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INVESTIGATION OF DORMANCY DURATION AND BREAKING METHODS IN SUNFLOWER HYBRID RSFH-700 SEEDS

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ABSTRACT

Dormancy, while an essential survival mechanism in plants, poses challenges in agriculture by delaying seedling establishment. This study investigates the dormancy duration and effective breaking methods for the sunflower hybrid RSFH-700, especially relevant for seed analysts and producers requiring prompt germination assessments. Two experiments were conducted at the Department of Seed Science and Technology, UAS- Raichur. The first explored dormancy duration. Germination percentage, shoot and root length, seedling dry weight, and seedling vigour indices I and II were assessed in a completely randomized design with four replications. Seeds were subjected to germination tests at 10, 20, 25, 30, 35, 37, 39, 41, 43, and 45 days after harvest. The second experiment aimed to identify effective dormancy breaking methods. Twelve treatments were evaluated are T_1, Exposing seeds to sunlight for 24 hours; T_2, Soaking seeds in water for 15 hours; T_3, Heat treatment at 80°C for 10 minutes; T_4, Soaking seeds in 500 ppm GA_3 for 24 hours; T_5, Soaking seeds in 0.2 per cent KNO_3 for 10 minutes; T_6, Soaking seeds in 0.3 ml L^{-1} ethrel for 24 hours; T_7, Soaking seeds in fresh butter milk over night;T_8, Soaking seeds in 5 per cent panchagavya for 15 hours; T_9, Soaking seeds in 6 per cent vermiwash for 15 hours; T_{10}, Soaking seeds in acetone @ 25 per cent for 15 minutes; T_{11}, Hot water treatment at 80°C for 15 minutes; T_{12}, Control (without soaking).Treatments were applied immediately after harvest, and seeds were subjected to germination tests. Observations included germination percentage, abnormal seedlings, ungerminated seeds, dead seeds, root length, shoot length, seedling dry weight, and seedling vigour indices I and II. Results revealed that the initial germination of the hybrid seeds was 20.50% 10 days after harvest. This progressively increased, reaching 74.75% at 35 days after harvest, exceeding the Minimum Seed Certification Standards (70%). Germination parameters also showed significant increases with progressing germination, indicating dormancy release. Pre-treatments significantly impacted the seeds' physiological parameters. Untreated seeds displayed the lowest values, highlighting the need for dormancy breaking methods to ensure uniform emergence and plant stand. Among the tested treatments, ethrel (0.3 ml L^{-1}) for 24 hours (T6) proved most effective, achieving a significantly highest normal seedling percentage (94.75%). This was followed by GA_3 500 ppm for 24 hours (93.00%) and KNo_3 0.2% for 10 minutes (92.75%). This study concludes that sunflower seed dormancy can be effectively broken by ethrel (0.3 ml L^{-1}) for 24 hours, providing valuable information for seed analysts and producers seeking improved germination and seedling establishment.

Key words: Dormancy, breaking dormancy, sunflower, Ethrel and GA_3.

Introduction

Dormancy is problematic in agriculture as it affects plant establishment but it is the ability of the seeds to delay their germination until the time and place are right reflecting an important survival mechanism in plants. Dormancy is the temporary blocking of the growth of

seeds before their maturation process is completed (Simpson, 2007). Dormancy is one mechanism by which seeds maintain their viability in unfavourable conditions. In spite of this advantage, dormancy creates problems for seed analysts and seed producers, especially when their germination percentage of seed lot must be determined in a few weeks after harvesting. Sometimes, even if the seeds germinate readily at harvest, due to unfavourable environmental conditions during storage or germination, secondary dormancy may develop.

Sunflower is the plant species with a prominent seed dormancy period. It generally takes more than 30 to 40 days after harvest for sunflower seeds to attain germination capacity. It is a rich source of edible oil (40-52%) and is considered as a good quality oil from a health point of view due to the presence of polyunsaturated fatty acids, with 55-60 per cent linoleic acid and 25-30 per cent of oleic acid, which are known to reduce the risk of cardiac related problems. It is cultivated on an area of 26.66 million hectares in the world, with an annual production of 51.95 million tonnes and a productivity of 1.94 tonnes per hectare (Anon., 2018). In India, sunflower is cultivated over an area of 0.226 million hectares, with a production of 0.228 million metric tonnes and a productivity of 1011 kg per hectare (Anon., 2022).

