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Performance of foxtail millet (*Setaria italica* L.) genotypes to sowing dates in Southern transition zone of Karnataka

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Abstract
A field experiment was conducted during *Kharif* seasons of 2016 and 2017 at University of Agricultural and Horticultural Science, Shivamogga to study the response of foxtail millet (*Setaria italica* L.) varieties to different dates of sowing. Among different varieties SIA 2644, recorded significantly maximum plant height (109.81 cm), number of leaves plant^{-1} (45.69), leaf area (701.14 plant cm^{-2}), grain yield (1870.90 kg ha^{-1}), straw yield (3980.71 kg ha^{-1}) and harvest index (0.32) as compared to other varieties like HMT-1 and Local. Among different dates of sowing crop sown on June 30 found significantly higher plant height (114.63), number of leaves plant^{-1} (49.38), leaf area (738.95 plant cm^{-2}), grain yield (2049.25 kg ha^{-1}), straw yield (4261.56 kg ha^{-1}) and harvest index (0.33) as compared to July 30 and August 30 dates of sowing. The interaction between the sowing dates and varieties not significant.

Keywords: Foxtail millet, date of sowing, genotypes, growth and yield parameters

Introduction
In recent years, there is an increased awareness 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 (Verma %., 1983) [11]. In India, they are cultivated on an area of 818.5 thousand hectares, producing 729.6 thousand tonnes with a productivity of 817 kg per ha (Anon., 2012) [2]. In Karnataka, small millets are cultivated on an area of 26 thousand hectares producing 12.3 thousand tonnes with a productivity of 510 kg per ha (Anon., 2012) [2]. Foxtail millet (*Setaria italica* L.) is an important minor millet belonging to the family Poaceae. In India, the cultivation of foxtail millet is confined to Andhra Pradesh, Karnataka, and Tamil Nadu. It is widely grown in Haveri, Dharwad, Belgaum and Chitradurga districts of northern of Karnataka. It has good nutritive value and 100 g of foxtail millet grains contain 9.9 g protein, 72 g carbohydrates, 2.5 g fat, 3.5 g ash, 10 g crude fibre, 0.27 mg potassium, 0.01 mg thiamine, 0.099 mg riboflavin, 0.82 mg pantothenic acid, 3.70 mg niacin, 0.02 mg folacin and 351 kilocalories of energy. It's grain used for human consumption and a feed for poultry and cage birds. It is used in several food preparations like chapati, fermented bread, biscuits, malts, etc. the stalks are used as fodder and for thatching. It is rich in micronutrients and good for diabetic patients. It protects against cancer and related heart diseases (Anon., 1993) [1].
It is tolerant to drought, and it can escape some drought because of early maturity. Due to its quick growth, it can be grown as a short-term catch crop. It is adapted to a wide range of elevation, soils, and temperatures. However, the potentiality of this crop is not fully exploited. The low seed yield in foxtail millet is attributed to genetic, physiological, and its cultivation in marginal land. The productivity of foxtail millet in Southern Transition Zone of Karnataka is very low due to the lack of suitable genotypes, as well as production packages. Hence efforts are needed to develop sound agronomic packages such as optimum date of sowing and variety for profitable cultivation of foxtail millet in Southern Transition Zone of Karnataka. With this background the present investigation was carried out.

Materials and Methods
A field experiment was conducted during *Kharif* seasons of 2016 and 2017 at University of Agricultural and Horticultural Science, Shivamogga. The soil of the experimental area was acidic in reaction; low in organic carbon (0.23%), low in available nitrogen (219.52 kg ha^{-1}), high in phosphorous (55.62 kg ha^{-1}) and medium in potassium (220.14 kg ha^{-1}) status. The experiment was designed in Randomized Complete Block Design (RCBD) with two-factor different dates of sowing *viz,* June 30, July 30 and August 30 and three improved Varieties *viz,*

Local, HMT-1 and SIA 2644 with nine treatments combination on a plot size of 3.6 x 3.0 m^2. Foxtail millet seeds were sown with a spacing of 30 cm × 10 cm and covered with the soil. The total quantity of nitrogen, phosphorus as per recommendation of 40:40:0 per hectare in the form of Urea (46%), single super phosphate (16%) respectively were applied below the seeds, and it was mixed thoroughly into the soil at the time of sowing. Two split application of nitrogen was applied, one at basal and the second application at top dressing. All the agronomic practices were carried out uniformly to raise the crop. For taking data on growth and yield components on foxtail millet, five plants were selected randomly in each plot. The data collected from the experiment at different growth stages were subjected to statistical analysis by adopting Fisher's method of analysis of variance as outlined by Gomez and Gomez (1984) [4].

