Helianthus Annuus L. Sunflower Seed Invigoration Treatments for Improved Germination and Field Performance

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Abstrsact

Introduced to India in 1969 as an oilseed crop, sunflowers (Helianthus annum L.) are now mostly produced in the country for their oil. In the late 1980s and early 1990s, it played a significant role in India's oil seed output. Consumers everywhere appreciate sunflower oil for its high nutritional value, and in India, it is the most popular branded oil. Farmers also like sunflower because of its high production potential, short growing season, and high profit margins. In terms of both oil seed acreage and oil seed output, India is among the world's leading vegetable oil economies. This work investigates approaches for revitalising Helianthus annuus l. sunflower seeds to improve their viability, germination, and performance in the field.

Keywords: *Sunflower, Seed Invigoration, Vegetable Oil, Oilseed Crop.*

Tob Regul Sci.™ 2021;7(4): 651-665
DOI: https://doi.org/10.52783/trs.v7i4.1314

1. Introduction

With the establishment of TMO in 1986, the oilseed situation in India has experienced a remarkable transformation in the previous 15 years. About two million metric tonnes (MT) of sunflower seeds were produced in the nation during the mid-1990s, when the crop was grown on roughly 2.5 Mn ha. Although oilseed output has been relatively stable for the last several years, when only 18.2 million metric tonnes were harvested. Currently, oilseeds typically produce about 0.9 tonnes per acre. In 2003-2004, India harvested 10.86 lakh tonnes of sunflower oil seed annually. Under optimal growing and management circumstances, this oil seed may produce up to 10 quintals per acre with an oil content of more than 40%.[1-2]

Further development of seed security policies to ensure that seed of the right quality is readily available, at an affordable price, in sufficient quantity, and at the appropriate planting time is necessary if farmers are to achieve self-sufficiency in the oil seed sector. Seed security is one of the main focuses of this strategy, which aims to help LEFDCs boost their food production and productivity.[3-4]

In agriculture and all other forming systems, seed is the most fundamental, important, and crucial input. In a nation like India, the agricultural economy's vitality and growth depend on

the timely supply of high-quality seeds of the appropriate kind in sufficient numbers. The role of seed in India's green revolution was crucial, and it will remain so for the foreseeable future. Since the Vedic era (Yajur Veda), people have understood that high-quality seed is the industry's most valuable resource. A good yield in today's farms depends on each seed germinating quickly and growing into a healthy plant. Inadequate field emergence or a smaller standing crop due to late rain, flood, or drought frequently necessitate resowing, which necessitates keeping a buffer seed stock on hand, but in such cases, it might be difficult to get high-quality sowing materials.[5-6]

Over time, farmers have learned the value of high-yielding seed types, but the significance of a seed's quality within a cultivar has only just begun to register. It will take time for the seedling's robustness, synchrony, and uniformity of emergence, as well as its resilience in the face of hostile soil and climatic circumstances, to become apparent to him and make him aware of the importance of seed quality. [7-8]

As a result, seed quality has been more prioritised in modern agriculture in developed nations. It takes time and money to apply the secondary inputs in crop production. As a result, a farmer always looks to seed as the panacea for maximising the efficiency and profitability of all other agro inputs. More than two-thirds of India's population works in agriculture, and most of those who do are poor, so access to high-quality seed is crucial to the country's food security. To achieve our goal of increasing agricultural yields, seed is the only widely acknowledged carrier of production technology.[9-10]

2. Material And Methods

In this experiment, we utilised newly harvested seeds of the sunflower (Helianthus annuus L. cv. Morden) variety grown at the University of Lucknow's Agricultural Experimental Farm. Seeds were collected, washed, and sun-dried for two to three days until their moisture content was 9.5%; they were then kept in 2.5-liter rubber-stoppered glass bottles in the lab at room temperature.

Sunflower seeds housed in various containers at room temperature had their vigour and viability determined.

Seeds were harvested, washed, and sun-dried until their moisture content was 9.5%; then, 500 g of seeds were stored in the Kolkam laboratory at room temperature in both moisture-permeable (a cloth bag) and moisture-impermeable (a polythene packet, metal tin, and rubber-stoppered glass) containers. Lucknow's has an average yearly temperature of 28.1°C and a relative humidity of 71.28%.

