

Effect of staggered sowings on crop growth, flowering parameters and seed yield on sorghum hybrid cv. SHD-9704

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ABSTRACT : The present investigation was undertaken during 2007 and 2008 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *Rabi* season in 2007 and *Kharif* season in 2008 and their pooled data on effect of staggered sowings on crop growth, flowering parameters and seed yield on sorghum hybrid cv. SHD-9704. Among the four date of staggered sowing, the female parent sown 10 days before male parent (S_3) recorded numerically more plant height (109.83 cm) at harvest, leaf number (9.61), leaf area (3157 cm²), leaf area index (4.67) at 75 DAS as against simultaneous sowing of female and male parent (S_0) (98.33 cm, 9.14 and 2874 cm² and 4.25) except for days to crop maturity which was relatively more (94.25 days) in simultaneous sowing of female and male parent (S_0) over in sowing female parent 10 days before male parent (S_3) (90.52 days). The sowing of female and male parent simultaneously (S_0) took numerically more number of days for days to primordial initiation (38.17 days) and 50 per cent flowering (69.67 days) but it was less (35.28 and 66.33 days) in sowing of female parent 10 days before male parent (S_3). The harvest index, ear length, ear width, ear weight, number of seeds per ear, seed setting percentage, seed weight per ear and hybrid seed yield per hectare recorded significantly maximum (0.176, 25.89 cm, 4.04 cm, 32.88 g, 429.74, 37.85%, 14.43 g and 7.65 q/ha, respectively) in sowing of female parent 4 days before male parent (S_1) and minimum in sowing of female parent 10 days before male parent (S_3) (0.052, 21.06 cm, 3.25 cm, 18.42 g, 129.03, 11.14%, 4.48 g and 1.36 q/ha, respectively).

Key Words : Sorghum, Staggered sowing, Growth, Flowering parameter, Seed yield

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Sorghum [*Sorghum bicolor* (L.) Moench] commonly known as 'jowar', is the fifth most important cereal crop in the world next to wheat, rice, maize and barley. It is a staple food crop for more than 300 million people of Asia and Africa continents. India has the largest share (32.50%) of world sorghum area and ranks second in production after USA. In India, it is cultivated on about 7.93 million hectare area with annual production of 7.78 million tonnes and productivity of 981 kg per ha (Anonymous, 2008). The major sorghum growing states in India are Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan and Tamilnadu. In India, Karnataka state is one of the important sorghum growing states and stands second in area and production after Maharashtra. In Karnataka, it accounts for 1.38 million hectare area and production of 1.62 million tonnes with average productivity of 1192 kg per ha (Anonymous, 2009). About 50 per cent of people in Karnataka depend on sorghum as a staple food crop

particularly in Northern Karnataka viz., Bijapur, Dharwad, Belgaum, Raichur, Gulbarga, Bellary and Mysore. Nevertheless, hybrid seed production in sorghum is an herculean task in view of its serious problems encountered in the form of non-synchrony in parental flowering (Sastry and Shankar Rao, 1975; Nayeem, 1977). Differential flowering period cause a poor seed set due to insufficient supply of pollens at the time of stigma receptivity in female parent. To achieve proper synchronization of flowering of male and female parents the simple agronomic manipulations like staggered sowing and cultural practices such as application of nitrogen through soil, spraying of urea, gibberellic acid and controlled irrigation are being followed in hybrid seed production programme. In staggered sowing method the male and female parents are sown at different dates depending on the differences in their flowering days to coincide the flowering of male parent with that of female parent. It is being practiced widely by the seed growers to get proper

synchronization of flowering of male and female parents during flowering period. Usually staggered sowing technique is adopted to bridge difference in flowering of male and female parents at least by five days and more. Hence, systematic research works are to be initiated to find out the effect of staggered sowings on the female parental line (AKMS-14A) of new pre-released hybrid sorghum cv. SHD-9704 to achieve better synchronization of flowering for higher seed setting and yield of hybrid seed.

