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Influence of dates of Sowing on Quality and Yield Potential in *Rabi* Sorghum Genotypes

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Abstract

Sorghum is predominantly grown under rainfed conditions, subjected to many biotic and abiotic stresses which are influenced by weather. Weather aberrations during crop growth and development results in drastic reduction in yield and quality. The time of sowing is one important decisive factor that has direct bearing on weather conditions, the crop encounter. Hence, the field experiment was conducted to evaluate the sorghum genotypes for cold tolerance under varied dates of sowing. The quality parameters such as seed germination, seedling shoot and root length, seedling dry weight and vigour index differed significantly with dates and genotypes. Standard germination (92.60 %), root length (15.22 cm), seedling vigour index (3,372) and seedling dry weight (15.94 mg) were observed significantly higher under the September 30th sowing compared to other dates of sowing. Among the genotypes significantly higher seed yield was recorded in genotype BJV-44 (1317 kg ha^{-1}) and 39th standard week recorded maximum seed yield (1378 kg ha^{-1}) followed by 41st (1212 kg ha^{-1}). The influence of temperature had a greater impact on seed yield in genotype BJV-44 i.e when lower temperature (29.60 °C) coincided with the reproductive phase. Reduced seed set per cent was observed under 52nd standard week (72.93%). However, temperature fluctuations (> 29.30/13.60 °C) favoured higher pollen fertility under delayed condition (S_6). The experiment suggested that, critical temperatures during the pre and post anthesis period of sorghum has a greater impact on seed set per cent and pollen fertility that contributes to the total grain yield in sorghum.

Keywords: Germination, *rabi* sorghum, Vigour index, Seed yield

1. Introduction

Sorghum is one of the main staple food for the world's poorest and most food insecured people across the semi-arid tropics. Globally sorghum is cultivated in 41 mha with a production and productivity of 64.20 mt and 1.60 t ha^{-1}, respectively. With exceptions in some regions, it is mainly produced and consumed by poor farmers. In India, sorghum is cultivated in an area about 5.65 mha with a total annual production of 4.41 mt and productivity of 780 kg ha^{-1}, while in Karnataka sorghum is grown in an area of 1.09 mha with the total productivity of 1.15 mt and productivity of 1,052 kg ha^{-1} (Agricultural statistics, 2016). In India, sorghum crop is being grown in two seasons viz; *kharif* (rainy) season as a rainfed crop while in *rabi* (post-rainy) season under residual soil moisture conditions. In general, the productivity levels are higher in kharif season as compared to *rabi* season. However, In Karnataka average area under *rabi* sorghum is 85%, average production is 81%. Lack of appropriate hybrids with acceptable grain quality adapted to different agro-ecological situations of *rabi* season characterized by terminal drought, low temperatures and biotic stresses like shoot fly infestation are the major constraints for higher productivity (Gite et al*.,* 2006). Therefore, there is a need for the development of varieties adapted to specific soil situation in *rabi* season to enhance production and productivity levels (Jirali et al*.,* 2007). Weather is one key important factor influencing the morphological and phenological traits of sorghum (Safari et al*.,* 2015). Under optimal conditions, sorghum has a high yields potential comparable to other cereals such as rice, maize or wheat (Mohamed, 2011). Variability among genotypes for seed setting behaviour and interaction of lower minimum temperature is observed in sorghum (Reddy et al., 2015). Hence, the study on seed setting behaviour across different temperature regimes helps in choosing a good, potential varieties or hybrid for cultivation. The cultivars like M 35-1, BJV-44 and parental lines of CSH 15-R (MS 104-B and RS-585) are sown in 6 dates with an interval of 10 days from 10th September to 30th October to know the effect of temperature regimes on seed yield and quality traits in *rabi* sorghum, the present study was undertaken.

2. Materials and Methods

The present field experiment was conducted during *rabi*

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2016-17 at Main Agricultural Research Station (MARS), UAS Dharwad, which is situated at 15012' N latitude and 76034'E longitude with an altitude of 678 above msl. The experimental site consisted of medium deep black soil. The sowing dates were represented in Standard Meteorological Week (SMW). The six dates of sowing was undertaken to create a different temperature regimes (S_1-Sowing on 10th of September (37th SMW), S_2-Sowing on 20th of September (38th SMW), S_3-Sowing on 30th of September (39th SMW), S_4- Sowing on 10th of October (41st SMW), S_5-Sowing on 20th of October (42nd SMW), S_6-Sowing on 30th of October (44th SMW). The crop was raised with a spacing of 45×15 cm^2, fertilized with 50:20:0 $N:P_2O_5:K_2O$. The T_{max} and T_{min} along with rainfall and humidity was recorded from the meteorological station UAS, Dharwad (Figure 1). The observation on seed yield, quality parameters such as, seedling shoot and root length, seedling dry weight and seedling vigor index were recorded on the 10th day of standard germination test.

