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Research Article

Influence of different temperature regimes on seed setting behavior and productivity traits in rabi sorghum

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Abstract :
The experiment was conducted involving 35 rabi sorghum genotypes sown at six different dates of sowing (from Sept Ist week to October IVth week) during 2006-07 to assess the stability for pollen fertility (%), seed setting (%) and other productivity traits viz., plant height, days to 50% flowering, number of leaves, length of panicle, panicle weight, panicle diameter, number of primaries/panicle and 500-grain weight. The influence of dates of sowing on different phenotypic characters indicated that delayed sowing reduced the expression of all the traits. Flowering was early when genotypes were sown at 3rd date. The grain yield in general was high in the Ist date of sowing compared to the remaining dates. The seed set % (irrespective of sowing dates) was more than 65 as long as minimum temperature was more than 13 ºc where as, it was drastically reduced when minimum temperature was dropped down below 10 ºc. Pooled analysis of variance revealed significant difference among the genotypes and environments for all the characters indicating genotypes and environments tested were diverse in nature. The G x E interaction was high and linear for most of the characters indicating significant and linear response of genotypes to changing environment for these traits. On the basis of stability parameters it was revealed that the two genotypes viz., DSH 4 and M 35-1 were stable for majority of the characters across the dates of sowing. As far as pollen fertility is concerned M31-2B, BJMS2B, 27B, 101B, BJMS204B, SPV570, BRJ62, RS29, AKR 150, BRJ 358, DSV5, DSV4, M35-1, DSH4, and CSH14 were stable in all the dates of sowing. The genotypes 1409B, 116B, M31-2B, 101B, R354, C43, DSV5, DSV4, M35-1, DSH4 and BRJH 129 were stable in seed setting behavior across the dates of sowing. With respect to grain yield/plant the two genotypes viz., 116B and M35-1 were most stable. In general, the B lines showed less stability for many characters and the hybrids were found to be more stable across the dates of sowing for many characters indicating the scope for development of hybrids for *rabi* season. Among the hybrid parents R lines exhibited stability for many characters across the dates of sowing while B lines were found to be not stable indicating the need for the development of stable B lines for *rabi* ecosystem. Among the 35 genotypes the lines *viz*., 296B, AKMS14B, C43, AKR150 and B35 were not stable for any of the characters indicating their sensitivity to *rabi* environment as a whole.

Key words:
Sorghum, seed setting behavior, productivity.

Introduction

Sorghum is one of the drought hardy crop and considered as camel of crop**.** *Kharif* sorghum has attracted the attention in terms of intensive breeding as early as 1965, resulting in the development of an array of high yielding varieties and hybrids suited to different agro-ecological conditions. On the other hand, yields of *rabi* sorghum have been almost stagnant at lower levels indicating less impact of breeding efforts. *Rabi* sorghum is being cultivated under conserved & residual moisture situation and moisture availability is a major constrain during grain filling period. Sowing dates depend upon the rainfall and generally done under favorable moisture conditions that occurs after the first week of September and extends till the end of October. In general, day length decreases from 12 hr to 11 hr from sowing to flowering and increases from 11 hr to 11-30 hr during grain filling. Minimum temperature declines from about 20°c at sowing to 12°c at flowering and increases to18°c during grain filling period. Usually, the post rainy adapted land races exhibit photoperiod sensitivity, thermo insensitivity, tolerance to terminal stress, resistance to stalk rot and charcoal rot, produce high biomass and have large lustrous grains. However, productivity of these lines is in general is low. The improved cultivars derived by involving temperate types are highly productive but relatively photoperiod insensitive and temperature sensitive. Because of this temperature sensitivity, their growth is reduced and development is delayed and seed setting is affected. Among the improved cultivars, hybrid parents and hybrids *per se* are more sensitive to temperature variation than the varieties. Stephens and Holland (1954) reported the interaction of viable pollen production and its shedding with temperature. Reddy *et al.* (2003) observed significant and positive correlation between low temperature during flowering and seed setting in rabi sorghum hybrids. The greater success can be

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achieved in breeding hybrids for post rainy season, if temperature sensitivity in both the parents is eliminated. Hence, the present study was undertaken.