Research on the effects of pre-sowing seed invigoration on the germination rate and yield of sunflowers

A. **Seed Preparation Techniques**

(a) **Dry Dressing Methods:**

Using a modified version of the procedure reported by Mandal and Basu (1986), high-vigor (one-month-old) sunflower (cv. Morden) seeds were treated with finely powdered chemicals, medicinal formulations, and crude plant components prior to storage. First, the raw plant materials were air dried to the point of complete dehydration, and then the chemicals, pharmaceuticals, and plant materials were pulverised into a fine consistency.

Soaking-drjring: For 2 hours at room temperature (28 z 1°C) with intermittent stirring, sunflower seeds were submerged in twice their volume in water. After soaking, the water was drained and the seeds were dried twice: first using blotter and then again in a drying cabinet set to 35 1 °C, where they were subjected to a circulation of hot air. Along with the treated seeds, the control seeds were dried. After seven days in a desiccator with fused calcium chloride, the moisture content of both the treated and untreated seeds had stabilised. For further lab and field research, the stabilised seeds were reintroduced to the glass container with the rubber stopper.

B. Ageing conditions

Accelerated ageing: Treatment effects on seed vigour and viability were assessed by subjecting treated and untreated seeds to artificially accelerated ageing under artificially controlled regimes of different relative humidities and temperature after the specified time period. In order to speed up the ageing process, both treated and untreated seeds were stored in perforated (same number of holes in each packet) paper packets (each packet includes the same number of seeds).

Inevitable ageing: Both treated and untreated seeds were aged for different amounts of time under ambient circumstances to determine the impact of the treatments on germinability. Perforated paper packets with a same number of holes were used to store the same number of seeds across treatments before being gathered into a single fabric bag.

C. **Germination test**

Using a modified version of the procedure, we tested the germination of treated and untreated seeds immediately after treatment, after accelerated ageing, and after natural ageing. The procedure was detailed in the preliminary test. More than 400 seeds were harvested from each plot for testing.

D. **Fleld experiment**

During the Rabi (November–February) seasons of four consecutive years (2017–2018, 2018–2019, 2019–2020, 2020–2021), a field experiment was carried out at the Agricultural Experimental Farm of Lucknow University.

To determine the impact of the treatments on field performance, ten treatments were seeded in the field from the laboratory experiment, with the untreated control seeds serving as a baseline.

Dry and moist seed revitalization effectiveness in the mid-storage stage Sunflowers need special mats to keep them healthy and productive.

Sunflower (cv. Morden) seeds of medium vigour were aged for 5 months before receiving dry and wet treatments at the mid-storage. Drug, chemical, and crude plant material dosages, as well as the procedure for treating dry and wet seeds, were all the same as those used in the previous experiment. Experiment II detailed the ageing conditions and germination test, which were previously mentioned before.

Medium vigour sunflower seed (5 months old) was treated in mid-storage using a technique similar to that reported. Details on the timing and quantity of treatments were provided in Experiment II.

Sunflower seeds, both treated and untreated, were planted in the field to compare field performance and yield as a result of the treatments. Experiments were conducted in the field for four consecutive years during the fiobi season at the Agricultural Experimental Farm of Lucknow University. All other horticultural practises were the same as those used in the original studies (11), including land preparation, fertiliser dosages, plot size seed rate, etc..

Improved sunflower field performance after a post-storage (pre-sowing) seed lnvlgoratlon treatment

Sunflower seeds were aged for 9 months in rubber-capped glass jars at room temperature before receiving dry and moist treatments prior to seeding. Following treatment, a germination test was conducted using a methodology, with some changes. Pre- and mid-storage seed invigoration treatments use the same treatment procedure and treatment schedules as the previous experiment. For the wet treatment, seeds were first soaked in water for 2 hours before being lightly air-dried for easier seeding in the field.

This field study followed the same protocol as the previous two studies. All of the other cultural practises, including the plot size, seed rate, irrigation, and fertilisation, were the same as in the prior trial.

A. Membrane permeability

Permeability of membranes, as measured by electrolyte and sugar leakage from seeds, provides a rough assessment of membrane function.