Due to the climate change and failure of monsoon cause difficulty in planning of seed production, distribution and sowing of crops. A rapid and uniform germination in the field is an important requirement. Persistence of dormancy after harvest can negatively affect the result of seed quality test and seed lots with some degree of dormancy cannot be sold immediately to catch the season.Therefore, it has become necessary to study the duration of dormancy period for the farmer who takes up seed production or crop production immediately after the harvest and suggest to simple method to break it for conducting germination test after harvest under those conditions where it is essential to issue a certificate for the sale of seeds for regulatory purposes (Hanumanthappa *et al.*, 2015). The objective of the study was to find out the duration of dormancy and to find out the best method to break dormancy in sunflower hybrid RSFH-700.

Materials and Methods

During the *rabi* 2022, an experiment was conducted in new area in the plot belonging to Dept of Seed Science and Technology, Main Agricultural Research Station, University of Agricultural Sciences, Raichur. The experimental materials consisted of CMS 38A as female line (A line) and RGM-49 as male line (R line) which resulted in RSFH-700 hybrid seeds. The germination test for sunflower seeds was conducted in the laboratory using between paper method as per ISTA procedure (ISTA, 2013). Hundred seeds of four replicates were placed in between germination papers. The rolled towels were placed in germination chamber maintained at 25°C ± 2°C and 90 ± 5 per cent relative humidity.

For duration of dormancy studies, the first test was done on the 10th day after harvest using Complete Randomized Design with four replications. The germinated seedlings were evaluated on 10th day (final count) of incubation and the cumulative percentage of germination was expressed based on the total number of normal seedlings. Dormancy was considered terminated when germination reached 70%. the seeds were subjected to germinated. In the similar way, the seeds were subjected to germination test at different intervals after harvest *viz.*, 20, 25, 30, 35, 37, 39, 41, 43, and 45 days after harvest and germination was recorded along with other seed quality parameters viz., root length, shoot length, seedling dry weight, seedling vigour index-I and seedling vigour index-II.

The seeds of RSFH-700 hybrid were used to conduct another experiment to find out method to break dormancy using Complete Randomized Design with four replications. It consisted of 12 treatments *viz.*, T_1, Exposing seeds to sunlight for 24 hours; T_2, Soaking seeds in water for 15 hours; T_3, Heat treatment at 80 ^{0}C for 10 minutes; T_4, Soaking seeds in 500 ppm GA_3 for 24 hours; T_5, Soaking seeds in 0.2 per cent KNO_3 for 10 minutes; T_6, Soaking seeds in 0.3 ml L^{-1} ethrel for 24 hours; T_7, Soaking seeds in fresh butter milk over night;T_8, Soaking seeds in 5 per cent panchagavya for 15 hours; T_9, Soaking seeds in 6 per cent vermiwash for 15 hours; T_{10}, Soaking seeds in acetone @ 25 per cent for 15 minutes; T_{11}, Hot water treatment at 80 ^{0}C for 15 minutes; T_{12}, Control (without soaking).The treatments imposition was done immediately after harvest and seeds were subjected to germination test. The germinated seedlings were evaluated on 10th day (final count) of incubation and the cumulative percentage of germination was expressed based on the total number of normal seedlings. The other

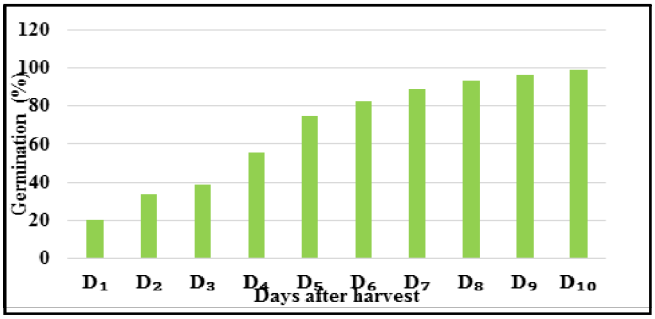

Fig. 1: Germination percentage at different days after harvest.

