

Original Research Article

Identification of Autogamous and Self-fertile lines in Sunflower (*Helianthus annuus* L.) over seasons.

ABSTRACT

This study investigated the autogamy and self-fertility percentage in sunflower (*Helianthus annuus* L.) across two distinct cropping seasons. Through the examination of 46 genotypes, the research aims to determine the effects of seasonal variations on seed set, autogamy and self-fertility across different sunflower genotypes during the Kharif and Rabi seasons. The study compared three modes of pollination: self-pollination (SP), self-pollination plus manual (S+M) pollination and open pollination (OP). Results indicated that the Rabi season favoured higher seed set and better seed filling compared to the Kharif season. The study revealed that the Rabi season's cooler temperatures, higher humidity and reduced solar radiation positively influenced seed yield and quality. In contrast, Kharif season conditions, particularly the monsoon, led to reduced seed yield and fewer filled seeds due to factors like higher pollen movement and lower humidity inside pollination bags. The autogamy and self-fertility percentages during Rabi were higher at 79.01 percent and 85.01 percent, respectively. Genotypes PB-892, EC-198072 and PB-1444 showed the highest seed set under S+M pollination during Kharif, while CMS-107B, PB-1212 and CMS-47B excelled in SP. Across both seasons, EC-198078, EC-178168 and GMU-770 were identified as highly self-fertile, making them valuable for developing self-fertile hybrids and enhancing population development.

Keywords: [Sunflower, autogamy, self-fertility, genotypes, seasonal variation]

1. INTRODUCTION

Oilseed crops hold a significant position in the agricultural economy, following food grains. Among these, Sunflower (*Helianthus annuus* L., $2n = 34$) stands out as a prominent oilseed crop globally, including India. Belonging to the family Asteraceae, tribe Heliantheae and sub-tribe Helianthae. Sunflower originated in North America. It ranks as the fourth most important oilseed crop worldwide, trailing behind soybean, groundnut and rapeseed, as extensively noted by Shamshad et al. (2016) and Yamgar et al. (2018). Its cultivation spans numerous countries, including Russia, Ukraine, Argentina, China, Myanmar, Spain, Kazakhstan, France and India.

Poor seed set represents a significant constraint in sunflower productivity. While various factors such as physiological, genetic, nutritional and environmental interactions influences seed filling, it has been determined that the ultimate seed set is largely dependent on the population of pollinators in the surrounding area, given that sunflower is primarily a cross-pollinated crop (Seetharam, 1982). Moreover, sunflower exhibits sporophytic self-incompatibility (Srivastava, 1998), necessitating alternative pollination methods to overcome this constraint. In breeding programmes aimed at heterosis, the development of inbred lines with high self-fertility is desirable, as it positively impacts hybrid performance

The ability of sunflower genotypes to self-pollinate, known as autogamy, plays a crucial role in the crop's reproductive success and yield stability. Autogamy and self fertility are particularly important in sunflower breeding programmes, whereas self-fertility is a desirable trait. However, environmental factors such as seasonal variation can significantly impact self fertility rates. This study aims to assess the autogamy and self fertility of various sunflower genotypes over two cropping seasons, providing insights into their stability and potential for breeding programmes.

2. MATERIAL AND METHODS

The aim of the study was to determine how seasonal variations affected autogamy and self-fertility in sunflower genotypes over the course of two separate growing seasons, Kharif and Rabi. There were forty-six different genotypes of sunflowers in the current study. Ten inbred lines, eleven CMS lines, seven restorer lines, seven population lines, seven germplasm lines and four checks were among the genotypes obtained from Oilseeds Research Station, Latur. These genotypes provided a broad genetic base for the investigation.

Two replications of each genotype were conducted in the Randomised Block Design (RBD) experimental design. Every genotype was sown in three rows, each row being 4.5 meters long and separated by 60 centimetres whereas plant within a row was separated by 30 centimetres. Two to three seeds were planted per hill and 15 days after sowing, the plant density was adjusted by thinning. Fifteen plants were randomly chosen for each treatment and replication. Five of these were covered with cloth bags as soon as the ray florets appeared, five more were covered and then manually pollinated by gently rubbing heads against the florets and the other five were left to be pollinated in the open. We used the George and Shain (1980) methods to determine seed set percentage, autogamy and self-fertility.

To assess the influence of different pollination methods on autogamy and self-fertility, the study incorporated three distinct modes of pollination:

1. **Self-Pollination (SP):** Self-pollination was facilitated by bagging individual flower heads before anthesis to prevent any foreign pollen from entering. This method aimed to

determine the intrinsic ability of each genotype to self-pollinate without the assistance of external pollinators.

2. **Self + Manual Pollination (S+M):** Sunflower heads were bagged with cloth bags prior to flowering. During flowering, the heads were rubbed through the bags on alternate days to guarantee self-pollination. The cloth bags stayed on the sunflower heads until harvest. This method was used to ensure that pollen from the same flower or plant reached the stigma, stimulating self fertility under controlled conditions and eliminating any potential barriers to pollen transfer.

