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Effect of seed invigoration treatments on synchrony of parental lines of sunflower hybrid PDKVSH- 952

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Abstract
An experiment was conducted with an objective to study effect of different seed invigoration treatments such as seed hydro priming, seed hydration with 50 ppm GA_3, seed hydration with 2% $CaCl_2$, seed hydration with 2% KNO_3, seed hydration with 2% $ZnSO_4$ and seed hydration with 0.1% NaCl on male parent (AKSF-6R) for 12 hours to synchronization of parental lines of sunflower hybrid PDKVSH-952. The experiment concluded that the seed invigoration treatment can be successfully used for better synchronization of flowering in parental lines and seed yield. Seed treatment with 50 ppm GA_3 recorded significantly superior results over all other seed invigoration treatments in respect to less number of days to flower initiation, less number of days to 50% flowering and capitulum diameter in male parent (AKSF-6R). Significantly superior results were recorded in yield contributing parameters like seed set percent, seed yield per plant (g), test weight (g) and seed yield per hectare (Kg) of female parent (CMS-302A) after crossing as influenced by seed invigoration treatments to male parent (AKSF-6R).

Keywords: Seed invigoration, 50ppm GA_3, days to 50% flowering, synchronization, yield

Introduction
Sunflower is second most important edible oilseed crop of the world next to soybean. Sunflower (*Helianthus annuus* L.) contains 38 – 42 percent oil. Sunflower oil is considered as premium oil as compared to most other vegetable oils because of its light yellow colour, bland flavour, high smoke point, high level of lenoleic acid (55 – 60%), low oleic acid (25 – 30%), fairly high content of polyunsaturated fatty acids (PUFA) and absence of linolenic acid. It contains vitamins A, D and E. Sunflower oil has good keeping quality. The oil extracted from seeds contributes about 80 percent of the value of crop (Anonymous, 2007) [1].

Sunflower is cultivated on an area of 24.76 million hectares in the world with annual production of 41.33 million metric tonnes and productivity of 1669 Kg per hectare (Anonymous, 2015). Presently, in India sunflower is grown over an area of 3.442 lakh hectares with a production of about 2.407 lakh tonnes and productivity of 699 kg per hectare (Anonymous, 2017) [3].

Maharashtra ranks second in terms of acreage and production. During year 2016-17, area under sunflower cultivation in Maharashtra was about 0.935 lakh hectares and production was 0.351 lakh tones with average productivity of 594 kg per hectare. Vidarbha region occupies an area of about 0.086 lakh hectares and production was about 0.027 lakh tonnes, with average productivity of 188 kg per hectare (Anonymous, 2016) [3, 4].

BSH-1 was the first hybrid released for commercial cultivation in the year 1980 (Seetaram *et al*. 1980). Since then number of hybrids have been released from both public and private seed producing institutions. The success of hybrids in many crops depends upon exploitation of hybrid vigour and the feasibility of economically viable seed production techniques. To increase the productivity level in the commercial front, supply of quality hybrid seeds assumes prime importance.

One of the major obstacles to hybrid seed production is non-synchrony of flowering in parental lines of sunflower hybrid. Synchronization problem to some extent could be solved where block planting technique is used by staggered sowing. However, the problem of synchronization is not adequately addressed owing to several factors like poor weather condition on 5th day, may not to allow the farmer to sow the female parent on that particular day. While, the recommendation of the staggered planting may have practical limitation in

implementation but it is the only method provided by the plant scientist for achieving synchronization of parental lines.
Therefore, another alternative to staggered sowing to achieve synchrony between parental lines of sunflower hybrid PDKVSH-952 in a given environment can be thought of by inducing fast growth and early flowering in late flowering parent (AKSF-6R) through seed invigoration treatment, so that simultaneous sowing of both the parents on the same day can be done in the 2:1 female to male proportion as the seed invigoration has been usefully demonstrated to improve germination and growth of many crops (Heydecker and Coolbear, 1977) [10].

Materials and methods

The present investigation entitled "Effect of seed invigoration treatments on synchrony of parental lines of sunflower hybrid PDKVSH-952." was undertaken at the field of Department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *kharif season* 2017. The experiment was laid out in a Randomized Block Design (RBD) with seven treatment and three replications.
Seeds of the female (CMS-302A) and male (AKSF-6R) parental lines of sunflower hybrid PDKVSH-952 were sown during research. Only the seeds of male (AKSF-6R) line were soaked in different solution for 12 hours. After the soaking period seeds were dried back to the original moisture content.