Table 1: Studies on presence of seed dormancy duration after harvest in sunflower hybrid RSFH-700.

Treatments	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling dry weight (µg)	Seedling vigour index I	Seedling vigour index II
D_1: 10 days after harvest	20.50	2.40	2.00	87.16	90	1787
D_2: 20 days after harvest	33.75	5.17	4.55	162.75	328	5493
D_3: 25 days after harvest	38.50	5.89	5.18	184.59	426	7107
D_4: 30 days after harvest	55.50	8.51	7.40	266.28	883	14779
D_5: 35 days after harvest	74.75	11.58	10.07	358.46	1618	26795
D_6: 37 days after harvest	82.50	13.00	11.16	396.90	1993	32744
D_7: 39 days after harvest	88.75	13.51	12.80	425.25	2335	37741
D_8: 41 days after harvest	93.50	15.37	13.00	454.23	2653	42471
D_9: 43 days after harvest	96.50	16.87	13.07	469.04	2889	45262
D_{10}: 45 days after harvest	98.75	16.23	13.59	472.50	2945	46659
Mean	**68.30**	**10.85**	**9.28**	**327.72**	**1616**	**26083**
S.Em.±	0.95	0.15	0.13	4.57	25	399
CD @ 1 %	3.69	0.59	0.50	17.7	96	1551

observations recorded include percentage of abnormal seedlings, fresh ungerminated seeds, dead seeds, root length, shoot length, seedling dry weight, seedling vigour index-I and seedling vigour index-II. The data was statistically analysed and the results for which are presented below.

Results and Discussion

Study on duration of seed dormancy in sunflower hybrid RSFH- 700

The Indian Minimum Seed Certification Standards for sunflower seed germination is 70 per cent. The seed germination was recorded at different intervals to find out the duration of dormancy present in RSHF-700 hybrid. The hybrid seeds initially showed 20.50 per cent of germination at 10 days after harvest (D_1). The seed germination of 74.75 per cent was recorded at 35 days after harvest (D_5) which is presented in Table 1. The germination parameters *viz.*, root length, shoot length, seedling dry weight, seedling vigour index I and II showed significant increase with increase in germination and release of dormancy as presented in Table 1. The seed dormancy of RSFH-700 sunflower hybrid was released at 35 days after harvest when the germination recorded was 74.75 per cent which was above the Minimum Seed Certification Standards (70%). Similar findings were reported by Rao *et al.*, (1990) in sunflower, where the dormancy duration was 30 days for modern variety and 40 days for EC- 68414 and APSH-11. The results are in agreement with Shivhare *et al.*, (1995) in Chilli, Mathur *et al.*, (2000) in Groundnut and Hanumanthappa (2013) in rice.

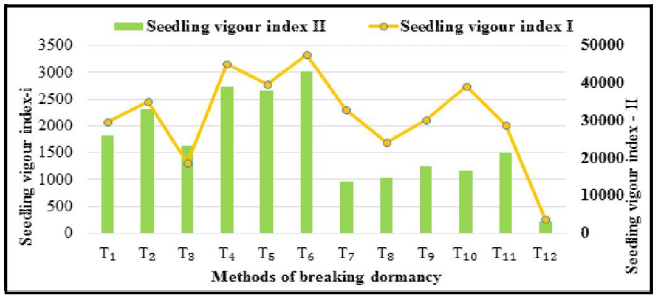

Fig. 2: Seedling vigour as effected by different methods of breaking dormancy.

Method of breaking seed dormancy in sunflower hybrid RSFH-700

The hybrid seeds were subjected to various pre-treatments to break dormancy which showed significant differences on seed physiological parameters of RSFH-700 sunflower hybrid, while the lowest physiological parameters were found for untreated seeds indicating that pre-treatments are required to overcome dormancy so as to improve uniform emergence and plant stand.

