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212

Seasonal Influence on Flowering, Seed Yield and Quality in Sunflower (*Helianthus annuus* L.) Hybrid KBSH-1

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ABSTRACT. *Studies were undertaken to elicit information on seasonal influence on synchronization of flowering, seed yield and quality in sunflower (Helianthus annuus L.) hybrid KBSH-1. A closer synchronization of flowering with only six days difference with earliness in female was observed when the parental lines were sown during September and October. Weather parameters prevailing during cropping season significantly influenced the days to button formation, 50% flowering and completion of flowering, head diameter, total number of whorls per head and seed filling per cent. The 100 - seed weight and germination of resultant hybrid seed also exhibited significant differences due to season of production.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) (2n=34) is the second most important oil seed crop of the world next to soybean. In India it is grown over an area of 2.09 million ha with a production of 13.15 million tons, and productivity of 640 kg ha^{-1} (Singhal, 1999). With a modest beginning of 1.5. million ha in 1972-73, the area under sunflower in India increased to 2.9 million ha during 1998-99. The increase was mainly due to development of hybrids. KBSH-1 (Karnataka Bangalore Sunflower Hybrid-1), is one of the most popular hybrids released from University of Agricultural Sciences, Bangalore. Due to its superior performance, it has been adapted to all sunflower growing areas of the country (All India Co-ordinated National Seed Project, 1999).

In sunflower hybrid seed production involving CGMS system, the pollination is very much inadequate or not properly followed leading to non-availability of pollen to stigma resulting in poor seed set. This inadequate pollen supply from male to female parent is mainly due to non-synchronised flowering behaviour of parental lines.

The success of hybrids in many crops depends on exploitation of hybrid vigour and feasibility of economically viable seed production. One of the most important problem encountered in hybrid seed production is non-synchrony of parental lines (Vidhyabushanam, 1977). Synchronization of flowering is mostly governed by floral biology and crop growth characteristics (Sharma, 1991; Bassi *et al.*, 1992). The successful cultivation of sunflower can be taken up throughout the year under a wide range of agro-climatic conditions (Yadava

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et al., 1976). However, change in date of planting is mostly accompanied by the changes in weather factors.

Delaying or advancing either of the parental lines will be the easiest and cheapest method to overcome the synchronization problem (Yadava, 1993). To adopt this method, information on the flowering behavior of seed and pollen parents with reference to time of sowing is a pre-requisite. When the edaphic and agronomic variables are almost constant, the factors that cause the variation within the parental lines could only be the weather factors (Siemer *et al.*, 1969 ; Wall and Ross, 1970).

The male parent (6D-1) of KBSH-1 is late flowering by six days than the female parent (CMS 234 A). Staggered sowing of pollen parent (6D-1), five days before the seed parent (CMS 234 A) lead to synchronized flowering of the parental lines (Seetharam and Sathyanarayana, 1983). Environmental factors such as temperature, relative humidity, rainfall *etc.*, also play a vital role in deciding the days to flowering, flowering duration and days to completion of flowering. Hence, location specific information on seasonal influence on synchronization of flowering is essential for efficient hybrid seed production.

MATERIALS AND METHODS

A field experiment with monthly sowing of parental lines of sunflower hybrid KBSH-1 *viz.*, CMS 234 A (female - A line) and 6 D-1 (male - R line) was conducted in a randomized block design with four replications, spaced 45×30 cm at Tamil Nadu Agricultural University, Coimbatore for a period of six months. The parental lines were allowed natural pollination. Observations on days to button formation, 50% flowering, completion of flowering, plant height at flowering, head diameter, number of whorls in bloom day^{-1}, total number of whorls $head^{-1}$, seed filling and seed yield were recorded. The resultant seed quality *viz.*, 100 seed weight and seed germination were evaluated as per the method suggested by ISTA (1999). The data were statistically analysed for significance following the methods proposed by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

In the present study, differences in days to button formation, 50% and completion of flowering due to different dates of sowing were noticed (Table 1). In both parents early button formation was observed in September sown as compared to February sown crop. The days to flowering significantly varied among the parental lines and sowing dates. Caddle and Weibal (1972) and Brown *et al.* (1976) reported that the influence of environmental factors was mostly pronounced at the period of floral initiation compared to other growth periods. The same results were also observed by Ujjinaiah *et al.* (1988) and Balamurugan (1993) in sunflower.

Though sunflower is regarded as photo insensitive, a differential behaviour in respect of flowering and maturity was observed when grown in different seasons. Various factors such as temperature, sunshine hours, day length and relative humidity play a major role in altering the days to 50% flowering (Goyne and Hammer, 1982).

