The Pharma Innovation Journal 2022; 11(3): 401-405

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 401-405

www.thepharmajournal.com
Received: 19-01-2022
Accepted: 21-02-2022

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Effect of seed priming on seed quality enhancement in chia (*Salvia hispanica* L.)

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Abstract
The laboratory experiment was conducted during 2020-21 with 15 treatments and 4 replications planned with CRD design. Seeds of chia were collected from University of Agricultural Sciences, Bangaluru. Results revealed that, among the different priming treatments, T_5 (GA_3 @ 100 ppm) recorded highest seed germination percentage (92.00%), speed of germination (34.85), root length (5.80 cm), shoot length (6.87 cm), seedling length (12.67 cm), seedling dry weight (12.20 mg), seedling vigour index I (1077), seedling vigour index II (1100) and lowest electrical conductivity (0.612 dSm^{-1}). While significantly lowest seed quality parameters (81.00%, 25.86, 4.11, 5.13, 9.24, 9.60, 748 and 778 respectively) and highest electrical conductivity (0.783dSm^{-1}) was recorded in control (T_1).

Keywords: chia, temperature, media, prming

Introduction

Chia (*Salvia hispanica* L.) is a small seeded crop that came from an annual herbaceous plant belongs to the mint family Lamiaceae and its name came from the Latin word ''salvere'', referring to the curative properties of the well known culinary and medicinal herb (*Salvia officinalis*). It is originated from Southern Mexico and Northern Guatemala, Historical records testify that this crop was used beside corn, beans and amaranth by ancient Mesoamerican Cultures- Aztecs and Mayas – in the preparation of folk medicines and food. It is mainly grown for its edible seeds and grows well in tropical and subtropical regions. Seeds are touted for their health benefits, being high in fibre and Omega-3 fatty acids, they are also high in dietary fibre (18-30%), fats (30– 33%), carbohydrates (26–41%), vitamins and dry matter (90–93%) and the seed contains from 25 to 40 per cent oil with 60 per cent of it comprising omega-3 alphalinolenic acid and 20 per cent omega-6 linoleic acid both essential fatty acids are required by the human body for good health and they cannot be artificially synthesized (Vuksan *et. al*., 2010) [24]. Nowadays, Mexico is recognized as the world´s largest chia producer. China was the leading exporter of chia seed, exporting about 112.4 million U.S. dollars worth to the rest of the world in 2020. The exact statistics on the area and production of chia is not available unlike other crops. However in India it is cultivated in the states of Karnataka, Rajasthan and Haryana, Uttarakhand. In Karnataka switching from traditional crops, farmers of Mysure and Bangalore district have boosted chia seeds which are become popular because of their nutritional value.

Chia has been relatively well studied with respect to its nutritional and medicinal values; however, regarding its agronomic aspects, experimental data are still very scarce, especially in the scope of seed technology. In India, the cultivation of this species is recent; therefore, this species does not yet have recommended cultivars. When cultivation comes into picture, the availability of good planting material becomes more crucial. As the seed is the basic unit for cultivation of any crop an adage says "Good seed: Good crop", holds good even today. A good source of quality "Seed" is necessary for raising healthy plants.

High quality seeds play an important role in the successful seed production programme. Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role and also to improve the seedling establishment there is a need to go for seed quality enhancement technique by priming with antioxidants and growth regulators. Several priming techniques have used widely including osmo priming, halo priming, hydro priming, hormone priming and various chemical solutions. Prior to soaking the seeds in priming chemicals, soaking duration needs to be standardized.

Scientifically seed priming is controlled hydration in which seeds are subjected to a certain period of imbibitions using chemical solution and they are dried back to the original moisture content (hydration-dehydration).

Material and Methods

A laboratory experiment was conducted in Department of Seed Science and Technology, College of Agriculture, Raichur during 2020-21, to know the effect of seed priming on seed quality of chia. The experiment was laid in a completely randomised design. There were 15 treatments, T_1: Control, T_2: Hydropriming, T_3: KNO_3 (1%), T_4: KNO_3 (2%), T_5: GA_3 (100 ppm), T_6: GA_3 (200 ppm), T_7: ethrel (50 ppm), T_8: ethrel (100 ppm), T_9: α-tocopherol (0.5%), T_{10}: α-tocopherol (1%), T_{11}: ascorbic acid (50 ppm), T_{12}: ascorbic acid (100 ppm), T_{13}: glutathione (0.05%), T_{14}: glutathione (0.1%) , T_{15}: salicylic acid (1 mM). The seeds were subjected to priming treatments for 10 h in seed to solution ratio of1:10 (w/v) and then seeds were air dried overnight to their original moisture content. These seeds were used for testing seed quality parameter. Data were recorded daily on germination for 14 days and finally on various aspects of speed of germination, root length, shoot length, seedling length, seedling dry weight, seedling vigour index and electrical conductivity.

Germination test was conducted using sixteen replicates of 25 seeds each in the petri plates where seeds were placed on top of two layers of blotter papers and incubated in the walk in seed germination room at alternate temperature 20/30 ± 2°C temperature and 90 ± 5 per cent RH. The number of normal seedlings in each replication was counted at the end of 14^{th} day and the germination percentage was calculated and was expressed in percentage (Anon, 2013).

$$\text{Germination (\%)} = \frac{\text{No. of normal seedlings}}{\text{Total no. of seeds}} \times 100$$

The speed of germination was calculated by using the formula given by Maguire (1962) [17].