Significant difference was observed for normal seedlings, abnormal seedlings, fresh ungerminated seeds and dead seeds due to dormancy breaking treatments as presented in Table 2.

Hybrid seeds treated with ethrel (0.3 ml L^{-1}) for one day registered significantly highest normal seedling percentage (94.75 %) (T_6) followed by GA_3 @ 500 ppm for 24 hours (93.00 %) (T_4) and KNO_3 @ 0.2 per cent for 10 minutes (92.75 %) (T_5). The lowest percentage of seedlings percentage was recorded in control (33.00 %) (T_{12}). The increased normal seedling percentage in ethrel might be due increased activity of peroxidase thereby increasing the permeability of cell membrane (Srivastava and Dey, 1982). They also reported that it may break dormancy by increasing RNA and protein content. Improvement in germination of the sunflower embryo may be due to protease activity as reported by Borghetti *et al.*, (2002). These results are in agreement with findings

Table 2: Effect of dormancy breaking methods on normal seedlings, abnormal seedlings, fresh un-germinated seeds and dead seeds of RSFH-700 sunflower hybrid seeds.

Treatments	Normal seedlings (%)	Abnormal seedlings (%)	Fresh un-germinated seeds (%)	Dead seeds (%)
T_1: Exposing seeds to sunlight for 24 hours	81.00	6.50	8.50	4.00
T_2: Soaking seeds in water for 15 hours	84.25	3.50	6.50	5.75
T_3: Heat treatment at 80 ^{0}C for 10 minutes	64.25	15.00	5.00	15.75
T_4: Soaking seeds in 500 ppm GA_3 for 24 hours	93.00	2.00	3.50	1.50
T_5: Soaking seeds in 0.2 per cent KNO_3 for 10 minutes	92.75	2.25	4.00	1.00
T_6: Soaking seeds in 0.3 ml L^{-1} ethrel for 24 hours	94.75	2.00	2.25	1.00
T_7: Soaking seeds in fresh butter milk overnight	82.00	4.50	7.50	6.00
T_8: Soaking seeds in 5 per cent panchagavya for 15 hours	79.50	7.00	4.00	9.50
T_9: Soaking seeds in 6 per cent vermiwash for 15 hours	81.00	6.50	5.50	7.00
T_{10}: Soaking seeds in acetone 25 per cent for 15 minutes	92.50	3.00	3.00	1.50
T_{11}: Hot water treatment at 80 ^{0}C for 15 minutes	73.50	6.75	4.75	15.00
T_{12}: Control (without soaking)	33.00	3.00	52.00	12.00
Mean	**79.29**	**5.17**	**8.88**	**6.66**
S.Em.±	1.04	0.08	0.20	0.10
CD @ 1 %	4.02	0.31	0.78	0.42

of Singh and Rao (1994) in sunflower and Gerald (1998) in wild sunflower.

The maximum abnormal seedlings (15.00 %) were observed in heat treatment at 80°C for 10 minutes (T_3) and the minimum percentage of abnormal seedlings were obtained from ethrel (0.3 ml L^{-1}) for one day (T_6) (2.00 %) followed by GA_3 @ 500 ppm for 24 hours (2.00 %) (T_4). However, control has shown 3 per cent of abnormal seedlings. The maximum abnormal seedlings were obtained in T_3 (heat treatment at 80°C for 10 minutes) due to exposure of seed to heat for longer period which may damage the embryo and seed coat resulting into more leachates by increasing cracks in the seed coat or reducing the perooxidase activity in the seed covering structures thereby promoting the degradation and evaporation of short chain saturated fatty acids (SCSFAs) from the dormant seeds thereby increasing the abnormal seedlings. Similar results were observed by Farhoudi *et al*., (2007) in potato seed.

Maximum percentage of fresh un- germinated seeds in control (T_{12}) (52.00 %) followed by seeds exposed to sunlight (T_1) (8.50 %) were observed. Significantly

Table 3: Effect of dormancy breaking methods on root length, shoot length, seedling dry weight, seedling vigour index I and seedling vigour index II of RSFH-700 sunflower hybrid seeds.