Table 1. Influence of month of sowing on days to button formation, 50% flowering and completion of flowering in parental lines of sunflower hybrid KBSH-1.

Month of sowing	Days to button formation			Days to 50% flowering			Days to completion of flowering		
	A line	R line	Mean	A line	R line	Mean	A line	R line	Mean
September '92	42.00	46.25	44.13	55.50	61.50	58.50	64.00	71.25	67.63
October '92	42.00	48.25	45.13	57.00	62.00	59.50	65.00	71.25	68.13
November '92	43.75	50.25	47.00	61.25	69.25	65.25	66.25	75.50	70.88
December '92	43.25	49.75	46.50	59.00	66.00	62.50	65.25	72.25	68.75
January '93	44.50	50.75	47.63	58.50	65.50	62.00	65.25	72.00	68.63
February '93	45.75	51.25	48.50	59.25	66.00	62.63	65.25	71.25	68.25
Mean	43.54	49.42		58.42	65.04		65.17	72.25	
	M	G	M×G	M	G	M×G	M	G	M×G
S.E. (difference)	0.547	0.316	NS	0.328	0.189	0.464	0.321	0.185	0.454
LSD (p=0.05)	1.113	0.643		0.687	0.385	0.942	0.653	0.377	0.923

M - Month of sowing G - Genotype M × G - Interaction effect

The results revealed that difference between seed and pollen parent varied from five to eight days on 50% flowering among sowing dates with the female parent showing earliness. A minimum of five day difference was noticed in October sown crop, which flowered during the second fortnight of November and maximum of eight days was noticed in November sown crop which flowered in January. Similar seasonal variation for flowering was reported by Kundu *et al.* (1989). The narrow difference between female and male parents observed for button formation got widened for 50% flowering. Such variations were reported in parental lines of rice hybrids by Reddy and Reddy (1992) and Bassi *et al.* (1992). The reason for such variation might be due to genetic difference (Khupi and Doto, 1989).

Variation among months of sowing was less in completion of flowering as compared to days to button formation and 50% flowering. Only two days difference in completion of flowering was observed among months of sowing in seed parent whereas in pollen parent it was four days. The differential flowering of the parental lines due to environmental conditions have been reported by Shekar *et al.* (1985) in rice and Vadivelu *et al.* (1983) in sorghum.

The results on head diameter also proved the superiority of September sowing by registering larger heads (Table 2). The number of whorls in bloom day^{-1} also play a major role in enhancing the hybrid seed yield. If seed parent opens more number of whorls than the pollen parent it may experience with insufficient pollen supply, leading to poor seed filling. On the other hand if pollen parent opens more number of whorls, it may also lead to poor seed filling, because all the pollen grains could not be used up for pollination. The number of whorls in bloom day^{-1} was also altered by environmental factors. In both the

parents, October, February and December sown crops had more number of whorls in bloom day^{-1} (Table 2). However, January sown seed parent and November sown pollen parent bloomed less number of whorls in bloom day^{-1}. The reason for such variation in number of whorls in bloom day^{-1}, might be due to the prevalence of varied relative humidity, sunshine hours and temperature that influenced the flower opening. Sharma (1991) and Siddiq *et al.* (1992) reported that spikelet in rice readily opened on a full sunny day but opening got delayed on humid and cloudy days. Besides genetic differences, flowering was also altered by weather conditions of the location (Bassi *et al.*, 1992), intensity of light and temperature (Wang *et al.*, 1992).

Table 2. Influence of month of sowing on head diameter (cm), number of whorls bloom day^{-1} and total number of whorls head^{-1} in parental lines of sunflower hybrid KBSH-1.

Month of sowing	Head diameter (cm)			Number of whorls bloom day^{-1}			Total number of whorls head^{-1}		
	A line	R line	Mean	A line	R line	Mean	A line	R line	Mean
September '92	10.50	5.28	7.89	2.00	1.33	1.66	18.25	13.50	15.88
October '92	9.98	6.10	8.04	2.25	1.35	1.80	18.11	12.25	15.13
November '92	7.70	5.30	6.50	2.00	1.18	1.59	18.50	12.50	15.50
December '92	6.90	5.53	6.21	2.25	1.23	1.74	17.75	12.00	14.88
January '93	7.13	5.85	6.49	1.93	1.20	1.56	18.25	11.25	14.75
February '93	6.85	4.23	5.54	2.25	1.35	1.80	17.75	11.50	14.63
Mean	8.18	5.38		2.12	1.27		18.08	12.17	
	M	G	M×G	M	G	M×G	M	G	M×G
S.E. (difference)	0.51	0.29	0.72	NS	0.10	NS	0.36	0.21	NS
C.D. (p=0.05)	1.03	0.59	1.46		0.21		0.73	0.42	

M - Month of sowing G - Genotype M × G - Interaction effect

The total number of whorls head^{-1} was maximum in September sown crop, which completed flowering during December (Table 2). Coincidence of cooler months with low intensity of light and minimum sunshine hours might have caused such increase in the total number of whorls of florets. In contrast, parental line of BSH-1 sown during June, July and August produced more number of whorls (Balamurugan, 1993). Number of whorls head^{-1} was significantly more in female parent as compared to male parent probably due to the larger head size of female parent.