Results and Discussion

Plant height differed significantly at harvest due to different sowing dates. Significantly taller plants were noticed with crop sown on June 30 (114.63cm), as compared to crop sown on July 30 (106.91 cm) and August 30 (100.19 cm). Among different genotypes, significantly taller plants were recorded with SIA-2644 (109.81cm) and were on par with HMT-1 (107.0 cm) and superior over local (104.92 cm). However, the effect of varieties may be due to the genetic makeup of the individual varieties. The interaction effect between different sowing dates and genotypes were not significant concerning plant height. The possible reason could be that early sown crop had availed prolonged photoperiod for vegetative growth as a result plant attained maximum plant height as compared to late sown crop and similar observations were also made by Maurya *et al*. (2016) [6] in pearl millet. Crop sown on June 30 recorded significantly higher number of leaves per plant (49.38) at harvest followed by July 30 (43.48 cm) as compared to August 30 (37.66 cm) (Table 1). Among genotypes, significantly higher number of leaves was recorded with SIA 2644 (45.69). However, it was on par with HMT-1 (43.41) and superior over local (41.42). The reason could be that early sowing crop which has prolonged photoperiod as a result of more assimilates was utilized by the plant in producing more leaves per plant as compared to late sown crop. These results conform to the findings of Maurya *et al*. (2016) [6]. Further, it is a well-known fact that the persistence of the assimilatory surface area is pre-requisite for prolonged photosynthetic activity, a higher leaf area was significantly recorded when the crop is sown with June 30 (738.95 plant cm^{-2}) as compared to July 30 (688.35 plant cm^{-2}) and August 30 (596.91 plant cm^{-2}). Among genotypes with SIA 2644 (701.14 plant cm^{-2}), however, it was on par with HMT-1 (676.70 plant cm^{-2}) and superior over local (646.37 plant cm^{-2}). These results are also reported by Siddig *et al*. (2013) [7] and Jan *et al*. (2015).

Table 1: Plant height, number of leaves and leaf area of foxtail millet genotypes at harvest as influenced by different dates of sowing.

	Plant height (cm)			Number of leaves			Leaf area (plant cm^{-2})		
Treatments	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**
Date of Sowing									
D1: June 30	113.27	115.99	114.63	45.35	53.41	49.38	731.63	746.27	738.95
D2: July 30	105.64	108.18	106.91	39.93	47.03	43.48	681.53	695.16	688.35
D3: August 30	99	101.38	100.19	34.58	40.73	37.66	591	602.82	596.91
F test	*	*	*	*	*	*	*	*	*
S.Em±	1.09	1.09	1.09	1.01	1.1	0.81	10.38	10.59	10.49
CD(p=0.05)	3.28	3.27	3.28	3.03	3.29	2.42	31.13	31.75	31.44
Genotypes									
G1: Local	103.68	106.17	104.92	38.04	44.8	41.42	639.97	652.77	646.37
G2: HMT-1	105.73	108.27	107	39.87	46.95	43.41	670	683.4	676.7
G3: SIA 2644	108.51	111.11	109.81	41.96	49.41	45.69	694.2	708.08	701.14
F test	*	*	*	*	*	*	*	*	*
S.Em+	1.09	1.09	1.09	1.01	1.1	0.81	10.38	10.59	10.49
CD(p=0.05)	3.28	3.27	3.28	3.03	3.29	2.42	31.13	31.75	31.44
DXG									
D1G1	110.44	113.1	111.77	42.71	50.29	46.5	723.3	737.77	730.53
D1G2	112.55	115.25	113.9	45.66	53.77	49.71	730	744.6	737.3
D1G3	116.81	119.62	118.21	47.7	56.18	51.94	741.6	756.43	749.02
D2G1	103.61	106.1	104.85	38.81	45.7	42.25	656.6	669.73	663.17
D2G2	105.64	108.17	106.9	39.86	46.94	43.4	680	693.6	686.8
D2G3	107.69	110.27	108.98	41.13	48.43	44.78	708	722.16	715.08
D3G1	96.98	99.31	98.14	32.61	38.41	35.51	540	550.8	545.4
D3G2	99.01	101.38	100.2	34.09	40.15	37.12	600	612	606
D3G3	101.02	103.45	102.24	37.05	43.63	40.34	633	645.66	639.33
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.Em+	1.89	1.89	1.89	1.75	1.9	1.4	17.98	18.34	18.16
CD(p=0.05)	-	-	-	-	-	-	-	-	-

Table 2: Grain yield, Stover yield and Harvest index of foxtail millet genotypes as influenced by different dates of sowing.

