition, some health benefits and processing - a review. Emir J Food Agric. 25:501–508.

Muthamilarasan M, Prasad M. 2015. Advances in Setaria genomics for genetic improvement of cereals and bioenergy grasses. Theor Appl Genet. 128:1–14.

Khafi, HR, Ramani, BB, Mehta, AC. And Pethani, KV. 2000, Effects of different levels of nitrogen, phosphorus and spacing on yield and economics of hybrid bajra. *Crop Res.*, 20(3): 411-414.

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