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INDUCED VARIABILITY FOR FLOWERING, SEED WEIGHT AND OIL CONTENT IN PARENTAL LINES OF SUNFLOWER HYBRID BSH–1

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ABSTRACT

Chemical and physical mutagens were employed in parental lines of sunflower hybrid BSH-1 to bring about synchronous flowering, to improve test weight and oil content. The mutagenic treatments significantly enlarged variability for days to flowering, test weight, and oil content in M_2 and M_3 generations of the parental lines HA-234 and RHA-274. Early and late flowering mutants were isolated in these lines. In all mutagenic treatments, the mean test weight shifted in positive direction. The chemical EMS was more effective than gamma rays in creating a wider range for test weight. The variability generated for oil content in the parental lines provided scope for selection of high-oil mutants. The utility of the improved lines isolated in breeding has been discussed.

Key words: Sunflower, mutagenesis, flowering, seed weight, oil content.

Mutation breeding has come to stay as a potential tool for the rectification of one or two defects in the established commercial varieties/lines/hybrids and/or for the release of polygenic variability. The development and release of the first sunflower hybrid in 1980 in our country marked the beginning of hybrid sunflower cultivation [1]. However, the parental lines of the BSH-1 hybrid sunflower suffered from asynchronous flowering, low test weight and low oil content. Improvement in these traits will be helpful not only in hybrid seed production but also in obtaining higher seed yield and oil recovery from the reconstituted hybrid. In the present study, an attempt has been made to correct the above deficiencies without altering much the background genotype of the parental lines through mutagenesis.

MATERIALS AND METHODS

Dry seeds of HA-234 (maintainer line of CMS-234) and RHA-274 (male parent of BSH-1 sunflower hybrid) were initially brought to 9.0% seed moisture. One hundred well filled seeds in each line, presoaked in water for 6 h, were treated with 0.1, 0.2, 0.3 and 0.4% aqueous solution of EMS for 8 h at room temperature with intermittent shaking. The treated seeds were washed in water. The seeds soaked in plain water served as control. The physical mutagen was

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employed only in RHA-274. Gamma irradiation with 5, 10 and 15 kR doses was done in $^{60}C0$ gamma cell at the Indian Horticultural Research Institute, Bangalore. To raise M_1 generation, all the treated and control seeds were sown in field. Germination was poor in RHA-274 with 0.4% EMS and 15 kR gamma-ray treatments, hence these two treatments were not considered for further study. The seeds collected from each selfed M_1 plant were planted in unreplicated progeny rows to raise M_2 generation during rainy season of 1984. The selfed individual variants isolated in M_2 generation for days to flowering, 100-seed weight and oil content were advanced to M_3 generation in rainy season of 1985, and the promising M_3 selections were evaluated in M_4 generation during summer 1986. Oil content was estimated on dry seed basis using minispec NMR spectrometer, 20 pi model.

RESULTS

The range, mean and standard deviation in M_2 and M_3 generations for days to flowering, 100-seed weight and oil content are presented in Tables 1 and 2. There was appreciable increase in range and SD for days to flowering in M_2 and M_3 generations in both HA-234 and RHA-274 (Table 1). In M_2 and M_3 generations of HA-234, very early flowering lines were noticed. Treatment with 5 and 10 kR gamma rays was more effective in enlarging

Table 1. Range, mean and standard deviation (SD) for days to flowering in M_2 and M_3 generations of HA-234 and RHA-274

Mutagen	Dose	M_2 generation			M_3 generation		
		range	mean	SD	range	mean	SD
			HA-234				
EMS	0.2%	53–70	59	3.9	56–68	60	2.52
	0.3%	52–70	62	4.9	53–66	59	2.81
	0.4%	53–72	60	3.9	54–68	60	3.05
Control		61–70	66	3.6	59–68	61	2.38
			RHA-274				
EMS	0.2%	49–59	55	3.5	47–64	58	2.9
	0.3%	45–59	56	3.8	50–66	59	2.6
Gamma rays	5 kR	49–63	57	2.8	48–68	59	2.9
	10 kR	51–65	57	2.7	53–68	60	3.6
Control		53–59	58	2.1	54–60	59	2.0

the range for days to flowering in RHA-274. For instance, in M_3 generation of 5 kR treatment, the range increased to 48-68 days from 54-60 days in the control. The comparison of mean values in different treatments with control showed a general trend of lower mean in M_2 generation, while in M_3 generation the mean values were almost at par with control.