Treatment No.	Treatment details
T_0	Control (Staggered sowing of male parent (AKSF-6R) with 4 day interval.)
T_1	Hydration with water
T_2	Hydration with GA_3 (50 ppm)
T_3	Hydration with KNO_3 (2%)
T_4	Hydration with NaCl (0.1%)
T_5	Hydration with $ZnSO_4$ (2%)
T_6	Hydration with $CaCl_2$ (2%)

Results and discussion

The observations were recorded on various parameters, *i.e.* Growth parameters of male parent (field emergence, plant height at 30, 45, 60 DAS, days to flower initiation, day to 50 percent flowering, capitulum diameter). Yield and yield attributing characters of female parent (CMS-302A) as influenced by seed invigoration treatments to male parent (Total no. seeds per capitulum, seed set %, seed yield per plant, seed yield per ha and test weight).

Growth parameters of male parent (AKSF- 6R)

1. Field emergence percent (%)

As per the results (table 1), it is revealed that pre-sowing seed invigoration treatment on male parent (AKSF-6R) with 50 ppm GA_3 recorded significant result on field emergence (86.67%) followed by 2% $CaCl_2$ (84.67%). This shows that seed priming treatment likely to contribute for rapid field emergence. The enhanced growth of plumule and radical associated with field emergence and seed vigour thus form important factor for establishment of initial crop stand. These results were in aggrement with the reports of Kathiresan *et al.* (1984) [11] in sunflower and Vasudevan *et al*. (2009) in sunflower.

2. Plant height (cm) at 30, 45 and 60 DAS

Significant results were recorded on plant height at 30, 45 and 60 day after sowing of male parent (AKSF-6R) of sunflower hybrid PDKVSH-952 as influenced by seed invigoration treatments to male parent are presented in table 1.
The exogenous application of GA_3 to the seed might have triggered germination process due to which seedlings emerged early and plant height increased vigorously. The male parent seeds (AKSF-6R) treated with 50 ppm GA_3 recorded highest plant height (30.49 cm, 59.18 cm and 89.04 cm at 30, 45 and 60 days after sowing respectively) followed by 2% $CaCl_2$ recorded highest plant height (28.48 cm, 58.91 cm and 85.98 cm at 30, 45 and 60 days after sowing respectively). The similar beneficial effects on growth parameters with these chemicals were also obtained by Fehar *et al.* (1984) [9] in sunflower, Berherea and Roul (1995) [6] in groundnut and Vasudevan *et al*. (2009) in sunflower.

3. Days to flower initiation

The results on days taken for opening of ray floret of male parent (AKSF-6R) as influenced by seed invigoration treatments are presented in table 1 shows significant effect.
The effect of different pre-sowing treatments in male parent (AKSF-6R) to reduced number of days to first ray floret opening. The result showed that all the treatments were effective in hastening the onset of flowering in male parent as compared to control. Among the various chemicals treatments seed priming with 50 ppm GA_3 was most effective in advancing the flowering of male line by 5 days earlier (51.67) than control (56.33) followed by 2% $CaCl_2$ (53.00) which was earlier almost 4 days than control. In other treatments it varied from 2-3 days. Basu (1999) [5] reported similar results that seed priming in maize, chickpea and rice resulted in faster emergence, more vigorous plant population, earlier flowering, earlier harvest and higher grain yield. Vasudeven *et al.* (2009) also reported similar results in sunflower and Dhage *et al*. (2011) [8] in okra.

4. Days to 50% Flowering

Seed invigoration treatments on male parent (AKSF-6R) showed significant effect on days to 50 percent flowering are presented in the table 1.
In days to 50 percent flowering same trend followed as days to flowering initiation. The advantages of increased rate of emergence could be correlated with early flowering, observed in the present study. The seed priming with 50 ppm GA_3 to male parent (AKSF-6R) recorded less number of days to 50% flowering (56.0) as compared to control (61.33).
This result may help to minimize the gap of flowering between parental lines of sunflower hybrid PDKVSH-952 resulting in synchronization and increasing seed yield which is the central objectives of present study. Basu (1999) [5] reported similar results that seed priming in maize, chickpea and rice resulted in faster emergence, more vigorous plant population, earlier flowering, earlier harvest and higher grain yield which support the present study. Kuchlan *et al.* (2002) [12], Chakrabarty *et al*. (2008) [7] and Vasudeven *et al.* (2009) also reported similar results in sunflower.

5. Capitulum diameter (cm)

Influence of seed invigoration treatments on capitulum diameter of male parent (AKSF-6R) are presented in table 1.
Male parent (AKSF-6R) hydrated with 50 ppm GA_3 recorded highest capitulum diameter (14.57 cm) followed by 2% $CaCl_2$ (13.78 cm) as compared to control (11.56 cm). Similar results were reported by Vasudevan *et al.* (2009) in sunflower.