3. Results and Discussion

3.1. Quality parameters

Good quality seed is a pre requisite for higher productivity of crop and it plays an important role in seed production of crop plants. Losses in seed viability and vigour do occur depending upon various factors viz., genetic makeup of the seed material, harvesting stage of seed, environmental conditions at harvesting time and seed size. The mean estimates of the standard germination (92.60%), root length (15.22 cm), seedling vigour index (3,372) and seedling dry weight (15.94 mg) were observed superior under the September 30th sowing having bold seeds with higher test weight than the seed obtained from other sowings (Table 1). The superior performance of the crop sown on September 30th than later sowings in respect of seed quality attributes may be due to favourable environmental condition particularly temperature to which the crop was subjected during vegetative growth,

Table 1: Effect of dates of sowing on seed yield and quality aspects in sorghum genotypes

Treatment	Seed germination (%)	Shoot length (cm)	Root length (cm)	Seedling vigour index	Seedling dry weight (mg 10 seedlings^{-1})	Seed yield (kg ha^{-1})
Dates of sowing (D)						
37th SMW (D_1)	91.77	21.90	14.3	3324	15.3	1115
38th SMW (D_2)	91.46	21.97	14.54	3341	15.36	1160
39th SMW (D_3)	92.60	21.19	15.22	3372	15.94	1378
41st SMW (D_4)	91.93	20.35	14.83	3234	15.85	1212
42nd SMW (D_5)	90.72	20.59	14.49	3183	15.23	1063
44th SMW (D_6)	87.08	21.15	14.13	3072	15.09	860
SEm±	2.03	0.21	0.18	30.82	0.18	50.29
CD (p=0.05)	0.53	0.67	0.58	97.12	0.55	158.4
Varieties (V)						
M 35-1 (V_1)	92.29	20.45	14.13	3202	15.35	1169
MS 104-B (V_2)	90.55	22.06	14.63	3314	15.33	996
RS-585 (V_3)	87.70	20.24	14.84	3076	15.49	1043
BJV-44 (V_4)	93.17	22.02	14.74	3426	15.67	1317
SEm±	0.53	0.39	0.11	40.05	0.09	30.16
CD (p=0.05)	1.53	1.12	0.32	114.9	0.25	86.5
Interactions						
D_1V_1	92.53	22.07	13.89	3328	15.33	1060
D_1V_2	91.53	22.05	14.61	3356	15.19	1029
D_1V_3	88.13	20.24	14.47	3059	15.36	1043
D_1V_4	94.86	23.23	14.24	3553	15.34	1329
D_2V_1	93.26	21.61	14.52	3369	15.21	1187
D_2V_2	91.00	22.88	14.33	3387	15.03	1026
D_2V_3	87.33	21.01	14.69	3118	15.24	1119
D_2V_4	94.26	22.40	14.63	3490	15.95	1306

Continue...

Treatment	Seed germination (%)	Shoot length (cm)	Root length (cm)	Seedling vigour index	Seedling dry weight (mg 10 seedlings^{-1})	Seed yield (kg ha^{-1})
D_3V_1	92.72	19.95	14.37	3182	15.95	1358
D_3V_2	92.01	22.40	15.34	3473	15.66	1355
D_3V_3	90.73	20.69	15.65	3298	15.9	1292
D_3V_4	94.94	21.71	15.52	3535	16.23	1508
D_4V_1	92.33	19.47	14.57	3145	15.54	1163
D_4V_2	91.40	21.71	14.86	3341	15.92	1076
D_4V_3	89.33	19.21	14.99	3051	16.11	1293
D_4V_4	94.65	21.00	14.90	3399	15.82	1317
D_5V_1	92.20	20.58	13.84	3174	15.15	1206
D_5V_2	92.00	22.68	14.39	3411	15.02	861
D_5V_3	88.33	18.42	15.41	2987	15.35	855
D_5V_4	90.33	20.68	14.31	3162	15.40	1327
D_6V_1	90.67	18.99	13.56	3017	14.93	1041
D_6V_2	85.33	20.61	14.26	2916	15.16	630
D_6V_3	82.33	21.87	13.85	2940	14.99	652
D_6V_4	89.99	23.13	14.86	3417	15.27	1117
SEm±	1.31	0.95	0.27	98.1	0.21	73.87
CD (p=0.05)	NS	NS	NS	NS	NS	211.9

flowering, seed setting and seed maturity. Similar findings were reported by Palanisamy and Ramasamy (2001) who noticed significant and positive correlation of temperature with number of flower, fruits plant^{-1}, seed germination and seedling vigour. Among the varieties the mean values for higher seed germination (93.17%) and seedling vigour index (3,426) and seedling dry weight (15.67 mg) was observed in BJV-44, however higher root length was recorded in RS-585 (14.84 cm) and was on par with BJV-44 (14.74 cm) and highest shoot length was found in MS 104-B (22.06 cm) which was also found on par with BJV-44 (22.02 cm). The variation between the varieties might be due to variation in expression of characters fully in the favourable environmental conditions reported by Mohankumar et al. (2013); Rayhan et al. (2016).