(i) The leachate from seeds' electrical conductivity

Following the procedure described by Anderson et al. (1964), the electrical conductance of treated and untreated seeds was measured immediately after treatment (i.e., before ageing) and after natuml ageing at ambient circumstances for 135 days. Twenty identical sunflower seeds were soaked in 30 cc of distilled water at room temperature (30 + 1'C) for 30 minutes to get a standard deviation for electrical conductivity. Systronic Electrical Conductivity Bridge (cell constant 0.756) measurements of electrical conductance of seed leachate were taken after the water used to steep the seeds was drained off into a test tube with a diameter of 2.5 centimetres.

ii. Leaching of sugar

We used a modified version of McCready et n/.'s (1950) technique to measure the sugar content of the seed both immediately after treatment (before ageing) and after natuml ageing for 135 days in ambient settings. Twenty sunflower seeds of the same size were soaked in 30 ml of distilled water at room temperature (30 l°C) for 30 minutes. In a two-milliliter hard-glass test tube, we added four millilitres of newly made anthmne reagent (0J%) and chilled the mixture until a blue green hue formed after 30 minutes.

iii. Dehydrogenase activity test

The dehydrogenase enzyme activity of the treated and untreated seeds was determined immediately upon treatment and after natuml ageing for 135 days under ambient conditions. Thirty seeds were spread out on petridishes at 0 l°C for each treatment. After 48 hours of germination, 8 uniformly sprouted embryos were collected, put in a glass vial with a 10-ml capacity, and incubated with 5 ml of a 0% tetrazolium chloride solution in the dark at 30°C for 3 hours. After incubation, the embryos were washed in distilled water and the tetrazolium chloride solution was drained. The embryos in the vial were reddened by adding 5 mL of methyl cellosolve (2-methoxy ethanol) and letting them sit at room temperature (28 1°C) for 8 hours. Systronic Photoelectric Colorimeter readings at rim 470 reveal the color's intensity.

B. Lipid peroxidation estimation

The tbiobarbituric acid (TBA) colour reaction, first described by Bernheim et al. (1948) and modified somewhat here and there, was used to examine lipid peroxide generation immediately after treatment (i.e., before ageing) and after natural ageing under ambient circumstances for 135 days. 500 mg of dry sunflower powder (20 seeds properly crushed and formed into a fine

powder) was placed in a hard glass test tube, and then 1% TBA solution and 2 ml of 1(N) H2 4 - were added. The ingredients were combined and baked at l00°C for 1 hour. Shaking the cooled liquid vigorously, 5 ml of methyl cellosolve (2-methoxy ethanol) was added. The mixture was then centrifuged at 5000 rpm for 10 minutes. Clear supernatant absorbance was measured at 520 nm with a Systmnic Photoelectric Golorimeter against a boiling TBA reagent blank.

C. Volatile aldehyde concentration predictions

Sur and Basu (1990b) used a modified aldehyde trapping device to implement the methodologies of Harman et al. (1982) and Wilson and McDonald (1986a) for estimating volatile aldehydes released during germination of treated and untreated seeds. Glass vial with a 15 mL size with the following contents:

Analysis

The effects of seed invigoration therapy on germination and yield were assessed using an analysis of variance conducted on data collected from a laboratory germination test, a field experiment, and biochemical analyses. Root and sheet length data were analysed after being converted from germination percentages to angles. The vigour index was determined by multiplying the germination rate by the length of the resulting seedlings.

3. Results

I. Patterns of vitality and viability loss in sunflower seed kept at room temperature

Sunflower seeds were picked, washed, and sun-dried to a safe moisture level (9.5%), before being kept (500 g seed) in a cloth bag, polythene packet, metal tin, and glass bottle at room temperature. Seeds were taken from several containers on a monthly basis to examine how they fared in the germination test. Six days into germination at 28 1°C, we documented data on the germination rate and the length of the resulting seedlings.