Treatments	Root length (cm)	Shoot length (cm)	Seedling dry weight (µg)	Seedling vigour index I	Seedling vigour index II
T_1: Exposing seeds to sunlight for 24 hours	14.11	11.54	320.00	2078	25920
T_2: Soaking seeds in water for 15 hours	16.01	13.10	390.30	2453	32883
T_3: Heat treatment at 80 ^{0}C for 10 minutes	11.25	9.20	360.51	1314	23163
T_4: Soaking seeds in 500 ppm GA_3 for 24 hours	18.67	15.27	420.67	3156	39122
T_5: Soaking seeds in 0.2 per cent KNO_3 for 10 minutes	16.51	13.50	408.00	2783	37842
T_6: Soaking seeds in 0.3 ml L^{-1} ethrel for 24 hours	19.32	15.81	455.50	3329	43159
T_7: Soaking seeds in fresh butter milk overnight	15.39	12.59	166.00	2294	13612
T_8: Soaking seeds in 5 per cent panchagavya for 15 hours	11.66	9.54	184.23	1685	14646
T_9: Soaking seeds in 6 per cent vermiwash for 15 hours	14.29	11.69	220.00	2104	17820
T_{10}: Soaking seeds in acetone 25 per cent for 15 minutes	16.29	13.33	180.00	2740	16650
T_{11}: Hot water treatment at 80 ^{0}C for 15 minutes	15.03	12.30	290.12	2009	21324
T_{12}: Control (without soaking)	4.31	3.53	89.18	259	2943
Mean	**14.40**	**11.78**	**290.38**	**2184**	**24090**
S.Em.±	0.19	0.15	4.03	30	345
CD @ 1 %	0.74	0.60	15.50	115	1327

minimum number of fresh un- germinated seeds (2.25 %) was observed in 0.3 ml L^{-1} ethrel for a day (T_6). Ethrel treatment has resulted in minimum number of fresh un-germinated seeds, this is due to softening effect on seed coat, denaturation of inhibitors and enhanced after ripening process. This might be assosciated with washing away of the inhibitor, ABA and further during the process the seed coat porosity also increases producing less fresh un-germinated seeds (Maiti *et al*., 2006). Similar findings were reported by Cetinbas and Koyuncu (2006) and Mani *et al*., (2013) in potato cultivars.

The seeds exposed to heat treatment at 80°C for 10 minutes (T_3) recorded significantly highest percentage of dead seeds (15.75 %) followed by hot water treatment at 80° C for 15 minutes (T_{11}) (15.00 %) and control (12.00 %). However, soaking seeds in 0.3 ml l^{-1} Ethrel for 1 day (T_6) and soaking seeds in 0.2 % KNO_3 for 10 minutes showed least number (1.00) of dead seeds. The more number of dead seeds were observed in heat treatment at 80° C for 10 minutes (T_3) , may be due to presence of dead embryo and endosperm due to excessive heat exposure. The results are in conformity with Janaiah *et al*., (2006) and Abdul *et al*., (2012) in bitter gourd.

The seeds treated with ethrel (0.3 ml L^{-1} for one day) also recorded significantly high root length (19.32 cm), shoot length (15.81 cm) and seedling dry weight (455.50 mg), compared to control (4.31cm, 3.53 cm and 89.18 mg respectively), ultimately giving highest values for seedling vigour index. Increase in seedling dry weight may be attributed to increase in seedling length and dry matter. The enhancement in root length and shoot length may be due to enhanced metabolic and enzyme activity (Airin and Khusro, 2013).

Conclusion

The seed dormancy in RSFH-700 hybrid was released 35 days after harvest with 74.75 per cent germination which is above Minimum Seed Certification Standards (70%). This aids the seed quality analyst to plan the seed quality evaluation and evaluate the quality of seed lot efficiently. Among the dormancy breaking treatments, soaking seeds in ethrel 0.3ml L^{-1} for a day is found to be effective in overcoming dormancy. By ethrel seed treatment we can successfully break dormancy and make the seed lot ready for sowing immediately after harvest.

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