	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index		
Treatments	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**
Date of Sowing									
D1: June 30	1985.88	2112.63	2049.25	4153.38	4369.75	4261.56	0.32	0.33	0.33
D2: July 30	1738.81	1849.80	1794.31	3807.09	3988.56	3897.82	0.31	0.33	0.32
D3: August 30	1411.19	1501.27	1456.23	3210.44	3369.29	3289.86	0.31	0.31	0.31

F test	*	*	*	*	*	*	NS	NS	NS
S.Em±	56.29	56.27	48.95	79.76	94.45	70.20	0.01	0.01	0.01
CD(p=0.05)	168.75	168.69	146.74	239.13	283.16	210.45	-	-	-
Genotypes									
G1: Local	1592.45	1694.10	1643.28	3519.11	3691.28	3605.19	0.31	0.32	0.31
G2: HMT-1	1730.38	1840.83	1785.61	3767.16	3959.52	3863.34	0.31	0.33	0.32
G3: SIA 2644	1813.04	1928.77	1870.90	3884.64	4076.79	3980.71	0.32	0.33	0.32
F test	*	*	*	*	*	*	NS	NS	NS
S.Em+	56.29	56.27	48.95	79.76	94.45	70.20	0.01	0.01	0.01
CD(p=0.05)	168.75	168.69	146.74	239.13	283.16	210.45	-	-	-
DXG									
D1G1	1831.50	1948.40	1889.95	3901.09	4091.64	3996.36	0.32	0.32	0.32
D1G2	2009.91	2138.20	2074.05	4220.81	4447.46	4334.13	0.32	0.33	0.33
D1G3	2116.22	2251.30	2183.76	4338.26	4570.14	4454.20	0.33	0.33	0.33
D2G1	1703.56	1812.30	1757.93	3798.94	3968.94	3883.94	0.31	0.32	0.32
D2G2	1725.46	1835.60	1780.53	3761.51	3946.54	3854.03	0.31	0.33	0.32
D2G3	1787.41	1901.50	1844.46	3860.81	4050.20	3955.50	0.32	0.33	0.33
D3G1	1242.30	1321.60	1281.95	2857.30	3013.25	2935.27	0.30	0.31	0.31
D3G2	1455.78	1548.70	1502.24	3319.17	3484.58	3401.87	0.30	0.31	0.31
D3G3	1535.49	1633.50	1584.50	3454.85	3610.04	3532.44	0.31	0.32	0.31
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.Em+	97.49	97.46	84.78	138.15	163.59	121.59	0.02	0.02	0.01
CD(p=0.05)	-	-	-	-	-	-	-	-	-

The economic yield of a crop is the integrated results of some physiological processes. An adequate supply of nutrient is necessary for metabolic activity as it finally affects the vegetative as well as reproductive phases. In the present study genotypes significantly influenced the grain yield of foxtail millet SIA 2644 (1870.90 kg ha^{-1}), straw yield (3980.71 kg ha^{-1}) and it was on par with HMT-1 (1785.61 kg ha^{-1}), straw yield (3863.34 kg ha^{-1}) and there is no any significant difference with respect to harvest index highest harvest index was noticed with SIA 2644 (0.32) (Table 2) as compared to HMT-1 and local. Among different dates of sowing, June 30 recorded significantly higher grain yield (2049.25 kg ha^{-1}) straw yield (4261.56 kg ha^{-1}) as compared to July 30 (1794.31 kg ha^{-1}), (3897.82 kg ha^{-1}) and there is no any significant difference with respect to harvest index highest harvest index was noticed with June 30 (0.33) as compared to other dates of sowing. This increase in yield was attributed to the greater yield components such as panicle length, test weight and total dry matter accumulation per plant due to different dates of sowing. Low yield in grain yield may be attributed to shorter growth period available for crop results in decreased grain yield and its components. Similar findings were also reported by Tejagouda, *et al.* (2015) [9] and Upadhyay *et al.* (2001) [10].