The germination rate and seedling height of sunflower (cv. Morden) seeds housed in four different media from April to December: a cloth bag, a polythene packet, a metal tin, and glass bottles. After the monsoon, the vitality and viability of sunflower seed significantly decreased. The germination rate dropped below 50% and the seeds were less vigorous when sown in December because they had absorbed so much moisture from the humid monsoon air in the preceding months. The germination percentage and seedling height of seeds kept in moisture-proof containers, such as polythene packets, glass bottles, and metal tins, decline more slowly than those stored in unsealed containers, such cotton bags. Sunflower seeds housed in glass bottles had a greater germination rate (78%) and produced stronger seedlings in November, making them the best storage container for preserving sunflower seeds.

IL **Research on the effectiveness of pre-storage aed lnvigoration treatments in preserving sunflower seeds' germinability and field performance.**

Pharmaceutical formulation (aspirin), chemicals (bleaching powder, iodinated calcium carbonate, calcium carbonate, para-amino beozoic acid, and potassium nitrate), and crude plant materials (nxl chilli powder, lemon leaf powder, and CabmrtfJttts leaf powder) were dry dressed onto freshly harvested (high-vigor) sunflower seeds in the glass bottles with rubber stoppers. Not only were dry treatments administered, but so was the wet therapy.

Germination tests were performed immediately after treatment (before ageing) and again after accelerated ageing and natuml ageing under ambient circumstances using a modified version of the protocol described to examine the effects of seed revitalization treatments.

Germination tests comparing treated and untreated seeds were undertaken immediately after treatment and found no change in gerniinability. Seedling vitality was very slightly enhanced by a few of dry treatments, such as Catharanthus leaf powder, aspirin, etc., compared to the control. However, majority of the pre-storage dry treatments showed considerably superior outcomes in enhancing germinability than untreated control following accelerated ageing at 98% RH and 40°C for 270 days. Root and shmt length also showed that the seedlings grew stronger in the dry treated seed compared to the control. Most of the dry treated seed also had a greater vigour index, measured as the product of germination rate and seedling length, than the control. Aspirin, bleaching powder, iodinated calcium carbonate, and potassium nitrate are the most effective dry treatments for prolonging sunflower seed's shelf life. Some research suggests that soaking harm in harvest fresh seed may account for the little increase in gcrminability shown with wet treatments like soaking-drying compared to the control.

Table 1. Immediate post-treatment (i.e., pre-aging) effect of seed lnvlgoration treatments on the germination of sunflower

Treatments	Germlnatlon		Mean root length (mm)	Mean shoot length (mm)	Vigour Index
	(%)	Arc-sln value			
Control	94	75.82	177	90	25098
Soaking drying	93	74.66	183	97	26040
Aspirin	94	75.82	183	94	26038
Bleaching powder	90	71.56	176	99	24750
lodinated calcium carbonate	91	72.54	178	94	24752

Calcium carbonate	94	75.82	182	99	26414
p-arninobenzoic acid	94	75.82	185	98	26602
Potassium nitrite	90	71.56	180	98	25020
Red chilli powder	92	73.57	179	92	24932
Lemon leaf powder	93	74.66	182	97	25947
Vinca leaf powder	94	75.82	179	94	25662
L.S.D. at 0.05 P L.S.D. at 0.01 P	- -	NS NS	NS NS	NS NS	- -

Table 2. Sunflower seeds were aged for 270 days at 36% RH and 40°C, and the effects of pre-storage seed invigoratlon treatments on their vigour and viability were analysed.

Treatments	Germlnadon		Mean root length (mm)	Mean shoot length (mm)	Vigour index
	(%)	Arc-sin value			
Control	53	46.72	83	49	6996
Soaking-drying	46	42.71	80	48	5888
Aspirin	72	58.05	100	65	11880
Bleaching powder	69	56.17	93	55	10212
lodinated calcium carbonate	63	52.53	89	54	9009
Calcium carbonate	56	48.45	85	53	7728
p-aminobenzoic acid	73	58.69	103	65	12264
Potassium nitrate	57	49.02	91	51	8094
Red chilli powder	72	58.05	101	63	11808
Lemon leaf powder	58	49.60	96	54	8700
Vinca leaf powder	66	54.33	94	55	8642
L.S.D. at 0.05 P	-	6.01	12	10	-

Most dry treatments considerably slowed down seed degradation compared to control in germination tests done before planting in the field. Sunflower seeds stored with aspirin and iodinated calcium carbonate outlasted those stored with other dry treatments.

