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RESEARCH PAPER

Mutagenic effect of EMS on seedling survival, yield and yield components in M_1 generation of *Rabi* sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract: Lack of genetic variability is the main reason for stagnation in *rabi* sorghum improvement. Under such situation induced mutagenesis is one of the best approach for induction of genetic variability. Therefore, an investigation was carried out in *rabi* sorghum to study the effect of chemical mutagen (EMS) on seedling survival in M_1 generation. Seeds of four *rabi* sorghum varities *viz*, M 35-1 (popular variety), SbABM (an axillary branched mutant), CSV29R and SPV2217 were subjected to mutagenic treatments using EMS (0.1%, 0.2% and 0.3). In all the four varieties in M_1 generation, 0.3% EMS showed reduction in seedling and plant survival. Germination percentage redution was noticed in SbABM and CSV 29R. Reduction in vigour index and high percentage of sterile plants was observed in all EMS treatments across four varieties.

Key words: Cereal, Mutagen, Sorghum, Survivability, Vigour

Introducation

Sorghum [*Sorghum bicolor* (L.) Moench] is an important cereal crop in India. It is popularly known as 'Jowar' and called as 'Great millet' due to its large size among other grain millets. It is one of the important dryland crop grown in marginal soils and a source of fodder, biofuel and food. Its easy adaptability to hot and dry agro ecology makes it a climate change-compliant crop. It is the fifth most important cereal crop in the world and third important cereal in India.

Globally, sorghum is cultivated over an area of 40.28 million ha with an annual production of 57.72 million metric tonnes of grains with a productivity of 1.43 metric tonnes ha^{-1}. In India, it is cultivated over an area of 4.66 million ha with an annual production of 4.63 million metric tonnes of grain with a productivity of 1.00 metric tonnes ha^{-1} (USDA, 2020). In Karnataka, it is cultivated over an area of 0.948 million ha with an annual production of 0.846 million tonnes of grain with a productivity of 892 kg ha^{-1} (Anon., 2017).

Mutation breeding has played a productive role in sustainable agriculture, as it is a supplementary approach for crop improvement which increases unselected genetic variability for practical breeding application. Induced mutagenesis can be profitably employed as a complementary breeding procedure. It is directed to improve yield and other quantitative characters and specific defects in adapted varieties and to create new genetic variability. The widespread use of induced mutants in plant breeding programmes throughout the world has led to the official release of more than 2,700 plant mutant varieties (Shu, 2009). For sorghum, only 15 mutant varieties have been released (FAOSTAT, 2008). Both physical and chemical mutagens have been employed in different crops to generate the desired variability. A desired mutation can be recovered in a homozygous stage as early as in the M_2 or M_3 generation as compared with F_6 or F_7 in the case of hybridization. Very few studies have been conducted in *Rabi* sorghum on effect of mutagens on yield traits. Therefore, an investigation was carried out to study the mutagenic effect of EMS on seedling survival, yield and yield components in M_1 generation of *Rabi* sorghum.

Material and methods

The experiment on study on mutagenic effect of EMS on seedling survival, yield and yield components in M_1 generation of *Rabi* sorghum was conducted at Regional Agricultural Research Station, Vijayapura, during *Summer* season 2018-2019. Four sorghum varieties namely M 35-1 (popular variety), SbABM (an axillary branched mutant), CSV-29R and SPV2217 were subjected to EMS treatments (EMS- 0.1%, 0.2%, 0.3%). Initially the seeds were soaked with distilled water then washed under tap water and dried. For each concentration of EMS the seeds were treated for 6h with constant intermittent shaking. Treated seeds were then rinsed thoroughly under running tap water and surface-dried with filter paper for immediate sowing in the field. Treated seeds along with control were sown separately for each genotype on 14.01.2019 at AICRP (Sorghum), RARS, Vijayapur. The observations recorded were seed germination, vigour index and number of plants survived at maturity and sterile plants at seedling stage, and yield parameters at maturity *viz*., days to 50% flowering, plant height (cm), panicle length (cm), panicle breadth (cm), panicle weight (g), grain weight (g/pl) and panicle harvest index (%).

Results and discussion

Mutagenic effect on seedling survival

Effectiveness of mutagens on different varieties subjected to treatment with EMS dosages (0.1%, 0.2% and 0.3%) revealed that reduction in seedling survival in terms of germination (%), vigour index, plant survival (%) was observed in all EMS dosages with highest in 0.3% EMS. There fore, 0.1% and 0.2% EMS dosages may be considered as effective dosages for

Table 1. Effectiveness of EMS mutagen on different varieties of *Rabi* sorghum as compared to untreated (control)in percentage

