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MA Shelake
Central Sugarcane Research Station, Padegaon, Tal. Phaltan, Satara, Maharashtra, India

KC Ombase
Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

BS Raskar
Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, Maharashtra, India

Corresponding Author:
MA Shelake
Central Sugarcane Research Station, Padegaon, Tal. Phaltan, Satara, Maharashtra, India

Influence of date of sowing and growth regulators on seed yield of single cross hybrid sunflower (*Helianthus annuus* L.)

MA Shelake, KC Ombase and BS Raskar

Abstract
The present investigation entitled "Investigation on seed yield and seed quality of hybrid and its parental lines in sunflower" was undertaken at the Post Graduate Institute Research Farm, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahamednagar during *kharif* 2010, *rabi* 2010-11 and summer 2011 in two distinct experiments, first to study the influence of dates of sowing and chemical spray treatments on seed yield and seed quality of parental line of sunflower hybrid and another to study the effect of mid storage treatments with fungicides, plant products, halogens and accelerated ageing in storage of hybrid seed of sunflower. The field experiment was laid out on a split plot design for three different seasons with three sowing dates in each season and three replications in each date of sowing. The spray treatments of growth regulators (TIBA @ 25 and 50 ppm) and micronutrient (Boron @ 0.1%) with absolute control (water spray) were applied at the ray floret initiation stage on the parental lines of hybrid Phule Raviraj. The applicability of mother plant nutrition technique to improve seed yield and seed quality of hybrid in sunflower was investigated by applying useful chemicals in combination with suitable growing season and sowing dates and the results were comparably best to the results obtained in control plots and the storability with halogens and botanicals was also found comparably better to the control. Thus, TIBA spray at ray floret initiation stage in *rabi* season with regular date of sowing for better seed yield and seed quality and seed treatment with halogens and botanicals for better storability appeared to be promising techniques in seed production of hybrid sunflower.

Keywords: Sunflower, vigour, TIBA, yield, quality, hybrid sunflower, promising techniques

Introduction
Sunflower can be grown throughout the year, since it is a day neutral crop. However, genotypes behave differently to the environmental conditions with respect to flowering, percentage of filled seeds, yield and seed quality. So it is necessary to determine the effect of seasonal influence and application of growth regulators to the seed parent of the hybrids. Seed vigour is an important aspect of quality, which controls field stand, establishment ability and performance. Seed invigoration implies an improvement in seed vigour by any post-harvest treatment resulting in improved germinability, greater storability and better field performance than the corresponding untreated seed (Basu, 1990) [1]. The problems associated with establishing vigorously growing sunflower seedlings are often related to poor seed quality. High quality sunflower seeds have the capacity to provide vigorous seedlings over a wide range of environments. Deterioration of high-quality seed, can render seed worthless for planting although its germination percent remains relatively high (Christiansen and Presley, 1967) [2]. Seed deterioration is a progressive process from the time of physiological maturity until the seed is dead (Delouche, 1963) [5].
Accelerated ageing is a test for predicting the storability of seed lots. It is assumed that the process of deterioration under accelerated ageing enormously increased (Delouche, 1971; Delouche and Baskin, 1973) [3, 4]. Hence, the present study was carried out to know the existence of variability for planting quality of seed among the genotypes in relation to seed treatment and to elicit information on the efficacy of seed treatment in controlling seed deterioration under a rapid deteriorative process. With this background and keeping foregoing points in view, the present investigation was therefore, planned and carried out to study the influence of physical seed enhancement techniques such as seed treatment with fungicides, plant products and halogenations on storability of sunflower hybrid seed with the following objectives.

Materials and Methods

The present investigations entitled "Investigation on seed yield and seed quality of hybrid and its parental lines in sunflower" was undertaken to study the influence of dates of sowing and chemical spray treatments on seed yield and seed quality of parental line of sunflower hybrid and the effect of mid storage treatments with fungicides, plant products, halogens and accelerated ageing in storage of hybrid seed of sunflower. The research work was carried out for field investigation at Post Graduate Research Farm, Department of Botany and for quality parameters and storage study at Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahamednagar during 2010-11. The data collected in respect of various parameters was analysed statistically as described by Sundarraj *et al*., (1972) [8] and Panse and Sukhatme (1978) [6]. The field observation data of first experiment was analysed in split-plot design with pooled data analysis and the laboratory data was analysed in factorial completely randomized design. The critical difference (CD) value were calculated at 5 percent probability level wherever 'F' test was significant. The data in percentage were transformed into arcsine root percentage and transformed data was used for the statistical analysis (Snedecor and Cochran, 1967) [7].