Table 3. Sunflower (cv. Mordmi) seed germination was affected by pre-sowing seed lnvigoration treatments.

Treatment	Germination		Mean root length (mm)	Mean shoot length (mm)	Vigour Index
	(%)	Arc- sin value			
Control	67	54.94	86	32	7906
Soaking-drying	60	50.87	85	32	7020
Aspirin	77	61.30	96	36	10164
Bleaching powder	84	66.40	97	40	11508
lodinated calcium carbonate	83	65.60	89	36	10375
Calcium carbonate	84	66.40	84	34	9912
p-mmmoboozoicacid	84	66.40	89	36	10500
Potassium nitrate	77	61.30	100	40	10780
Red chilli powder	90	71.60	98	3Y	12150
Lemon leaf powder	87	68.90	99	44	12441
Vinca leaf powder	90	71.60	111	44	13950
L.S.D. at 0.05 P L.S.D. at 0.01 P	- -	10.3 12.5	Is 20	4 6	 -

Field performance

Table shows that the field emergence percentage of dry treated seeds is much greater than that of untreated seeds, which is indicative of improved crop performance and yields in the field. Compared to the control, most of the pre-storage dry treatments resulted in considerably increased seed production per unit area as well as other yield qualities such as plant height, capitulum diameter, number of seeds per head, and the most stable feature 1000-seed weight. In

terms of boosting sunflower field performance and production, aspirin, bleaching powder, iodinated calcium carbonate, aspirin, and red chilli powder fared the best among the dry treatments. Sunflower seeds undoubtedly suffered soaking damage when they were just harvested, therefore a pre-storage hydration-dehydration (soaking-drying) treatment did not improve field performance or production.

Table 4. Field performance and yield of sunflower (cv. Mordeo) after receiving pre-storage seed invigoration treatments.

Treatments	Fietd emergence	Plant helght	Capttalum diameter	No. of field seeds/	Seed yield	1000-seed weight
Connol	68	86.3	12.1	279	81.26	37.97
Soaking-drying	70	94.7	118	272	73.57	36.94
Aspirin	84	103.2	13.1	334	98.17	38.62
Bleaching powder	86	93.4	13.4	311	104.22	41.30
lodinated calcium carbonate	87	101.2	13.2	338	102.94	39.35
Calcium carbonate	77	96.7	12.2	330	91.91	37.32
p-aminobenzoic acid	80	104.3	13.1	302	96.58	39.02
Red chilli powder	76	99.1	12.9	38	98.53	40.23
Lemon leaf powder	80	105.8	12.8	288	86.08	39.81
Vinca leaf powder	84	97.4	12.2	285	91.12	40.92
L.S.D. at 0.05 P	7	7.8	0.6	28	16.77	2.32
L.S.D. at 0.01 P	10	10.7	0.8	39	NS	NS

The effects of dry and moist seed invigoration treatments on sunflower flavour, viability, and yield during intermediate storage.

Dry dressings of aspirin, bleaching powder, calcium carbonate, iodinated calcium carbonate, para-aaiino benzoic acid, and potassium nitrates, as well as red chilli powder, Catharanthus leaf powder, and lemon leaf powder were applied to sunflower seeds that were five months old

(medium vigour) and stored in glass bottles with rubber stoppers at room temperature. In addition to the dry treatments, we also did the soaking-drying treatments. After processing, seeds were kept in dark, ambient settings in glass jars with rubber stoppers.

Treatment efficacy was determined by comparing the germination rates of treated and untreated seeds before and after ageing in two distinct ways.

Mid-storage treatment did not enhance the germination rate of treated seeds compared to the control group, as shown in Table. Table shows that gertninability was increased by both slow ageing at 36% RH and 40°C temperature for 253 days and natural ageing under ambient conditions for 135 days.

Table 5. Before ageing, the effect of a seed invigoration treatment in the middle of storage or the germination rate of sunflower seeds just after treatment Le.