Variety	Germination %	Vigour index	Plant survival (No./plot)	Sterile plants (%)
M 35-1				
0.10 %	-10.0	-87.6	26.3	36.3
0.20 %	-26.0	-38.8	-29.8	42.5
0.30 %	-62.0	-76.7	-59.7	58.3
SbABM				
0.10 %	-56.0	-24.8	-14.3	2.5
0.20 %	-58.0	-34.4	-33.8	11.4
0.30 %	-64.0	-70.8	-61.0	26.2
CSV 29R				
0.10 %	-48.0	-39.3	0.0	9.1
0.20 %	-36.0	-34.3	-40.0	36.4
0.30 %	-76.0	-82.2	-60.0	13.6
SPV2217				
0.10 %	-42.0	-53.1	-12.8	1.5
0.20 %	-48.0	-55.7	-42.3	5.0
0.30 %	-57.0	-80.6	-64.1	1.9

inducing viable mutations. Seedling characters decreased at 0.3% in both parents and hybrids, however less reduction in hybrid was earlier reported in sorghum by Sarada Mani (1989) indicating effectiveness was dose dependent among genotyepes. Suthakar *et al.* (2014) also reported that survival percentage and mean value of M_1 generation were found decreased with increasing doses/conc. of treatment. Malinovskii *et al.* (1975) observed M_1 plants depending on mutagen and concentration. The results on effectiveness of mutagens on different varieties for seedling survival (% control) in M_1 generation subjected to EMS are summarized in Table 1.

Mutagenic effect on yield parameters

The results on effectiveness of mutagen on different varieties for yield parameters (% control) in M_1 generation subjected to EMS (dosage wise) are summarized in Table 2. In general desired effect on various yield parameters due to EMS treatment was low. Maximum reduction in mean values of yield traits was noticed for the dosage 0.3% except for days to 50% flowering. The increasing concentration of EMS, DES and Sodium azide decreased in phenotypic and yield characters studied in maize have been attributed to the physiological difference or chromosomal anomalies caused to the cells of the plant by the mutagen (Gnanamurthy *et al*., 2012).

None of the EMS treatment dosages reduced the mean flowering time across the varieties. As the dose increased, the days to flowering has increased. Highest dose/concentrations were showed a significant variation in days to first flowering. This was supported by the earlier report of Singh ansd Singh (2001) and Deepalakshmi and Anandakumar (2004). Similar inhibitory effects in quantitative characters have been reported by other workers [Kajjidoni *et al*., 2009) and Kharkwal, 1998)] in Sorghum. In M 35-1, 0.1% EMS increased panicle breadth and plant height and 0.2% increased panicle length. In CSV 29R, increased mean values for plant height, panicle weight, grain weight and panicle harvest index were noticed due to 0.1% EMS. In SPV 2217, it was observed that all the dosages of EMS resulted high mean values for panicle harvest index with highest in 0.1%. Suthakar and Mullainathan (2015) reported more yield in Sorghum with EMS treatment (40 mM) compared to control and gamma rays treatments. Induced mutation studies in M_2 and M_3 generation on yield and yield contributing traits in *Rabi* sorghum were conducted and results indicated relatively higher mean performance in M_2 and M_3 families of EMS (0.2%) doses for most of the characters studied (Preeti, 2017).

Conclusion

Mutagenic treatments with EMS dosages revealed that reduction in seedling survival was observed in all EMS dosages with highest in 0.3% EMS. Hence, 0.1% and 0.2% EMS dosages may be considered as effective dosages for inducing viable mutations. The data obtained on yield and yield components in M_1 generation of each variety was revealed that for days to 50% flowering, none of the EMS dosages reduced the flowering time. Similarly, none of the EMS dosages significantly reduced plant height across different varieties. Frequency of plants with early flowering and reduced height was low across varieties. Effect of EMS dosages on yield was varied among genotypes with increased values obtained in one variety CSV 29R at 0.1%.

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Table 2. Effectiveness of EMS doses on different varieties of *Rabi* sorghum for yield traits (% control) in M_1 generation.

Traits	M 35-1			SbABM			CSV 29R			SPV2217		
	0.10%	0.20%	0.30%	0.10%	0.20%	0.30%	0.10%	0.20%	0.30%	0.10%	0.20%	0.30%
Panicle length (cm)	-2.74	7.74	-5.08	-9.74	-9.51	4.87	-10.59	-29.41	-5.88	-1.17	-8.69	4.09
Panicle breadth (cm)	1.85	-5.19	-34.14	-7.24	-6.84	-24.34	-12.73	-51.52	-3.03	-9.51	-9.19	-1.18
Plant height (cm)	0.94	-1.39	-13.51	-12.1	-17.54	-0.6	2.73	3.49	-12.37	15.46	-3.97	1.39
Days to 50% flowering	1.35	1.35	2.7	2.78	2.78	6.94	1.32	7.89	11.84	2.7	2.7	8.11
Panicle weight (g)	-37.95	-51.65	-78.77	-36.01	-59.15	-61.57	1.67	-75	-20.83	-42.32	-46.92	-49.62
Grain weight (g/plant)	-57.08	-66.49	-100	-52.01	-89.66	-100	68.89	-100	-83.33	-23.1	-34.92	-37.64
Panicle Harvest Index (%)	-10.03	-40.11	-100	-16.63	-76.1	-100	51.56	-100	-69.55	82.21	34.87	14.71

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