Table 3: Yield components of foxtail millet as influenced by dates of sowing and genotypes

	Panicle length (cm)			**Panicle weight (g)**			**Test weight (g)**		
Treatments	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**	**2016**	**2017**	**Pooled**
Date of sowing									
D_1:June 30	14.29	15.83	15.06	6.43	6.90	6.67	3.28	3.45	3.37
D_2:July 30	12.72	14.33	13.53	5.63	6.14	5.88	3.03	3.12	3.08
D_3:August 30	10.19	12.45	11.32	4.55	4.60	4.58	2.84	2.97	2.90
F test	*	*	*	*	*	*	*	*	*
S.Em±	0.29	0.24	0.20	0.06	0.03	0.04	0.04	0.05	0.04
CD(p=0.05)	0.88	0.70	0.60	0.19	0.09	0.12	0.12	0.15	0.12
Genotype									
G_1:Local	11.58	13.45	12.52	5.29	5.74	5.52	2.94	3.07	3.01
G_2:HMT-1	12.37	14.39	13.38	5.48	6.11	5.80	3.05	3.18	3.12
G_3:SIA-2644	13.24	14.78	14.01	5.84	5.78	5.81	3.16	3.28	3.22
F test	*	*	*	*	*	*	*	*	*
S.Em±	0.23	0.23	0.20	0.06	0.03	0.04	0.04	0.05	0.04
CD(p=0.05)	0.88	0.70	0.60	0.19	0.09	0.12	0.12	0.15	0.12
DXG									
D_1G_1	13.65	15.44	14.55	6.25	6.73	6.49	3.13	3.29	3.21
D_1G_2	14.18	15.85	15.01	6.43	6.86	6.64	3.30	3.47	3.38
D_1G_3	15.05	16.20	15.62	6.62	7.11	6.87	3.42	3.59	3.51
D_2G_1	11.99	13.32	12.66	5.26	5.62	5.44	2.97	3.08	3.01
D_2G_2	12.86	14.56	13.71	5.49	6.19	5.84	3.00	3.12	3.06
D_2G_3	13.30	15.12	14.21	6.14	6.61	6.37	3.12	3.18	3.15
D_3G_1	9.11	11.60	10.35	4.37	4.88	4.63	2.73	2.87	2.80
D_3G_2	10.08	12.75	11.42	4.54	5.29	4.91	2.85	2.96	2.91
D_3G_3	11.37	13.01	12.19	4.75	3.62	4.19	2.93^{c}	3.06	3.00
S.Em±	0.51	0.42	0.35	0.11	0.05	0.07	0.07	0.09	0.07
CD(p=0.05)	-	-	-	-	-	-	-	-	-

Grain yield is a manifestation of yield contributing characters. The present study showed significant variance in yield components *viz.,* panicle length, panicle weight and test weight with respect to date of sowing. Crop sown on June 30th recorded significantly more panicle length (15.06 cm), panicle weight (6.67 g) and test weight (3.37 g) when compared to other sowing dates. Significantly higher yield components was noticed with genotype SIA 2644 panicle weight (5.81 g), panicle length (14.01 cm) and test weight (3.22 g) and it was found to be on par with HMT-1 and superior over local (Table 3). The reduction of yield components with delayed sowing due to decrease in moisture in late sown condition which reduces cell division and cell expansion which influences meristematic development of yield components as a result less production of photosynthates due to shorter growing period. Lower test weight in late sowing is due to shrivelling of grain due to hot winds prevailed during milk and grain filling stage. The results support the findings of Maurya *et al.* (2016) [6], Soler *et al.* (2007) [8] and Ashoka and Halikati (1997) [3] in pearl millet.

Conclusion

From the above study, concluded that the foxtail millet variety SIA 2644 is found to be most suitable for sowing at 30th June. The growth and yield of foxtail millet variety SIA 2644 and sowing date 30th June provides favourable weather condition for better growth and yield under Southern Transition Zone of Karnataka condition. In case of late sowing condition, the weather parameters were not favorable for the foxtail millet varieties, thus affecting of growth and yield parameters which ultimately reduced the yield.

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