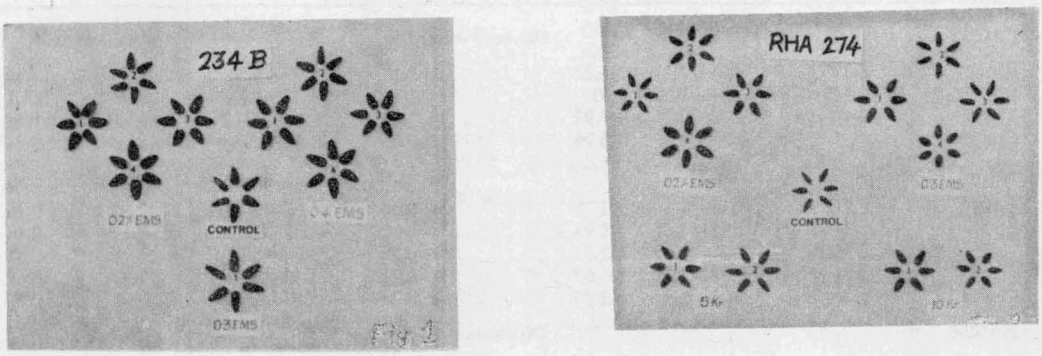

Fig 1. Seed size variation in M_3 generation of some selected mutant lines of 234 B (HA-234) and RH A-274.

As in the case of days to flowering, the mutagenic treatments had a significant effect on test weight of both HA-234 and RHA-274 (Fig. 1, Table 2). A wide range in negative as well as positive directions was recorded in M_2 and M_3 generations. RHA-274 showed differential response to EMS treatments with wider range than gamma rays. It is of interest to note that the mean test weight was apparently higher in all the mutagenic treatments than in the control in both M_2 and M_3 generations.

Oil content showed wide variability in both positive and negative directions in M_2 and M_3 generations (Table 2). In M_3 generation, the range was from 20.1% (0.2% EMS) to 43.5% (0.4% EMS) for HA-234 as against 29.0%– 39.8% recorded in the control, while for RHA-274 it was from 21.2% (0.3% EMS) to 42.6% (0.3% EMS) compared to 27.5%– 36.2% in the control. Although, most mutagenic treatments enlarged the variance, the mean either shifted in negative direction or did not change appreciably.

Table 2. Range, mean and standard deviation (SD) for 100-seed weight and oil content in M_2 and M_3 generations of HA-234 and RHA-274

Treatment	Dose	M_2 generation			M_3 generation		
		range	mean	SD	range	mean	SD
HA-234			**100-seed weight (g)**				
EMS	0.2%	2.16–7.34	4.22	1.18	4.05–9.36	7.70	1.35
	0.3%	2.14–10.14	4.30	1.42	6.03–8.89	6.96	1.01
	0.4%	1.78–7.2	8 4.92	1.24	6.0–9.18	7.11	1.28
Control		3.34–4.8	0 3.94	0.66	3.6–5.10	4.09	0.71
RHA-274							
EMS	0.2%	1.38–4.4	5 1.77	0.50	1.61–5.12	2.88	0.76
	0.3%	1.31–4.65	1.93	0.99	1.52–2.84	2.37	0.48
Gamma rays:	5 kR	1.05–2.6	2 1.71	0.39	1.79–3.72	2.78	0.62
	10 kR	1.07–2.7	4 1.62	0.35	1.43–3.72	2.37	0.63
Control		1.28–1.9	0 1.54	0.28	1.73–1.90	1.81	0.10
HA-234			**Oil content (%)**				
EMS	0.2%	23.9–42.6	32.3	5.1	20.1–41.2	35.0	3.8
	0.3%	24.2–40.3	32.5	4.1	27.5–42.8	35.3	4.1
	0.4%	23.5–42.1	34.4	4.3	20.2–43.5	34.6	4.2
Control		32.0–39.2	37.2	3.3	29.0–39.8	34.5	3.2
RHA-274							
EMS	0.2%	23.1–42.3	33.2	3.3	21.6–41.8	31.8	4.0
	0.3%	24.6–43.3	32.5	4.8	21.2–42.6	32.2	4.8
Gamma rays	5 kR	23.6–38.9	31.3	2.3	30.3–41.9	32.8	4.8
	10 kR	24.6–44.2	33.2	3.9	27.9–42.3	35.1	3.8
Control		29.8–38.2	35.1	3.4	27.5–36.2	31.9	4.7

The selections made in M_3 generation of HA-234 and RHA-274 were advanced to M_4 generation and evaluated for days to flowering, 100-seed weight, and oil content (Table 3). A few selections exceeded in seed weight and oil content over the respective untreated HA-234 and RHA-274 populations.