Results and Discussion

Influence of date of sowing

Sunflower is being a photo period insensitive in character; it can be grown in all seasons of the year. Since, the crop is highly cross pollinated and insects (honey bees and butterflies) play an important role in the pollination and hence it requires large number of insect pollinators in the vicinity of the sunflower field. The insect activity is mainly depends on the environmental factors like relative humidity, temperature, sunshine, wind velocity and rainfall. Hence considerable differences in seed yield and quality were observed in different seasons. Dates of planting showed the non-significant differences for the number of days to 50 percent flowering. D_1 (47.64 days) planting showed significantly less number of days to 50 percent flowering followed by D_3 (48.92 days) and D_2 (48.97 days). Optimum sowing time is the most important factor for successful seed production of crops. Its importance has fully been recognized and encouraging results have been observed in many field crops on seed yield and quality. However, only few reports are available regarding Sunflower. The seeds planted at D_3 exhibited statistically significant differences in plant height at maturity. D_3 (143.51 cm) planting showed significantly less plant height at maturity over D_2 (158.84 cm) and D_1 (165.20 cm) planting. For the character number of green leaves per plant at maturity, the dates of sowing showed significant differences. D_1 (5.94) planting showed significantly more number of green leaves per plant at maturity followed by D_2 (5.71) and D_3 (5.33).

Dates of planting showed the significant differences for the capitulum diameter. Significantly higher capitulum diameter was observed in D_1 (21.42 cm) planting followed by D_2 (18.14 cm) and D_3 (15.08 cm). Dates of planting showed the significant differences in total dry matter weight per plant. D_1 (401.19 g) planting recorded significantly higher total dry matter weight per plant followed by D_2 (359.93 g) and D_3 (320.74 g). The highest total number of seeds per head was observed with S_3 (1174.00) followed by S_1 (1142.24) and S_2 (1130.30) spray treatments while the lowest number of seeds per head was observed in S_0 (1014.25) spray treatment. The significant differences for 100 seed weight. D_1 (6.19 g) planting showed significantly the higher weight of 100 seeds followed by D_2 (6.04 g) and D_3 (5.89 g). Dates of planting showed significant difference for processed seed yield per hectare. D_1 (2238.21 kg) planting harvested significantly the higher processed seed yield per hectare followed by D_2 (1755.68 kg) and D_3 (1371.71 kg) planting dates. The interaction between different spray treatments and dates of sowing showed the significant difference in processed seed yield per hectare. The increased processed seed yield in regular planting due to the higher values of yield attributes such as capitulum diameter, number of filled seeds, seed yield per capitulum and 100 seed weight. These results are in accordance with the reports of Vyakarnahal (1998) [9] and Vyakarnahal *et al*. (2001) [10]. Bigger size of capitulum obtained during early planting as compared to late and extra late planting has helped in accommodation of more number of filled seeds per capitulum which resulted in an increased sink strength might have allowed more translocation of photosynthates.

Influence of chemical spray

In spray treatments, the less number of days to 50 percent flowering was observed in S_2 (47.29 days) followed by S_1 (47.94 days) and S_3 (49.16 days). While the higher number of days was recorded in S_0 (49.63 days). The lowest plant height at maturity was observed in S_2 (150.64 cm) followed by S_1 (154.65 cm) and S_3 (158.30 cm) however S_0 (159.81 cm) recorded the highest. However, S_3 and S_0 recorded at par results. In spray treatments, though the dates of sowing showed significant differences for the character number of green leaves per plant at maturity, the highest number of green leaves per plant was observed in S_2 (6.04) followed by S_1 (5.88), which were found at par with each other. The lowest number of green leaves per plant at harvest was observed in S_0 (5.33). The highest capitulum diameter was observed in S_2 (19.20 cm) than S_3 (18.11 cm) and S_1 (18.01 cm), S_3 andS_1 recorded at par results. Whereas S_0 (17.50 cm) recorded the smallest size of capitulum. Dates of planting showed the significant differences in total dry matter weight per plant. D_1 (401.19 g) planting recorded significantly higher total dry matter weight per plant followed by D_2 (359.93 g) and D_3 (320.74 g). The highest total number of seeds per head was observed with S_3 (1174.00) followed by S_1 (1142.24) and S_2 (1130.30) spray treatments while the lowest number of seeds per head was observed in S_0 (1014.25) spray treatment.