3. **Open Pollination (OP):** In this mode, plants were left to naturally receive pollen from surrounding plants, allowing for cross-pollination. This method provided a baseline for comparing the natural reproductive success of the genotypes under typical field conditions

The percentage of seed set in the self-pollinated heads was used to assess autogamy. It is determined by the ratio of seeds set under autogamous pollination to those under open pollination.

By analysing the seed set in the assisted pollination treatment, self-fertility was evaluated. It is determined by the ratio of the seed set under hand pollination (expressed as a percentage) to the seed set under open pollination (also expressed as a percentage).

This method made guaranteed that any variation in the seed set was caused by the genotype's natural capacity for self-fertilization rather than by outside influences.

An analysis of variance (ANOVA) was performed on the data to ascertain the significance of variations in genotypes, seasons and pollination modes.

3. RESULTS AND DISCUSSION

Significant seasonal variation in autogamy and self-fertility among the genotypes of sunflowers was found through this study. These genotypes inconsistent performance throughout the course of the two seasons suggests that environmental variables were a major determinant of these features.

Genotypes during the Rabi season displayed higher levels of seed set, autogamy and self fertility compared to the Kharif season. In self pollination, the average seed set of genotypes during Kharif was 50.30 percent; in S+M pollination, it was 68.81 percent. Out of all the pollination modes, open pollination produced the highest seed set (81.62%). During Kharif, the percentages of autogamy and self-fertility were 61.79 and 84.36, respectively.

During Rabi, the average seed set of genotype in self pollination was 68.01 percent; in S+M pollination, it was 73.43 percent. The highest seed set (86.14%) was obtained by open pollination out of all the pollination methods. The percentage of autogamy and self fertility during Rabi were 79.01 percent and 85.01 percent, respectively. Season had a significant effect on genotypes because, compared to Kharif season, Rabi season favoured higher seed yields and better seed filling. Higher relative humidity, colder temperatures, less sun radiation and less pollen movement inside the cloth bags may all be responsible for the decrease in seed yield and number of filled seeds, especially during the monsoon in the heads covered with the bags (Darade F.S., 2008). While PB-892, EC-198072 and PB-1444 had the maximum seed set with S+M mode of pollination during Kharif and the genotypes CMS-107B, PB-1212 and CMS-47B had the highest seed set via self pollination. EC-178168, EC-198072 and CMS-107B were the genotypes with the highest seed set via self pollination during Rabi, whereas EC-198078, EC-178168 and Morden were the genotypes with the best results under S+M pollination. Over the course of two seasons, EC-198078,

EC-178168 and GMU-770 were highly self fertile lines, while PB-1212, CMS-47B and EC-934477-1 were highly autogamous lines. The self fertility of genotypes had been evaluated using the seed set (Table 1), which is expressed as a percentage of filled seeds proportion to total seeds. As a result, open pollination results in the highest seed set percentage, which is then followed by S+M mode of pollination and self pollination. Comparable results were observed by Swamy & Giriraj (1988), Janamma et al. (2007) and Sumangala and Giriraj (2002).

4. CONCLUSION

The study demonstrates the importance of seasonal variations while evaluating sunflower genotypes for autogamy and self-fertility. The self fertility of genotypes had been evaluated using the seed set (Table 1), which is expressed as a percentage of filled seeds proportion to total seeds. As a result, open pollination results in the highest seed set percentage, which is then followed by S+M mode of pollination and self pollination. Similarly, high self fertile lines viz., PB-892, PB-1212, CMS-249B, EC-178168 and EC-198072 offer valuable genetic resources for breeding programs aimed at improving sunflower yields. Further research should focus on the underlying genetic and environmental factors influencing autogamy and self-fertility in sunflower to enhance the development of high-yielding, self-fertile varieties and hybrids.

Sr. No.	Genotypes	Seed set (%)	Autogamy (%)	Self fertility (%)
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Table 1: Percentages of seed set, autogamy and self fertility across a two-season period