Materials and methods

The present investigation focusing mainly on study of pollen fertility and seed setting behavior in *rabi* sorghum genotypes in response to varying temperature regimes was carried out during *rabi* season 2006-07 at Regional Agriculture Research Station, Bijapur. The experimental material consisted of 35 elite sorghum genotypes which included hybrid parents (R & B lines), hybrids, varieties and land races. The experimental material was evaluated over eight different dates of sowing. Each sowing was taken with an interval of 7-8 days so as to adjust flowering at different temperature regimes. The experiment was laid out in a randomized complete block design (RCBD) with two replications in all test environments. The genotypes were allotted randomly within each replication. The inter and intra row spacing of 60 cm and 15 cm was provided respectively. Recommended package of practice was followed, and the crop stand and crop growth were satisfactory in all the six environments. Twelve quantitative characters *viz.,* plant height, days to 50% flowering, number of leaves per plant, length of the panicle, panicle weight, panicle diameter, number of primaries per panicle, number of grains per panicle, 500 grain weight, grain yield per plant, seed setting percentage and pollen fertility percentage were recorded. Data collected on these parameters are subjected to stability analysis (Eberhart and Russell, 1966) to know the G x E interaction and effect of different temperature regimes on yield and other productivity traits. The three stability parameters *viz.,* mean, regression coefficient (bi) and mean square deviation from regression line (S^2di) were considered to judge the stability of individual genotype for different traits.

Result and discussion

Stability of genotypes for seed setting behavior across different temperature regimes assumes lots of importance. In addition, stability of genotypes for yield and yield components across different dates of sowing is very important, as sowing dates in *rabi* season spread from 2nd week of September to till the end of October. It is very much necessary to know the influence of dates of sowing on the expression of different phenotypic characters to come out finally with a good hybrid.

The comparison of mean for plant height over six dates indicated that 3rd date of sowing was the optimum environment for the expression of this character, while date 6th was found to be unfavorable (Table 1). The large variation was observed in 2nd date of sowing. The results revealed that plant will produce more number of leaves when they are grown in 6th date. Genotypes flowered early at the 3rd sowing date. Reduction in panicle length, panicle weight, number of primaries per panicle was observed in plants at 6th date of sowing. Panicle length showed varied expression when plants are grown at 2nd date. Similarly, varied panicle weight ranging from 31.2 to 118.3 g was observed at 4th date, while range for number of primaries per panicle was high at 5th date of sowing.

Pollen fertility is increased when planting was delayed. Maximum pollen fertility was observed at 6th date. On the contrary seed set percentage was lowest at 6th date indicating that seed setting is not solely dependent on pollen fertility. Narrow range of pollen fertility was observed at 2nddate, while variation in seed setting behavior was less at 6th date. Number of seeds per panicle as well as yield per plant were reduced when planting was delayed indicating that even potential and high yielding genotypes are drastically affected under stress. Low yield was recorded in plants which were sown at 6th date. In 3rd date, number of seeds per panicle was maximum indicating suitability of this environment for the full expression of this trait. For grain yield per plant the plants sown at 1st date recorded highest yield indicating that this period is optimum to take up sowing to achieve highest productivity.

Pooled analysis of variance

The pooled analysis of variance (Table 2) revealed that mean sum of squares (MSS) due to genotypes were highly significant for all the characters under study indicating the presence of large amount of variability in the material chosen for the study. The MSS due to environments were also significant for all the traits indicating the validity of conduct of experiment in these environments. The genotype x environment interactions were significant for all the traits except plant height, number of leaves, panicle length, panicle diameter and pollen fertility percentage indicating considerable amount of interaction between the genotypes and environments. The MSS due to environment (linear) was significant for all the characters indicating that environmental effects are additive. The linear component of G×E interaction was also significant for all the characters (except number of leaves, days to 50% flowering and seed set percentage) indicating significant rate of linear response of the genotypes to environmental changes. The pooled deviation was also significant for all the characters except plant height indicating that non linear component of G×E interaction was predominant. Similar results were reported by Shivanna (1989), Patil *et al (*1991), Dale and Saver (1992), Muppidati *et al* (1995), Narkhede *et al* (1998) and Esha (2002) and this indicates genotype

under study is interacting with growing environment. Hence, there is a need to identify stable genotype which interacts positively with the environment and gives stable performance.

