



Effect of Seed Priming with GA₃ on Quality Attributes of Harvested Seeds of Sunflower under Mid-Himalayan Region of Himachal Pradesh

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Abstract: To investigate the effect of seed priming with GA₃ on enhancement of seed quality attributes in sunflower, analysis of harvested seeds was done at Department of Seed Science and Technology, Dr YS Parmar UHF, Nauni, Solan during the year 2021-22. Under field conditions, there were ten different seed priming treatments i.e. 8 concentrations of GA₃ (25, 50, 75, 100, 125, 150, 175, 200 ppm) and hydropriming, both for a duration of 12 hours along with control. Among all treatments GA₃ @ 100 ppm significantly enhanced the seed germination (92.25 %), speed of germination (54.66), seedling length (27.84 cm), seedling fresh weight (581.70 mg), seedling dry weight (28.71 mg), SVI-I (2567.79), SVI-II (2648.73), oil content (43.81 %) and resulted in the lowest EC (322.75 μS/m) of harvested seeds. Therefore, seed primed with GA₃ @ 100 ppm for 12 hours could be recommended for improving the seed quality attributes in sunflower.

Keywords: DRS-1, GA₃, Oil content, Seed priming, Sunflower, *Helianthus annuus* L.

Sunflower (*Helianthus annuus* L.), a member of the Asteraceae family, is a highly sought-after oil-yielding plant in the Indian subcontinent (Das et al 2019). Holds a prominent position as one of the world's top three productive oilseed crops (Ahmed et al., 2020). In India, during the 2019-20 season, sunflower cultivation spanned an area of 0.24 million hectares, resulting in a production of 0.22 million tonnes and productivity rate of 891 kg/ha (Anonymous 2020). Despite their many benefits, sunflowers are becoming less prevalent in agricultural areas for a number of reasons, such as being unable to harvest their full potential along food value chains due to unfavorable weather and a shortage of viable seeds for farmers (Bassegio et al., 2016). Therefore, in order to minimize the problems, some seed quality enhancement treatments like priming need to be employed. Choudhary et al (2008) observed that seed priming is a controlled hydration process that restricts germination while facilitating essential physiological and biochemical changes. Among the various priming agents, gibberellic acid (GA₃) is widely recognized and utilized due to its pivotal role in growth and development processes and effectively breaks seed dormancy, promotes germination, stimulates internodal elongation, facilitates hypocotyl growth and induces cell division in the cambial zone (Yamaguchi 2008). Furthermore, demonstrated tolerance to adverse abiotic conditions and exhibit an earlier onset of blooming and maturation, contributing to their overall resilience and productivity (Ulfat et al., 2017). The present investigation aimed to study the effect of seed priming with

GA₃ to enhance quality attributes of harvested seeds in sunflower grown under mid-Himalayan region of H.P.

MATERIAL AND METHODS

The study was conducted at Department of Seed Science and Technology, Dr YS Parmar UHF, Nauni, Solan (H.P.) during the year 2021-22. The seeds of sunflower var. 'DRSH-1' from the field trial were harvested and evaluated for various parameters. In field trial, there were ten different seed priming treatments all for a duration of 12 hours (Table 1). Observations on different parameters including seed germination (%), speed of germination, seedling length (cm), seedling fresh weight (mg), seedling dry weight (mg), seed vigour indices, electrical conductivity (μS/m) and oil content (%) were performed as per the standard procedures.

For computation of seed germination, the seeds were allowed to germinate using paper towel method at 25°C in the seed germinator.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds used}} \times 100$$

Speed of germination was recorded by counting the number of seedlings emerged each day up to final count of seedling emergence and rate of germination (Maguire 1962).

Speed of germination =

$$\frac{\text{Number of normal seedlings}}{\text{Days to first count}} + \dots + \frac{\text{Number of normal seedlings}}{\text{Days to final count}}$$

For measuring the seedling length, ten normal seedlings

were selected at random from each treatment combination. The seedling length was worked out by measuring the total length of each seedling from the tip of the apex leaf to the tip of primary root with the help of a scale and expressed as mean value in centimetre (cm). For calculation of seedling fresh weight, ten normal seedlings selected for seedling length were weighed on an electronic balance and average was worked out and expressed in milligrams (mg). For seedling dry weight ten seedlings were wrapped in butter paper pockets and kept in oven at 50°C for 48 hours. Then, dry weight of seedlings was recorded and the mean value was expressed in milligrams (mg). Seed vigour index-I and II was calculated (Abdul-Baki and Anderson 1973)

Seed vigour index-I = Germination percentage (%) × Seedling length (cm)

Seed vigour index-II = Germination percentage (%) × Seedling dry weight (mg)

For electrical conductivity, four replications of 0.5 g seeds of each treatment were weighed and soaked in 100 ml distilled water and incubated for 24 hours at 25 °C in the dark. At first, the electrical conductivity of distilled water was measured and then the electrical conductivity of the leachate was measured using electrical conductivity meter and actual value was worked out.