Table 1: Effect of seed invigoration treatments on field emergence percent, plant height, days to flower initiation, days to 50% flowering and capitulum diameter of male parent (AKSF-6R) of hybrid PDKVSH-952.

Treatments	Field emergence (%)	Plant height (cm)			Days to flower initiation	Days to 50% flowering	Capitulum diameter (cm)
		30 DAS	45 DAS	60 DAS			
T_0 : Control (staggered sowing)	78.00	21.91	46.98	76.92	56.33	61.33	11.56
T_1 : Hydration with water	80.33	24.34	50.33	77.58	56.00	59.67	11.85
T_2 : Hydration with GA_3 (50ppm)	86.67	30.49	59.18	89.04	51.67	56.00	14.57
T_3 : Hydration With KNO_3 (2%)	83.00	26.06	55.12	80.36	55.00	58.33	13.17
T_4 : Hydration With NaCl (0.1%)	81.33	24.62	54.36	78.30	56.33	60.33	12.83
T_5 : Hydration With $ZnSO_4$ (2%)	83.67	26.98	56.00	84.49	54.00	57.67	13.55
T_6 : Hydration With $CaCl_2$ (2%)	84.67	28.48	58.91	85.98	53.00	57.00	13.78
Mean	82.52	26.12	54.41	81.81	54.61	58.61	13.04
F test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	1.65	1.53	2.56	2.72	1.04	1.01	0.6
CD @ 5%	5.09	4.73	7.89	8.37	3.21	3.12	1.70

Yield and yield attributing characters of female parent (CMS 302A)

The data on yield parameters i.e total number of seeds per capitulum, No. of filled seed per capitulum, seed set percent, seed yield per plant (g), seed yield (kg/ha) and test weight (g) in female parent (CMS-302A) of sunflower hybrid PDKVSH-952 as influenced by seed invigoration treatment to male parent are presented in table 2

In the present study, seed invigoration treatments to male parent were found to influence the yield and yield parameters of female parent (CMS-302A) significantly. Seed invigoration with 50 ppm GA_3 to the male parent recorded significantly highest values for all the yield parameters in the female line compared to untreated seeds. This treatment has influenced in production of highest number of filled seeds (519.93), highest total number of seeds (701.07), maximum seed set percent (75.49%), highest seed yield per plant (32.47 g), highest seed yield kg/ ha (1042.11 kg) and maximum test weight (5.79 g) compared to all other treatments.

This increase in yield attributing parameters in female line is mainly due to early flowering of male parental line which bridged the gap between male and female parental lines leading to perfect synchrony, hence more pollen was available to pollinate female parent. Further, increase in capitulum diameter of male line was also noticed in the treatment *i.e.* hydration with 50 ppm GA_3 (14.6 cm) which might have influenced in production of more pollen producing disc florets in male line which may help to high seeds setting in female line. The results are in confirmity with those of Vadivelu *et al*. (1983) in sorghum, Kuchlan *et al*. (2002) [12] in sunflower, Surendra *et al*. (2006) [13, 15] in okra, Vasudevan *et al*. (2009) in sunflower and Dhage *et al*. (2011) [8] in okra.

Table 2: Total number of seed per capitulum, number of filled seed per capitulum, seed set %, seed yield per plant (g), seed yield (Kg/ha) and test weight of female parent (CMS-302A) of sunflower hybrid PDKVSH-952 as influenced by seed invigoration treatments to male parent (AKSF-6R).

Treatments	Total no. of seeds per capitulum	No. of filled seed per capitulum	Seed set (%)	Seed yield per plant (g)	Seed yield (kg/ha)	Test weight (g)
T_0: Control (staggered sowing)	561.53	364.07	63.93	26.74	772.43	4.15
T_1: Hydration with water	576.27	380.27	66.70	28.05	844.69	4.41
T_2: Hydration with GA_3 (50ppm)	701.07	519.93	75.49	32.47	1042.1	5.79
T_3: Hydration With KNO_3 (2%)	592.67	401.93	67.74	30.19	928.00	4.89
T_4: Hydration With NaCl (0.1%)	582.60	390.40	67.38	27.94	841.65	4.71
T_5: Hydration With $ZnSO_4$ (2%)	611.67	423.87	70.06	30.95	959.15	5.01
T_6: Hydration With $CaCl_2$ (2%)	652.53	452.80	71.24	31.18	977.72	5.73
Mean	611.19	419.03	68.93	29.64	909.39	4.95
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	24.76	20.32	2.13	1.20	36.14	0.22
CD @ 5%	76.30	62.60	6.57	3.69	111.35	0.68

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