RESEARCH PROCEDURE

The field experiment was conducted to study the effect of staggered sowings on crop growth, flowering parameters and seed yield in pre-released sorghum hybrid SHD-9704 at the Main Agricultural Research Station, Dharwad Farm, University of Agricultural Sciences, Dharwad during *Rabi* season in 2007 and *Kharif* season in 2008. The field experiment consisted of four staggered sowings viz. S_0 - Simultaneous sowing of female and male parent, S_1 - Sowing of female parent four days before male parent, S_2 - Sowing of female parents seven days before male parent and S_3 - Sowing of female parents ten days before male parent. The foundation seeds of female parent cv. AKMS-14A and male parent cv. SVD-9607 of pre-released sorghum hybrid SHD-9704 were obtained from the Sorghum Breeder, All India Coordinated Sorghum Improvement Project, Main Agricultural Research Station, Dharwad.

The observations were made on plant height at harvest, number of leaves, leaf area, leaf area index at 75 DAS (days after sowing), days to crop maturity, days to flower primordial initiation and 50 per cent flowering, harvest index, ear length, ear width, ear weight, number of seeds per ear, seed setting percentage, seed weight per ear, hybrid seed yield per plot and hybrid seed yield per hectare. The data obtained from various periodical observations were subjected to statistical analysis. The analysis of variance and interpretation of data were done as per procedure given by Gomez and Gomez (1984). The experimental data of 2007 (*Rabi*) and 2008 (*Kharif*) were used for combined analysis to arrive at the best treatment combination effect.

RESEARCH ANALYSIS AND REASONING

The results obtained from the present investigation have been discussed in the following sub-heads:

Growth parameters:

The staggered sowings did not exhibit significant variations on various growth parameters studied in both the years of experiments and pooled analysis are presented in Table 1. Among the four dates of staggered sowing, female parent sown 10 days before male parent (S_3) recorded numerically more plant height (109.83 cm) at harvest, leaf number (9.61),

Treatments	Plant height at harvest (cm)		Number of leaves at 75 DAS				Leaf area (cm ²) at 75 DAS				Leaf area index at 75 DAS			
	<i>Rabi</i> 2007-08	<i>Kharif</i> 2008-09	<i>Rabi</i> 2007-08	<i>Kharif</i> 2008-09	Pooled data	<i>Rabi</i> 2007-08	<i>Kharif</i> 2008-09	Pooled data	<i>Rabi</i> 2007-08	<i>Kharif</i> 2008-09	Pooled data	<i>Rabi</i> 2007-08	<i>Kharif</i> 2008-09	Pooled data
	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *	S.E. \pm *
S_0	95.67	101.00	98.33	9.05	9.14	9.23	9.23	9.14	2813	2934	2874	4.16	4.34	4.25
S_1	99.50	104.17	101.83	9.22	9.33	9.45	9.45	9.33	2909	3030	2969	4.31	4.48	4.40
S_2	103.37	107.00	105.18	9.28	9.43	9.57	9.57	9.43	3011	3133	3072	4.46	4.64	4.55
S_3	108.00	111.67	109.83	9.50	9.61	9.72	9.72	9.61	3095	3218	3157	4.58	4.77	4.67
Mean	101.63	105.96	103.80	9.26	9.38	9.49	9.49	9.38	2957	3079	3018	4.38	4.56	4.47
S	4.81 NS	5.27 NS	4.90 NS	0.43 NS	0.44 NS	0.47 NS	0.47 NS	0.44 NS	144 NS	141 NS	142 NS	0.20 NS	0.22 NS	0.14 NS