Actual electrical conductivity of seeds = Electrical conductivity of leachate - Electrical conductivity of distilled water

Oil content was calculated using Soxhlet Extraction apparatus

$$\% \text{ crude fat} = (W_2 - W_1) \times \frac{100}{S}$$

Where, W_1 = Weight of empty flask (g), W_2 = Weight of flask and extracted fat (g), S = Weight of sample

Statistical analysis: This was done by with windows-based computer application OPSTAT (Sheoran 2006).

RESULTS AND DISCUSSION

Seed germination (%): The various priming treatments on sunflower seeds var. DRSH-1 significantly affected seed germination (Table 1). The seeds primed with GA_3 @ 100 ppm for 12 hours resulted in maximum seed germination (92.25%), while the minimum seed germination (74.75%) was in un-primed seeds. This might be due to accelerated biochemical, metabolic and molecular processes that resulted from the priming of the seeds and led to increased accumulation of enzymatic, nuclear and cytoplasmic contents in the cells thereby leading to establishment of good crop stand in the field (Baskin and Baskin 2014).

Speed of germination: The seeds primed with GA_3 @ 100 ppm for 12 hours resulted in maximum speed of germination

(54.66) and minimum (34.90) in un-primed seeds. The priming with GA_3 has resulted in bolder seeds with thicker seed coat and higher weight that has ensured quick germination. In addition to this, these seeds had larger concentrations of carbohydrates, proteins and RNA, which accelerates the biochemical and metabolic processes involved in germination and led to faster rate of germination (Pavitrarnata et al., 2023). Kumar and Singh (2013) also observed similar results in bitter gourd seeds.

Seedling length (cm): The seeds that were primed with GA_3 @ 100 ppm for 12 hours resulted in maximum seedling length (27.84 cm) and minimum (20.50 cm) in un-primed seeds. The longer seedlings in seeds primed with GA_3 @ 100 ppm may be due to the hastening of numerous processes and reactions during seed germination which led to the improved crop stand establishment in the field (Pallaoro et al., 2016). The results are very similar to Selvakumari et al. (2007) in sweet william and Zahedi et al (2012) in china aster.

Seedling fresh weight (mg): The seeds that were primed with GA_3 @ 100 ppm for 12 hours gave highest fresh weight (581.70 mg) and untreated seeds had the lowest fresh weight (441.48 mg). The increased seedling fresh weight after seed priming with GA_3 @ 100 ppm due to enhance water uptake of seedling which may have activated enzymes and mobilized the reserve materials that were transported in the embryo resulting stronger seedlings as a result of improved growth of embryo. Similar findings were reported by Eisvand et al. (2011) in carrot.

Seedling dry weight (mg): The seeds primed with GA_3 @ 100 ppm for 12 hours exhibited maximum seedling dry weight (28.71 mg), while minimum seedling dry weight (26.27 mg) was found in un-primed seeds. Pratibha et al. (2015) also reported the similar results in papaya.

Seed vigour indices: The maximum value of seed vigour



Plate 1. Seed germination (%) of harvested seed T_1 and T_6

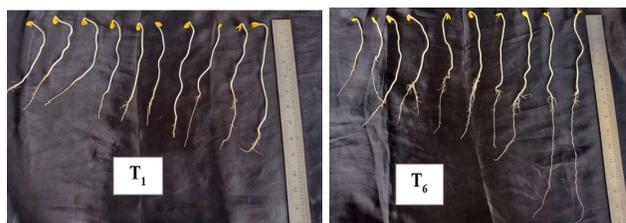


Plate 2. Seedling length (cm) of harvested seed in treatments T_1 and T_6

index-I (2567.79) was in seeds that were primed with GA₃ @ 100 ppm for 12 hours and minimum (1531.89) was in control. The seeds primed with GA₃ @ 100 ppm had the highest value for seed vigour index-I, which may be due to the reason that these seeds had demonstrated the highest percentage of germination and resulted in the seedlings that were tall and robust. Seeds with higher germination percentage and taller seedlings have contributed to the higher seed vigour index-I. Similar results were found by Yari et al. (2011) in bell pepper.