The highest number of filled seeds per head was observed in S_3 (973.41) followed by S_2 (960.20) and S_1 (924.50) (Table 8.a). The S_0 (766.03) showed the lowest number of filled seeds per head in all the sowing dates. The highest 100 seed weight was observed in S_2 (6.14 g) followed by S_1 (6.08 g) and S_3 (6.03 g). Whereas, S_0 (5.89 g) recorded the lowest 100 seed weight in all the sowing dates. In spray treatments, the highest processed seed yield per hectare was observed by S_2 (2021.45 kg) spray treatment followed by S_3 (1917.28 kg) and S_1 (1883.56 kg). In the plots of control (S_0) the lowest processed seed yield per hectare was obtained in all the sowing dates. The interaction between spray treatments and dates of sowing showed the non-significant differences. TIBA seemed to enhance seed yield components like capitulum diameter, number of filled seeds per capitulum, 100 seed weight and seed weight per capitulum which probably due to more number of green leaves at harvest which increasing the leaf senescence period pertaining to increased duration for photosynthesis that provide photosynthate during late seed development and maturation phase and also due to inhibition

of basipetal movement of auxins from the capitulum resulting in the proper utilization of auxins for the development of capitulum and sink by achieving proper mobilization of nutrients from source to sink (Vyakarnahal, 1998; Vyakarnahal *et al*., 2001) [9, 10]. Further it can be seen that increased number of filled seeds per capitulum and 100 seed weight might be due to the cause of TIBA that increased the appreciable movement of metabolites in to the capitulum. As a result of these, seed yield per plant and per hectare was increased.

Table 1: Pooled growth and seed quality as influenced by date of sowing and chemical sprays of sunflower

Treatment	50 percent flowering (%)	Plant height (cm)	Number of green leaves plant^{-1}	Capitulum diameter (cm)	Total number of seeds head^{-1}	Total Dry Matter (TDM) plant^{-1}	100 seed weight (g)	Seed yield ha^{-1} (kg)
A) Dates of sowing								
D_1 (Regular sowing)	47.64	165.20	5.94	21.42	1296.56	401.19	6.19	2238.21
D_2 (Late sowing)	48.97	158.84	5.71	18.14	1110.25	359.93	6.04	1755.68
D_3 (Extra late sowing)	48.92	143.51	5.33	15.08	938.78	320.74	5.89	1371.71
S.E.±	1.85	2.35	0.19	1.07	55.88	11.70	0.02	70.37
C.D. at 5%	NS	9.21	NS	4.21	219.40	45.94	0.07	276.32
B) Chemical sprays								
S_0 (Water spray)	49.63	159.81	5.33	17.50	1014.25	361.31	5.89	1331.84
S_1 (TIBA 25 ppm)	47.94	154.65	5.88	18.01	1142.24	359.10	6.08	1883.56
S_2 (TIBA 50 ppm)	47.29	150.64	6.04	19.20	1130.30	354.13	6.14	2021.45
S_3 (Boron 0.1%)	49.16	158.30	5.38	18.11	1174.00	367.95	6.03	1917.28
S.E.±	0.37	0.69	0.05	0.11	10.03	1.18	0.03	30.56
C.D. at 5%	1.09	2.05	0.16	0.32	29.81	3.50	0.09	90.80
C) Interaction								
S.E.±	1.93	1.20	0.09	0.18	17.38	2.04	0.05	52.93
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
General mean	48.51	155.85	5.66	18.21	1115.20	360.62	6.04	1788.53

Conclusion

The applicability of mother plant nutrition technique to improve seed yield and seed quality of hybrid in sunflower was investigated by applying useful chemicals in combination with suitable growing season and sowing dates and the results were comparably best to the results obtained in control plots and the storability with halogens and botanicals was also found comparably better to the control. Thus, TIBA spray at ray floret initiation stage in *rabi* season with regular date of sowing for better seed yield and seed quality and seed treatment with halogens and botanicals for better storability appeared to be promising techniques in seed production of hybrid sunflower

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