Stability of genotypes for different characters and frequency of stable genotypes for different traits under different dates of sowing and temperature regimes

The genotypes exhibiting stability for each character was given a score of 1 and total score obtained by each genotype across 12 traits were calculated. Similarly, for each trait total number of stable genotypes was calculated (Table 3). Of the 35 genotypes, the hybrid DSH 4 was found to be stable for as many as 11 characters followed by M35-1 (7 characters) and BRJH 129 (6 characters). Among the B lines M 31-2B was found to be stable for five characters followed by 116 B (4 characters) and BJMS 2B (4 characters). In general, the B lines showed less stability for many characters and the hybrids were found to be more stable across the dates of sowing for many characters indicating the scope for development of hybrids for *rabi* season. Among the hybrid parents R lines exhibited stability for many characters across the dates of sowing while B lines were found to be not stable indicating the need for the development of stable B lines for *rabi* ecosystem. Among the 35 genotypes the lines *viz*., 296B, AKMS14B, C43, AKR150 and B35 were not stable for any of the characters indicating their sensitivity to *rabi* environment as a whole.

Among the genotypes tested as many as 17 genotypes exhibited stability for plant height, while 15 genotypes showed stability for number of leaves and pollen fertility. For panicle length, 13 genotypes were found stable while ten genotypes exhibited stability for seed setting behavior. Many of the B lines, R lines and hybrids were found to be not stable for seed setting behavior across the dates of sowing and different temperature regimes indicating their sensitivity to the *rabi* environments particularly lower minimum temperature during flowering. On the other hand, only four genotypes were found to be stable for days to 50% flowering and number of seeds per panicle. Interestingly, only two genotypes 116B and M35-1 were found to be stable for grain yield per plant across different sowing dates. Of these two genotypes M35-1 was found stable for many other traits also. Reddy *et al.* (1987) also observed the stability of M35-1 for grain and fodder yield across the dates of sowing. Reddy *et al.* (1983) indicated that delay in flowering on account of late sowing is less in M35-1 compared to many of the improved cultivars. Reddy *et al.* (2003) further indicated that the characters like photoperiod sensitivity, thermoinsesitivity, tolerance to moisture stress, high grain and stover yielding ability, bold and lustrous grain quality are exemplified in the popular *rabi* sorghum variety M35-1.

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Table 1: Mean and range values of yield and yield related characters in rabi sorghum in different dates of sowing

	Mean						Range					
	I date	II date	III date	IV date	V date	VI date	I date	II date	III date	IV date	V date	VI date
Plant height (cm)	165.6	164.6	167.3	155.1	128.7	115.0	95.5-231.5	85.2-238.0	85.3-233.0	72.2-220.0	69.0-188.0	61.6-155
No. of leaves	6.4	7.0	6.7	6.6	7.8	7.8	4.3-8.15	5.1-9.30	4.9-9.4	51.0-8.3	5.8-10.2	5.80-9.50
Days to 50% flowering	77.4	72.1	67.9	68.9	71.3	78.4	73.0-82.5	65.0-80.5	62.5-74.5	59.0-79.5	66.0-79.5	69.0-86.5
Panicle length (cm)	22.2	22.8	23.9	21.9	17.3	16.2	17.1-29.2	13.5-29.5	15.3-30.4	13.7-25.7	11.1-24.5	10.2-22.5
Panicle weight (g)	63.6	69.1	65.9	61.2	33.3	26.4	25.3-95.4	37.1-114.7	28.0-99.4	31.2-118.3	11.5-63.4	12.2-54.8
Panicle diameter (cm)	13.9	14.7	14.0	14.3	10.3	10.4	9.0-16.8	10.9-18.1	9.9-17.6	7.2-18.8	7.3-13.7	7.1-16.1
No. of primary /panicle	56.3	55.5	58.7	58.7	47.2	30.5	38.4-75.90	35.8-74.3	39.6-70.6	40.7-82.1	29.2-75.7	25.6-66.6
Pollen fertility %	91.1	93.8	92.7	93.0	94.4	95.3	58.6-97.5	85.5-98.9	72.6-98.4	81.2-97.9	79.5-99.0	82.6-99.7
Seed set %	65.4	74.1	70.9	73.7	64.8	57.7	36.5-86.0	31.4-92.8	24.9-95.1	6.5-95.5	9.1-90.8	17.-79.0
500 seed weight (g)	15.8	15.1	14.5	14.7	13.6	14.2	11.6-20.0	11.7-18.9	8.4-19.1	7.8-18.2	9.2-18.1	10.0-18.3
No. of seeds/panicle	1747.5	1593.6	1782.9	1486.9	1146.3	581.2	861.9-3365.8	720.3-2252.2	753.4-2595.6	624.9-3136.1	569.7-1878.3	203.4-1076.8
Yield/panicle (g)	55.0	48.0	51.8	45.6	30.8	16.3	22.9-90.9	21.0-80.2	21.0-86.3	15.7-117.4	14.6-56.0	7.0-26.3