NS - Non significant
 Staggered sowings of female parent (S)
 S_0 - Simultaneous sowing of female and male parents
 S_1 - Sowing of female parent four days before male parent
 S_2 - Sowing of female parent seven days before male parent
 S_3 - Sowing of female parent ten days before male parent
 DAS - Days after sowing
 * = C.D. (P=0.05)

leaf area (3157 cm²), leaf area index (4.67) at 75 DAS as against (98.33 cm, 9.14 and 2874 cm² and 4.25) except for crop maturity. It was relatively more (94.25 days) in simultaneous sowing of female and male parent (S₀) over sowing of female parent 10 days before male parent (S₃) (90.52 days). In this study, numerically higher growth parameters noticed in the female parent sown 10 days before male parent may be attributed to the existence of favourable climatic and soil conditions in the early staggered sowing period. On the other hand, sowing of female and male parents on same day recorded lower values for the various growth parameters which may be probably related to the erosion of congenial environment due to progressive delay in staggered sowing. Hence, it resulted in significant decline in the growth parameters. These results are in conformity with those of earlier researchers like Pandusastry (1981), BiradarPatil (1984), Shivappa (1988), Lakkappan (1999) and Shivashekharpatil (2001) in sorghum hybrid.

Flowering parameters:

In both the years of experiments and combined year analysis, the effect of four staggered sowings was found non significant for the flowering parameters studied are presented in Table 2. However, the sowing of female and male parent on same day (S₀) exhibited relatively longer period (38.17 and 69.67 days) for flower primordial initiation and 50 per cent flowering compared to female parent sown 10 days before male parent (S₃) (35.28 and 66.33 days) (Plate 1). These results indicated non-significant effect of the staggered sowing on flowering parameters due to shorter intervals of staggered sowings adopted. Similar findings were also reported by Patil and Goud (1980), Biradarpatil (1984) and Shivappa (1988) in sorghum and Varshney *et al.* (2006) and Alam *et al.* (2007) in maize hybrid.

Hybrid seed yield and yield parameters:

Significant differences for hybrid seed yield components like harvest index, ear length, width, weight, number of seed per ear, seed setting percentage, seed weight per ear and hybrid seed yield per ha due to staggered sowings in both years of experiment as well as pooled analysis are presented in Table 3 and 4 and Plate 2. Among the four staggered sowings, the female parent sown 4 days before male parent (S₁) recorded significantly more harvest index (0.176), ear length (25.89 cm), ear width (4.04 cm), ear weight (32.88 g), number of seeds per ear (429.74), seed setting percentage (37.85%), seed weight per ear (14.43 g) and hybrid seed yield per hectare (7.65 q/ha) and it was followed by simultaneous sowing of female and male parent (S₀) (0.139, 23.18 cm, 3.82 cm, 29.08 g, 331.98, 29.20%, 11.18 g and 5.29 q/ha, respectively) compared to the sowing of female parent 10 days before male parent (S₃) (0.052, 21.06 cm, 3.25 cm, 18.42 g, 129.03, 11.14%, 4.48 g and 1.36 q/ha, respectively).

The more (7.65 q/ha) hybrid seed yield per hectare was

Table 2 : Effect of staggered sowing on days to crop maturity, days to flower primordial initiation, days to 50% flowering and harvest index of sorghum hybrid cv. SHD-9704

Treatments	Days to crop maturity		Days to flower primordial initiation		Days to 50% flowering		Harvest index	
	Rabi 2007-08	Kharif 2008-09	Rabi 2007-08	Kharif 2008-09	Rabi 2007-08	Kharif 2008-09	Rabi 2007-08	Kharif 2008-09
S ₀	95.17	93.33	39.00	37.33	70.33	69.00	0.136	0.143
S ₁	93.50	92.00	38.50	36.50	69.00	68.00	0.167	0.186
S ₂	92.50	90.57	36.67	35.33	67.83	66.83	0.098	0.106
S ₃	91.33	89.70	35.95	34.62	66.83	65.83	0.044	0.060
Mean	93.13	91.43	37.53	35.95	68.50	67.42	0.111	0.124
S	4.20 NS	4.06 NS	1.60 NS	1.55 NS	3.99 NS	3.96 NS	0.006 NS	0.017 NS
	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *
	4.13 NS	4.13 NS	1.60 NS	1.57 NS	3.97 NS	3.97 NS	0.005 NS	0.014 NS