Table 3. Performance of selected M_3 lines in M_4 generation

Mutant	Days to flowering	100-seed weight (g)	Oil (%)
	HA-234		
A2-27	60	5.44	35.7
A2-33	58	6.85	34.6
A2-47	57	6.02	36.2
A2-48	54	6.43	35.4
A3-42	55	4.76	36.2
A4-13	55	5.09	34.9
A4-50	58	5.21	33.8
Control	62	5.37	34.6
	RHA-274		
R2-2	60	2.40	37.4
R2-9	56	3.00	36.4
R2-11	54	2.08	29.3
R3-5	57	2.86	37.6
R3-6	58	2.08	37.9
R3-14	57	2.84	35.8
R3-18	60	2.71	32.8
R5-13	53	2.66	30.4
R5-15	55	3.32	33.0
R5-27	55	2.28	33.2
R10-14	57	2.75	31.8
R10-51	57	2.56	35.7
Control	55	2.28	33.8

DISCUSSION

Conventional breeding methods usually require more time when more than one economic character is to be improved in an agronomically desirable genotype. Under such situation, mutation breeding serves as a viable alternative and there are many reports of such improvements in oilseed crops [2–6]. The present study has also shown that it is possible to correct deficiencies in parental lines of sunflower hybrid BSH-1 for three attributes, viz. synchronous flowering, test weight and oil content.

The mutagenic treatments had significant effect on variability for days to flowering in M_2 and M_3 generations of HA-234 and RHA-274 (Table 1). Early as well as late flowering mutants were isolated. Although mean flowering time of the irradiated population did not alter significantly, the enlarged variance offered much scope for selecting early/late flowering lines in HA-234 and RHA-274.

Synchronous flowering in parental lines could be achieved either by increasing the duration of flowering in male parent (RHA-274) or by reducing the flowering duration in the female parent (HA-234). However, the latter approach is time consuming as the earliness of

the HA-234 mutants has to be incorporated in the female parent (CMS-234 A) by back-crossing. Hence, the late flowering mutant lines isolated in RHA-274 will be of direct use.

Test weight is one of the important yield components. This is more so in the present study, where the male parent has very small seeds with the 100-seed weight ranging from 1.54–2.28 g. This naturally results in considerable processing loss of quality hybrid seed. Besides, increase in test weight of the parental lines will be reflected in yield improvement of the reconstituted hybrid.

Higher variability and shift in mean towards positive direction in M_1 and M_3 of all mutagenic treatments of both parental lines resulted in identification of high test weight mutants (Fig. 1, Table 2). For this, the EMS treatments were more potent than gamma rays in inducing variability and influencing test weight. For instance, in M_3 generation of RHA-274, the mean 100-seed weight of chemically induced mutants ranged from 1.52–5.12 g, as against the range of 1.43 – 3.72 g recorded with the physical mutagen.

Several workers have succeeded in upgrading oil content by resorting to mutagenesis. The present study has also shown that the enlarged variability created for oil content (Table 2) in HA-234 and RHA-274 does provide good scope for isolating high oil lines. Varanceanu and Stoenescu [7] likewise reported increased variation for oil content in mutant lines of sunflower.

A few selections made in M_3 generation of HA-234 and RHA-274 based on flowering duration were further evaluated in progeny rows for days to flowering, 100-seed weight and oil content in M_4 generation (Table 3). In HA-234, the range of flowering time in the selected mutants was 54–60 days, which was quite close to that of RHA-274 (53–60 days), indicating the possibility of identifying synchronous lines. For instance, A2-27 with R2-2/R3-18, A2-47 with R3-5/R3-14/R10-14/R-10-51 may be considered for synchronous flowering. Many selections of HA-234 and RHA-274 surpassed their respective parent for seed weight and oil content.

Increase in test weight may be either due to higher kernel or husk content. In sunflower, negative relationship between husk and oil content has been established. In many mutants isolated in this study, both test weight and oil content increased significantly. This indirectly suggests lower husk content, higher kernel and oil content, or combinations of all three components. In M_4 generation, the lines A2-33, A2-47, A2-48 in HA-234, and R2-2, R2-9, R3-5, R3-6, R10-51 in RHA-274 possess higher test weight as well as oil content. The general and specific combining abilities of these selected mutant lines are being studied.

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