Table 2: Pooled ANOVA for stability of twelve quantitative characters in rabi sorghum in different dates of sowing

Source	df	Plant height	No. of leaves	Days to 50% flowering	Panicle weight	Panicle length	Panicle diameter	No. of primaries /panicle	Pollen fertility (%)	Seed set (%)	500 seed weight	No. of seeds/ panicle	Yield/ plant
Varieties	34	71.30**	4.21**	41.02**	87.50**	51.62**	9.79**	21.0**	91.94**	810.0**	18.50**	46.82**	75.68**
Environment	05	171.64**	12.65**	661.0**	1189.7**	355.5**	144.4**	208.16**	74.03**	1397.7**	18.86**	732.58**	767.25**
Variety × environment	170	1.98	0.39	11.82**	15.4**	3.55	2.67	5.59**	19.76	208.07**	2.76**	15.07**	13.54**
Environmental (linear)	1	858.24**	63.25**	3305.0**	5948.7**	1777.7**	722.4**	1040.86**	369.9**	6988.4**	94.37**	3662.91**	3836.2**
Variety × Environmental (linear)	34	4.2**	0.37	9.98	36.0**	6.38**	5.66**	11.36**	24.15**	165.7	4.09**	25.03**	27.03**
Pooled error	204	3.13	0.73	3.30	10.4	5.14	2.83	5.17	27.26	134.54	2.00	5.71	3.97
Pooled deviation	140	1.38	0.38**	11.92**	10.0**	2.76**	1.87**	4.02**	18.13**	212.4**	2.36**	12.22**	9.87**

* Siginificant at 5% level ** Significant at 1% level

Table 3—Stability of genotype for different characters

Genotype	Plant height	No. of leaves	Days to 50% flowering	Panicle weight	Panicle length	Panicle diameter	No. of primaries /panicle	Pollen fertility (%)	Seed set (%)	500 seed weight	No. of seeds/ panicle	Yield/ plant	Total score
401B										1			**1**
104B							1			1			**2**
296B													**0**
AKMS 14B													**0**
1409B									1		1		**2**
116B						1			1		1	1	**4**
M31-2B	1			1				1	1	1			**5**
BJMS-1B	1				1								**2**
BJMS-2B	1		1		1			1					**4**
ICSB-37					1	1							**2**
27B								1					**1**
101B					1			1	1				**3**
BRJ 204B	1							1					**2**
SPV-570	1							1					**2**
BRJ 62	1	1						1					**3**
R-354	1	1		1					1				**4**

Table contd…

Genotype	Plant height	No. of leaves	Days to 50% flowering	Panicle weight	Panicle length	Panicle diameter	No. of primaries /panicle	Pollen fertility (%)	Seed set (%)	500 seed weight	No. of seeds/ panicle	Yield/ plant	Total score
C-43													**0**
RS 29		1						1	1				**3**
AKR-150													**0**
RS 585	1	1	1					1					**4**
R-16	1	1											**2**
B-35													**0**
RSG-03123		1			1								**2**
BRJ-358	1	1						1		1			**4**
CSV 216R		1											**1**
DSV-5	1	1						1	1				**4**
DSV-4	1			1	1			1	1				**5**
M35-1	1	1	1		1			1			1	1	**7**
DSH-4	1	1	1	1	1	1	1	1	1	1	1		**11**
BRJ H 129	1	1		1	1				1	1			**6**
CSH-14								1					**1**
CSH-16		1		1	1	1	1						**5**
DSH-3				1	1	1							**3**
CSH 15R	1	1			1	1	1						**5**
CSH 19R	1	1			1		1						**4**
Total	**17**	**15**	**4**	**7**	**13**	**6**	**5**	**15**	**10**	**6**	**4**	**2**	