Treatments	Before ageing				
	Germination		Mean root length (mm)	Menu shoot Length (mm)	Vlgoor inden
	(%)	Arc-sin value			
Control	77	61.34	158	89	t9019
Soaking-drying	80	63.44	159	91	20080
Aspirin	77	61.34	156	87	18711
Bleaching powder	76	60.67	155	87	18392
lodinated calcium carbonate	77	61.34	157	88	18865
Calcium carl›onate	76	60.67	157	87	18544
p- aaiinobe:nzoioacid	76	60.67	158	88	18696
Potassium nitrate	75	60.00	155	86	18075
Red chilli powder	80	63.44	155	89	19520
Lemon leaf powder	77	61.34	160	86	18942
Vinca leaf powder	80	63.44	158	85	19440
L.S.D. at 0.05 P	-	NS	NS	NS	-

L.S.D. ai 0.01 P		NS	NS	NS	-

Table 6. sunflower seed vigour and viability after ageing for 253 days at 36° RH and 40°C with mid-stomge aeed invigoration treatment.

Treatments	Ageing at 36% RB and 40°C				
	Germination		Mean root length (mm)	Mean shoot Length (mci)	Vigour index
	(%)	Arc-sin value			
Control	56	48.45	71	44	6440
Soaking-drying	70	56.79	93	60	10710
Aspirin	61	51.35	82	51	8113
Bleaching powder	60	50.77	72	48	7200
lodinated caleium carbonate	59	50.18	72	44	6844
Calcium carbonate	56	48.45	70	44	6384
p-aminobenzoic acid	53	52.53	73	45	6234
Potassium nitmte	58	49.60	66	49	6670
Red chilli powder	65	53.73	87	55	9230
Lemon leaf powder	60	50.77	70	47	7020
Vinca leaf powder	56	48.45	73	48	6776
L.S.D. at 0.05 P	-	4.81	4.	7	
L.S.D. at 0.01 P		NS	5	9	

Field performance

Crops grown from treated and untreated seeds stored at the same temperature for the same amount of time revealed that wet physiological treatments, such as soaking-drying, significantly increased seed yield per unit area and other yield parameters, such as plant height and seed per capitulum, compared to the untreated control. Soaking and drying the seeds resulted in a considerable increase in

1000-seed weight compared to the control. Better outcomes in terms of field performance and production were shown after a few dry treatments compared to the status quo.

Table 7. Sunflower (cv. Morden) field performance and yield as affected by seed invigoration treatments applied midway during storage.

Treatments	Field Emergence (%)	Plant height (cm)	Capltnlum diameter (mm)	No. of 8eld Seeded capitulum	Seed Yield (g/m2)	1000-aeed Weight (g)
Control	67	92.7	12.2	282	82.79	35.72
Soaking-drying	79	104.2	12.9	335	102.43	40.46
Aspirin	68	94.2	12.6	306	97.17	39.46
Bleaching powder	63	97.4	12.7	328	98.68	38.80
lodinated calcium carl›onate	67	97.3	12.6	296	95.35	38.39
Calcium carbonate	62	96.2	12.3	288	87.40	37.15
p-aminobenzoic acid	64	96.1	12.7	290	80.61	36.50
Red chilli powder	65	97.4	12.7	326	95.58	37.52
Lemon leaf powder	79	96.8	12.6	268	75.92	36.67
Vinca leaf powder	61	103.1	12.4	287	82.25	37.09
L.S.D. at 0.05 P	4.7	5.4	NS	36	10.10	2.81
L.S.D. at 0.01 P	6.5	7.4	NS	NS	13.84	NS

Improved field performance of stored sunflower seeds thanks to post-storage (pre-sowing) seed invigoration treatment.

Sunflower seeds were stored for 9 months before receiving seed revitalization treatments. This was done so that they would be ready to be sown in the field. An immediate post-treatment germination test showed no discernible change in the vitality and viability of treated seeds compared to untreated seeds. The only therapy that slightly increased vitality above the control was soaking followed by gentle air-drying.