Among the interactions, higher germination (94.94%) and seedling dry weight (16.23 mg) was found under S_3V_4 combination. The higher yield and seed quality parameters might be due to optimum temperature in early sown crop which was beneficial for the early establishment of crop and subsequent proper growth, resulting in producing more height, foliage and higher number of seeds panicle^{-1} and seed weight which ultimately resulted in higher yield and seed quality and full expression of the varietal characters during favourable conditions, which existed during early sown crops. These results are also in conformity with Samarah et al. 2006 in barley, reported that yield and yield components were improved by early planting date as compared with late planting date.

Thus, the present study confirmed that, the crop environment that gives higher seed yield also produces seed lot with high germination and vigour index. Variation in seed germination and vigour due to variation in sowing date has also been reported by earlier workers (Rahman et al., 2005; Rahman et al., 2013). The variation in seed germination and vigour comes from the environmental conditions that the crop experiences during the seed development and maturation. Seed germination and vigor rapidly decreased in seeds exposed to adverse environmental conditions, when parental plants are exposed to high temperature during growth and development the quality of seed is highly influenced in wheat (Hasan et al., 2013); Hampton et al. (2005) also reported that higher individual seed weight might have been related to higher germination of the crop. The seed lot showing higher seedling vigour index is considered to be more vigorous and a decreased vigour index was observed with delayed sowing in rabi soybean (Rahman et al., 2013). The results are also in agreement with the findings of Ayyub et al. (2007) who reported that physiologically matured seeds exhibited better viability and seed quality.

3.2. Yield and reproductive efficiency

Among the genotypes BJV-44 recorded significantly higher seed yield (1,317 kg ha^{-1}) compared to rest of the genotypes. Among the date of sowing September 30th sowing recorded significantly higher seed yield (1,378 kg ha^{-1}) compared to rest of the treatments. Whereas, late sowing during 30th

October recorded significantly lower seed yield (840.6 kg ha^{-1}). This is probably due to early sown crop enjoy favourable climatic conditions in terms of temperature and other climatic parameters during various crop growth stages, which reflected in better growth. The significant grain production is ascribed to favourable temperatures at different growth stages, which may increase photosynthetic rate, assimilates the supply for seed growth rate with early sown crops than in late sown crop (Aslani and Mehrvar, 2012). The improvement in grain yield to an extent of 997.2 to 1,317 kg ha^{-1} was due to greater genetic ability of variety to translocate the photosynthates to economic part. Crop yield depends not only on the accumulation of photosynthates during the crop growth and development, but also on it's translocation in the desired storage organs. These inturn, are influenced by the efficiency of metabolic processes within the plant (Verma et al., 2012). Interaction effects revealed that genotype BJV-44 planted during 30th of September recorded significantly higher seed yield (1,508 kg ha^{-1}) as compared to rest of the interactions. Under 48th SMW maximum temperature (31.40 °C) coincided with the reproductive phase in genotype BJV-44 (Table 2). This resulted in increased pollen fertility (89.10). However, this temperature favoured higher seed set per cent (81.13%) compared to other dates of sowing. Further, under delayed sowing (52nd SMW) lower temperature (Figure 1) was recorded (11.80 °C) which influenced on the seed sitting per cent (72.93%). This indicated that, seed setting per cent depends on the range of maximum and minimum temperature over the reproductive phase of flowering. Under delayed sowing reduced pollen fertility was recorded (73.10%). This results indicated that critical temperatures during the pre and post anthesis period of sorghum has a greater impact on seed set per cent and pollen fertility that contributes to the total grain yield in sorghum.

Table 2: Seed set per cent and pollen fertility per cent of genotype BJV-44 under six sowing dates

Variety	Flowering week (SMW)	Max. Temp (°C)	Min. Temp (°C)	Seed set per cent	Pollen fertility per cent
BJV-44	46th SMW	31.00	17.50	79.13	79.72
	47th SMW	30.10	13.10	78.13	78.68
	48th SMW	31.40	13.10	81.13	89.10
	49th SMW	29.60	15.60	78.73	88.29
	52nd SMW	30.50	11.80	72.93	73.10
	2nd SMW	29.60	13.60	78.33	90.18

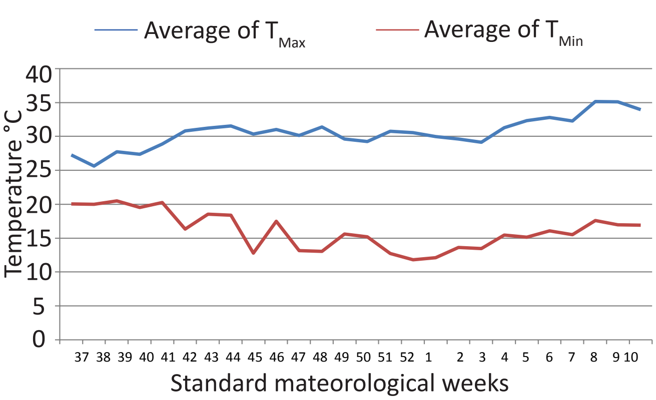

Figure 1: Weekly meteorological data of Minimum and maximum temperature (0C) for the crop growing period 2016-17

4. Conclusion

Among all the sowing dates and genotypes, sowing during September 30th (S_3) was optimum and the genotype BJV-44 (V_4) was found good for getting higher yield and quality in *rabi* sorghum under northern transition zone.

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