		Self		Self + Manual		Open		Kharif	Rabi	Kharif	Rabi
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi				
1	R-856	38.37	51.79	60.99	62.20	74.46	76.60	51.53	67.62	81.91	81.21
2	EC-279309-1	54.79	72.97	58.89	70.21	67.13	84.82	81.62	86.03	87.72	82.78
3	TSG-111	32.60	51.99	73.21	75.04	83.13	87.38	39.22	59.50	88.07	85.87
4	BK-R-1	59.88	74.34	62.39	76.39	73.46	79.85	81.52	93.10	84.94	95.66
5	EC-623008	50.90	69.23	71.24	70.17	80.31	84.41	63.39	82.02	88.72	83.13
6	EC-601951	64.52	77.66	72.08	77.19	78.75	94.80	81.94	81.93	91.53	81.43
7	RHA-138-2	57.49	80.64	73.97	84.22	86.75	96.18	66.27	83.85	85.26	87.57
8	PB-1444	25.03	51.86	79.45	71.45	84.45	94.61	29.64	54.81	94.08	75.52
9	PB-1445	24.90	52.40	63.00	70.26	74.79	90.81	33.30	57.70	84.25	77.37
10	PB-1435	50.49	64.35	66.79	62.45	75.74	74.86	66.67	85.97	88.19	83.42
11	PB-1212	71.50	75.98	75.55	73.74	79.31	80.14	90.16	94.80	95.27	92.01
12	PB-892	60.02	81.32	88.24	84.71	90.63	93.83	66.22	86.66	97.36	90.28
13	12-R-1	56.56	73.62	51.32	57.30	66.20	78.15	85.44	94.20	77.52	73.32
14	NO-1147-2	49.25	70.58	57.79	79.84	94.18	93.39	52.29	75.57	61.36	85.49
15	SCG-08	44.31	62.35	51.22	69.62	77.45	82.64	57.21	75.45	66.13	84.25
16	GMU-477	52.81	64.61	62.41	70.01	92.17	92.55	57.29	69.81	67.71	75.65
17	RHA-95C-10-1	49.03	67.26	51.06	60.33	75.17	79.12	65.23	85.01	67.92	76.25
18	EC-601766	23.34	36.44	46.11	42.70	57.51	58.95	40.59	61.83	80.18	72.44
19	EC-502036	52.96	70.37	62.41	65.66	76.46	77.18	69.26	91.18	81.63	85.08
20	GMU-481	27.80	48.18	53.43	50.84	63.17	74.84	44.01	64.37	84.59	67.93
21	GMU-258	56.28	80.48	70.08	75.00	85.39	95.79	65.92	84.02	82.08	78.30
22	GMU-249	61.96	79.98	76.30	87.44	92.20	96.11	67.21	83.21	82.76	90.97
23	EC-601924	33.91	59.65	67.65	75.51	82.63	89.16	41.04	66.90	81.87	84.70

Contd, Table 1

Sr.	Genotypes	Seed set (%)	Autogamy	Self fertility
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No.		Self		Self + Manual		Open		(%)		(%)	
		Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi
24	EC-934477	35.59	60.02	60.23	62.77	84.90	94.84	41.93	63.28	70.95	66.19
25	17B	33.88	59.05	59.01	67.11	78.63	90.06	43.08	65.57	75.04	74.51
26	CMS-103B	40.81	62.10	61.48	78.40	81.18	88.96	50.27	69.80	75.73	88.13
27	ARM-243B	50.51	71.01	78.67	73.31	81.96	84.90	61.63	83.64	95.99	86.35
28	CMS-10B	53.38	74.42	54.13	63.28	85.69	90.84	62.29	81.92	63.17	69.66
29	CMS 112B	51.69	78.79	76.73	86.88	90.77	95.67	56.95	82.36	84.52	90.81
30	CMS-249B	58.77	84.27	75.31	85.66	83.63	93.63	70.28	90.00	90.04	91.49
31	CMS-234B	59.70	81.50	70.71	82.39	81.37	88.40	73.37	92.20	86.89	93.21
32	CMS-47B	70.79	80.04	67.21	78.12	78.60	83.44	90.06	95.93	85.51	93.63
33	NDCMS-2B	53.20	75.88	72.15	89.55	90.11	96.00	59.04	79.04	80.07	93.28
34	CMS-107B	72.42	84.85	78.42	84.86	87.00	89.70	83.24	94.60	90.14	94.60
35	CMS-607B	61.27	79.70	75.66	87.90	89.70	94.31	68.30	84.51	84.35	93.21
36	GMU-520	61.16	32.71	79.15	35.31	93.11	39.68	65.69	82.42	85.01	88.98
37	EC-934477-1	69.42	84.21	70.02	81.29	79.24	86.46	87.60	97.40	88.36	94.02
38	EC-178168	67.66	88.06	72.81	90.47	76.10	94.78	88.91	92.91	95.68	95.45
39	EC-198072	64.78	87.99	82.02	82.48	92.48	94.15	70.04	93.46	88.69	87.61
40	EC-198078	61.30	81.31	77.51	91.83	79.52	95.42	77.09	85.22	97.47	96.24
41	GMU-770	56.58	74.73	76.88	84.16	78.96	89.97	71.66	83.06	97.37	93.55
42	CSFI-1509	41.23	61.17	78.08	73.74	86.80	84.52	47.51	72.38	89.96	87.25
43	DRSF-108	46.86	69.26	76.35	72.33	79.92	91.87	58.63	75.38	95.54	78.73
44	LSF-08	47.18	39.89	76.62	39.48	87.61	51.29	53.85	77.78	87.46	76.97
45	P. Bhasker	33.87	53.72	75.78	84.13	91.37	92.01	37.07	58.38	82.94	91.43
46	Morden	22.82	45.57	74.95	90.13	84.59	95.36	26.98	47.79	88.61	94.51
	Mean	50.30	68.01	68.81	73.43	81.62	86.14	61.79	79.01	84.36	85.01

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