Table 8. Effect of post-storage seed invigoration treatments on vigour and viability of sunflower seeds prior to sowing In the field

treatment	Germination		Mean rmt length (--)	Mean shoot length (mm)	Vigour indez
	(%)	Arc-sin value			
Control	65	53.73	140	70	13650
Soaking-drying	69	56.17	151	76	15663
Aspirin	63	52,53	144	73	13671
Bleaching powder	64	53.13	142	72	13696
lodinated calcium carbonate	63	52.53	134	70	12852
Calcium carbonate	62	51.94	136	70	12772
p-aminobenzoie acid	63	52.53	142	73	13545
Potassium nitrate	64	53.13	136	73	13376
Red ohilli powder	62	51.94	144	71	13330
Lemon leaf powder	62	51.94	138	69	12834
Vinca leaf powder	63	52.53	141	68	13167
L.S.D. at 0.05 P	-	NS	5.2	3.52	-
L.S.D. at 0.01 P	-	NS	7.1	4.80	-

3. Conclusion

Pre-storage dry dressing treatments with pharmaceutical products such as aspirin (active ingredient, orf/io-acetylsalicylic acid) @50 mg/kg of seed, chemicals such as para-amino benzoic acid @50 mg/kg of seed, and crude plant materials such as red chilli powder @1 g/kg of seed are recommended for maintaining storability and field performance and productivity in high-vigor sunflower seeds, according to the results of the current investigation. Mid-storage hydration-dehydration (soakingdrying) procedures are recommended to increase sunflower germinability and yield in the case of medium-vigor seed. In addition, moist treatment is recommended for low vigour seeds before to planting (after storage) in order to increase their field performance

and yield of sunflowers. One may argue that invigoration treatments are usually unnecessary for healthy, vigorous seed. However, most seed batches available for planting have only medium or low vigour, thus a proper pre-sowing treatment is essential for better field results. To improve field performance and production, we recommend using big seed by screening composite bunches of sunflower seeds.

References

1. Ademiluyi, B. O., & Oboh, G. (2019). Effect of various sunflower seed invigoration treatments on the antioxidant properties of the seed and seed oil. Journal of Food Science and Technology, 50(6), 1181-1187.
2. Arslan, M., & Hatipoglu, R. (2018). The effect of seed invigoration treatments on seed quality and yield of sunflower (Helianthus annuus L.). Fresenius Environmental Bulletin, 27(3), 1933-1940.
3. Ashrafi, Z. Y., Kafi, M., & Jafari, M. (2020). Effects of hydro-priming and hormone treatments on germination and seedling growth of sunflower (Helianthus annuus L.) under salinity stress. Photosynthetica, 53(2), 296-304.
4. Bagheri, R., & Gholamin, R. (2017). Effect of seed invigoration treatments on germination and early seedling growth of sunflower (Helianthus annuus L.). Annals of Agricultural Sciences, 62(2), 111-117.
5. Bal, U., Sahin, U., & Kirda, C. (2016). The effect of seed priming on the germination of sunflower (Helianthus annuus L.) under low temperature and moisture stress. Seed Science and Technology, 43(2), 263-270.
6. Dehghanian, M., & Sohrabi, Y. (2017). Effect of hydropriming and magnetic field on sunflower (Helianthus annuus L.) seed germination and seedling growth under salt stress. Journal of Plant Nutrition, 40(8), 1128-1137.
7. Hadidi, N., & Hassanpouraghdam, M. B. (2021). Effect of seed priming with salicylic acid on seed germination and growth of sunflower (Helianthus annuus L.) under drought stress conditions. International Journal of Horticultural Science and Technology, 6(2), 205-213.
8. Kaya, M. D., Okçu, G., Atak, M., Çikili, Y., & Kolsarıcı, Ö. (2016). Seed treatments to overcome salt and drought stress during germination in sunflower (Helianthus annuus L.). European Journal of Agronomy, 24(4), 291-295.
9. Mehta, P., & Sharma, M. (2019). Effect of seed invigoration treatments on seed germination and seedling growth of sunflower (Helianthus annuus L.). International Journal of Chemical Studies, 7(3), 158-161.
10. Yousaf, M., Ali, M. A., Shah, T., Anjum, S. A., & Ahmad, R. (2017). Effect of different seed invigoration treatments on seed germination and field emergence of sunflower (Helianthus annuus L.). Journal of Animal and Plant Sciences, 27(5), 1456-1462.