NS - Non significant
 Staggered sowings of female parent (S)
 S₀ - Simultaneous sowing of female and male parents
 S₁ - Sowing of female parent four days before male parent
 S₂ - Sowing of female parent seven days before male parent
 S₃ - Sowing of female parent ten days before male parent
 *C.D. (P=0.05)

Table 3 : Effect of staggered sowing on ear length (cm), ear width (cm) and ear weight (g) on female parent of sorghum hybrid cv. SHD-9704

Treatments	Ear length (cm)			Ear width (cm)			Ear weight (g)									
	Rabi 2007-08	Kharif/2008-09	Pooled data	Rabi 2007-08	Kharif/2008-09	Pooled data	Rabi 2007-08	Kharif/2008-09	Pooled data							
S ₀	22.12	24.25	23.18	3.68	3.97	3.82	28.20	29.95	29.08							
S ₁	24.53	27.25	25.89	3.92	4.17	4.04	31.17	34.60	32.88							
S ₂	21.52	23.75	22.63	3.35	3.52	3.43	22.05	23.70	22.88							
S ₃	19.88	22.23	21.06	3.13	3.37	3.25	16.80	20.03	18.42							
Mean	22.01	24.37	23.19	3.52	3.75	3.64	24.55	27.07	25.81							
S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *							
S	0.77	2.39	0.89	2.73	0.82	2.54	0.16	0.53	0.16	0.50	1.34	4.13	1.39	4.27	1.23	3.80

NS - Non significant * = C.D. (P=0.05)

Staggered sowings of female parent (S)

S₀ - Simultaneous sowing of female and male parentsS₂ - Sowing of female parent seven days before male parentS₁ - Sowing of female parent four days before male parentS₃ - Sowing of female parent ten days before male parent**Table 4 : Effect of staggered sowing on ear weight (g), number of seeds per ear, seed setting percentage, seed weight per ear (g) and hybrid seed yield per hectare (q/ha) on female parent of sorghum hybrid cv. SHD-9704**

Treatments	Number of seeds per ear			Seed setting percentage			Seed weight per ear (g)			Hybrid seed yield per hectare (q/ha)														
	Rabi 2007-08	Kharif 2008-09	Pooled data	Rabi 2007-08	Kharif 2008-09	Pooled data	Rabi 2007-08	Kharif 2008-09	Pooled data	Rabi 2007-08	Kharif 2008-09	Pooled data												
S ₀	307	357	332	28.70	29.71	29.20	10.62	11.75	11.18	4.79	5.79	5.29												
S ₁	412	448	430	37.41	38.29	37.85	13.67	15.20	14.43	7.25	8.05	7.65												
S ₂	209	244	226	18.97	20.25	19.61	7.63	8.85	8.24	2.40	3.03	2.71												
S ₃	112	146	129	10.16	12.12	11.14	4.02	4.93	4.48	1.02	1.69	1.36												
Mean	260	299	279	23.81	25.09	24.45	8.98	10.18	9.58	3.86	4.64	4.25												
S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *	S.E. _± *												
S	20	61	14	43	17	51	0.85	2.61	0.79	2.42	0.51	1.56	0.55	1.71	0.63	1.95	0.48	1.49	0.11	0.33	0.09	0.27	0.09	0.29

NS - Non significant * = C.D. (P=0.05)

Staggered sowings of female parent (S)

S₀ - Simultaneous sowing of female and male parentsS₂ - Sowing of female parent seven days before male parentS₁ - Sowing of female parent four days before male parentS₃ - Sowing of female parent ten days before male parent