In the present investigation, plant height was higher when the crop was sown in February under moderate temperature rather than cooler and high temperature condition (Table 3). The increased plant height might be due to an increased internodal length caused by the synthesis of higher amount of GA-3 under cooler temperature conditions (Noggle

and Fritz., 1991). This was in conformity with the results of Shuster and Boye (1971) and Goyne and Schneiter (1988).

Observation on seed filling is shown in Table 3. Even though the difference between parental lines for synchronized flowering was high in December sown crop the increased seed filling recorded might be due to the reduced head diameter and the number of whorls of floret·head^{-1}. The smaller heads with less number of florets might have received adequate pollen grains for fertilization. However, no significant difference in seed yield was observed between parents as well as months of sowing.

Table 3. Influence of month of sowing on plant height (cm), seed filling (%) and seed yield (kg plot^{-1}) in parental lines of sunflower hybrid KBSH-1.

Month of sowing	Plant height (cm)			Seed filling (%)			Seed yield (kg plot^{-1})		
	A line	R line	Mean	A line	R line	Mean	A line	R line	Mean
September '92	117.5	103.5	110.5	50.88	70.75	60.81	1.85	1.80	1.83
October '92	119.2	95.25	107.3	53.38	68.38	60.88	1.83	1.95	1.89
November '92	123.2	100.3	111.8	57.25	69.05	63.15	1.97	1.90	1.94
December '92	130.5	100.5	115.5	54.60	74.35	64.48	1.96	1.84	1.90
January '93	122.3	103.0	112.6	54.65	67.30	60.98	1.98	1.84	1.91
February '93	138.5	94 50	116.5	51.15	68.18	59.66	1.92	1.90	1.91
Mean	125.2	99 50		53.65	69.67		1.92	1.87	
	M	G	M×G	M	G	M×G	M	G	M×G
S.E.(difference)	NS	1.85	4.530	1.223	0.706	1.729	NS	NS	NS
LSD (p=0.05)		3.764	9.219	2.487	1.436	3.518			

M - Month of sowing G - Genotype M × G - Interaction effect

The resultant seed quality attributes *viz.*, 100 - seed weight and seed germination also exhibited seasonal influence. Compared to A line, R line recorded lower 100 - seed weight due to smaller sized seeds. Such variation in seed size might be due to the varietal difference. Similar varietal difference for 100 - seed weight was reported by Egli (1981) in wheat. The seed weight variation due to genotypes could be determined by a mechanism intrinsic to seed that depends upon the source-sink relationship. In the present investigation, 100 - seed weight and seed germination showed significant differences among the months of sowing and parental lines (Table 4). September sown crop on par with October and November sowings resulted maximum seed weight and germination. Such significant difference in seed quality parameters due to seasons were also reported by Krishnaveni (1997) in sunflower.

Table 4. Influence of month of sowing on 100 - seed weight (g) and seed germination (%) in parental lines of sunflower hybrid KBSH-1.

Month of sowing	100 - seed weight (g)			Seed germination (%)		
	A line	R line	Mean	A line	R line	Mean
September '92	6.31	4.25	5.28	97	94	96
October '92	6.38	4.15	5.27	93	92	93
November '92	6.13	4.08	5.11	96	96	96
December '92	5.90	3.97	4.93	92	91	92
January '93	6.38	4.22	5.30	96	88	92
February '93	6.20	4.10	5.15	92	86	90
Mean	6.15	4.13		94	91	
	M	G	M×G	M	G	M×G
S.E. (difference)	0.104	0.060	NS	1.668	0.963	NS
LSD (p=0.05)	0.210	0.121		3.394	1.960	

M - Month of sowing G - Genotype M × G - Interaction effect

CONCLUSIONS

From the foregoing investigations, it is obvious that variations occurred in different parameters were not only due to environment and genotype but also due to the interaction between them. Among the months of sowing, September and October sown crops showed a minimum difference in flowering duration between parental lines. Still, suitable staggering in sowing of the parental lines would enhance the seed filling, yield and quality.

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