Similarly, seed vigour index-II was maximum (2648.73) in seeds that were primed with GA₃ @ 100 ppm for 12 hours and was found to be minimum (1888.04) in control. The higher seedling vigour of the seeds harvested from the plants obtained from the GA₃ (100 ppm) primed seeds resulted in

the production of much bolder and better quality seeds in the plants. GA₃ primed seeds displayed higher percentage of germination, increased seedling length and seedling dry weight too and this accounted for higher seed vigour index-II. These results are in confirmation with the results of Arefi et al. (2012) in caper seeds.

Electrical conductivity ($\mu\text{S/m}$): The seeds that were primed with GA₃ @ 100 ppm exhibited minimum seed EC (322.75 $\mu\text{S/m}$) whereas, the maximum (466.50 $\mu\text{S/m}$) was in unprimed seeds. Electrical conductivity of seeds was reported maximum in control and may be due to the facts that the seeds might have leaked more solutes when hydrated in water and hence became less vigorous. The minimum electrical conductivity with the GA₃ (100 ppm) treated seeds

Table 1. Effect of GA₃ seed priming for 12 hours on seed quality attributes of freshly harvested seeds in sunflower

Treatments	Seed germination (%) *	Speed of germination	Seedling length (cm)	Seedling fresh weight (mg)	Seedling dry weight (mg)
T ₁ (Control)	74.75 (8.70)	34.90	20.50	441.48	25.26
T ₂ (Hydropriming of seeds)	81.50 (9.08)	37.25	22.46	461.32	25.50
T ₃ (Seed priming with GA ₃ @ 25 ppm)	84.00 (9.22)	39.93	23.79	542.70	25.76
T ₄ (Seed priming with GA ₃ @ 50 ppm)	86.00 (9.33)	42.71	24.79	543.48	25.82
T ₅ (Seed priming with GA ₃ @ 75 ppm)	88.25 (9.45)	46.33	25.12	555.34	25.98
T ₆ (Seed priming with GA ₃ @ 100 ppm)	92.25 (9.66)	54.66	27.84	581.70	28.71
T ₇ (Seed priming with GA ₃ @ 125 ppm)	90.00 (9.54)	50.07	25.21	566.86	26.88
T ₈ (Seed priming with GA ₃ @ 150 ppm)	89.50 (9.51)	48.42	24.58	565.35	26.21
T ₉ (Seed priming with GA ₃ @ 175 ppm)	87.50 (9.41)	46.16	24.12	553.01	25.83
T ₁₀ (Seed priming with GA ₃ @ 200 ppm)	85.25 (9.29)	46.05	23.90	547.02	25.79
Mean	85.90 (9.32)	44.65	24.23	535.83	26.17
CD (p=0.05)	(0.09)	2.13	0.49	13.16	0.23

*Figures in the parenthesis represent square root transformed values

Table 2. Effect of GA₃ seed priming on seed vigour indices, Seed EC and oil content of freshly harvested seeds in sunflower

Treatments	Seed Vigour Index-I (Length)	Seed Vigour Index-II (Mass)	Seed EC ($\mu\text{S/m}$)	Oil content (%)
T ₁	1531.89	1888.04	466.50	41.81
T ₂	1830.22	2078.31	434.50	42.38
T ₃	1997.94	2164.01	396.25	42.71
T ₄	2132.12	2220.51	354.25	42.75
T ₅	2216.87	2292.32	334.25	43.06
T ₆	2567.79	2648.73	322.75	43.81
T ₇	2268.49	2418.76	329.75	43.19
T ₈	2198.99	2345.93	361.75	43.13
T ₉	2110.05	2260.08	376.25	42.75
T ₁₀	2037.38	2198.17	389.25	42.50
Mean	2089.17	2251.48	376.55	42.81
CD (p=0.05)	44.09	52.74	2.28	0.84

See Table 1 for details

could be due to the reason that the seeds were highly vigorous and had leached minimum quantum of solutes. Zahedi et al. (2012) in sweet william and Selvakumari et al. (2007) in China aster also observed same results.

Oil content (%): The seeds that were primed with GA₃ @ 100 ppm for 12 hours resulted in maximum oil content (43.81 %) which was statistically at par with T₇ (43.19 %), T₈ (43.12 %) and T₅ (43.06 %). The minimum oil content was in un-primed seeds (41.81 %).

CONCLUSION

Seed priming with GA₃ @ 100 ppm for 12 hours was found superior among all the treatments tested for quality seed production and significantly improved all the seed quality attributes in sunflower. Therefore, can be recommended for producing quality seeds under mid-Himalayan region of Himachal Pradesh.

AUTHORS CONTRIBUTION

BSD, designed the study and supervised the experiment; AT collected the data, performed the analysis and developed a draft of the manuscript; RS contributed in supervising and drafting; RV contributed in supervising and analysis; SK made contributions in the analysis and drafting; V assisted in data collection and drafting; and further, all the authors improved and approved the manuscript.

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