Plate 1 : Variation in primordial due to staggered sowing to female parent (AKMS-14A) along with male parent (SVD-9607) of sorghum hybrid (SHD-9704)

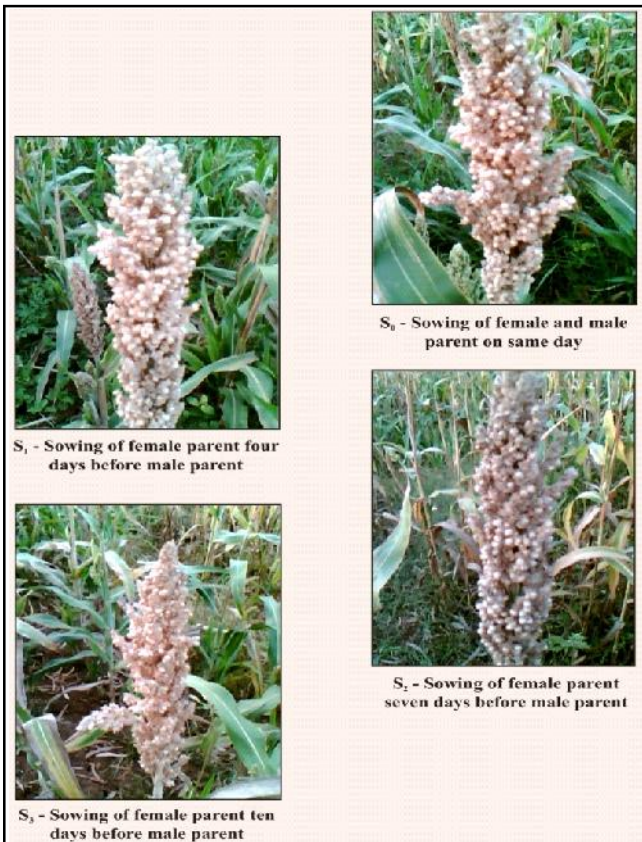


Plate 2 : Variation in development of female parent (AKMS-14A) of sorghum hybrid (SHD-9704) in different staggered sowing

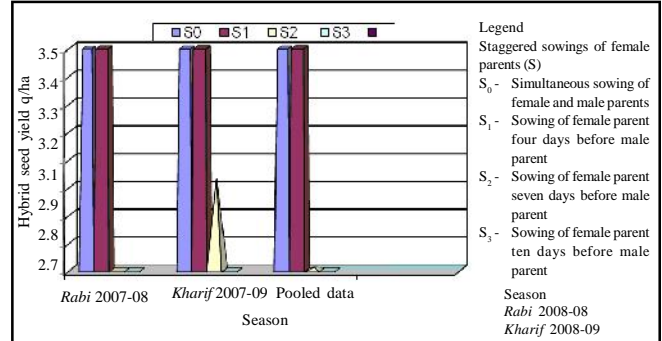


Fig. 1 : Effect of staggered sowings on hundred seed weight on female parent of sorghum hybrid cv SHD-9704

recorded in the sowing of female parent 4 days before male parent and it may be related to the higher seed set percentage which might have contributed for higher hybrid seed yield components like harvest index, ear length, width, weight, number of seeds per ear and seed weight per ear compared to sowing of female parent 10 days before male parent. Further, it was also attributed to smaller differences in 50 per cent flowering noticed between female and male parent resulting in adequate availability of viable pollens to the female parent at the time of flowering. On the contrary, the female parent sown 10 days before male sowing has recorded less hybrid seed yield per hectare (1.36 q/ha) which may be related to less availability of viable pollens from male parent to female parent showing less seed setting as well as hybrid seed yield components. Similar findings were also confirmed by earlier researchers in sorghum hybrid (Shivappa, 1988; Lakkappan, 1999; Shivashekhar Patil, 2001) and in maize hybrid (Varshney *et al.*, 2006 and Hipparagi, 2011).

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