Speed of germination = $G_1/D_1 + G_2/D_2 + G_3/D_3 + \ldots\ldots\ldots\ldots. + GnDn$

Where,

G_1, G_2, --- Gn are the number of seeds germinated on D_1, D_2, --- Dn day

Seedling vigour index I and II

The seedling vigour index I and II was computed using the formula as suggested by Abdul-Baki and Anderson (1973) as follows

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

Seedling vigour index II = Germination percentage x Seedling dry weight (mg)

Electrical conductivity (dSm-1)

Five grams of seeds in four replications were soaked in acetone for 30 seconds and thoroughly washed in distilled water three times. Then, the seeds were soaked in 25 ml distilled water and kept in an incubator maintained at 25°C ± 1°C for 12 h. The seed leachate was collected and the volume was made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured in the digital conductivity bridge (ELICO) with a cell constant 1.0 and the mean values were expressed in deci simons per meter (dSm-1) (Milosevic *et al*., 2010) [19].

Results and Discussion

In the present investigations, seed priming enhanced seedling emergence and vigour. Seed primed with GA_3 and SA emerged earlier compare to other treatments. Both GA_3 and SA showed improved germination, seedling length, seedling dry weight which in turn improved higher seedling vigour index, germination speed, *etc*.

The result on physiological parameters as influenced by seed priming with chemicals and antioxidant is presented in the Tables 1 to 3.

Among different seed priming treatments, a significantly higher seed germination (92.00%) and speed of germination (34.85) was reported in treatment GA_3 @ 100 ppm (T_5) which was on par with seeds primed with 1mM SA (T_{15}) which recorded 91.00 (%) and 34.16 respectively. Whereas control (T_1) recorded significantly lowest seed germination (81.00%) and speed of germination (25.86). The enhancement of seed germination percentage in chia seeds occurs mainly due to priming with GA_3 it might be due to gibberellins play a key role in enhancing seed germination mainly because gibberellins are involved in controlling reserve hydrolysis upon which the growing embryo depends and also increase the growth potential of embryos and ultimately promotes the percentage of seed germination. Similar findings were reported by Ashri and Palevitch (1979) [2] in sesame and Costa *et al*. (2021) [5] in *Salvia hispanica*.

The different seed priming treatments showed significant differences for root length, shoot length seedling length and seedling dry weight. Among the various priming, the significantly maximum root length, shoot length, seedling length and seedling dry weight was registered in seeds primed with GA_3 @ 100 ppm (T_5) (5.80 cm, 6.87 cm, 12.67 cm and 12.20 mg, respectively) and control (T_1) recorded significantly lowest root length, shoot length, seeding length and seedling dry weight (4.11 cm, 5.13 cm, 9.24 cm and 9.24 cm respectively). The increase in root length of primed seeds is because GA_3 may enhance the metabolic activity and activates the α-amylase. Thus also increasing protein, sugar and RNA content which might have resulted in quicker germination and better growth of seedlings and resulting in more root length. The present results are also in line with findings of Kattimani *et al*. (1999) [11] and Vakeswaran (2001) in ashwagandha, Gupta (2003) [7] in *Cassia tora*, *Withania coagulens*, *Argemone maxicana* and *Ocimum sanctum*.

Priming of seeds with GA_3 @ 100 ppm for 10 h has revealed highest seedling dry weight compared to control this may be due to the use of GA_3 enhance the water uptake of the seedlings. This might have activated the enzymes responsible for the mobilization of food reserve materials present in the embryo that could have been utilized efficiently for production of vigourous seedlings. Thus increases the fresh weight of the seedlings which is positively correlated with the dry weight of seedlings. These results are in conformity with the study of Rastogi *et al*. (2013) [20] in linseed and Costa *et al*. (2021) [5] in *Salvia hispanica*.

The different priming treatments showed significant differences for seedling vigour index-I and II. Among them, significantly the maximum seedling vigour index-I (1166) and

seedling vigour index II (1122) was recorded in seed priming with GA_3 @ 100 ppm (T_5) and lowest seedling vigour index- I (748) and seedling vigour index II (778) was recorded in control (T_1).
Seedling vigour indices are important for the estimation of seed quality parameters as reported by Abdul-Baki (1980). The higher seedling vigour index-I may be due to the priming of seeds with GA_3 might have increased the soluble protein contents that resulted in membrane reconfiguration as well as the synthesis of the certain membrane, activation and re-synthesis of some enzymes, DNA and RNA (Jeng and Sung (1994) [10]. Similar results have also been reported by Thakur *et al*. (1997) [22] in bell pepper and Lalith Kumar Bharath *et al*. (2008) [14] in tulsi, ashwagandha, periwinkle and kalmegh.
The electric conductivity of seed leachates varied significantly among the priming treatments. Among all the seed priming treatments, significantly lowest electrical conductivity (0.612 dSm^{-1}) was recorded in seed priming with GA_3 at 100 ppm (T_5) and highest electrical conductivity was recorded in control (T_1) (0.789 dSm^{-1}). Generally, electrical conductivity (EC) indicates the membrane integrity and quality of the seeds. Lower the EC, higher the membrane integrity and seed quality. These results may be obtained due to hormonal priming treatments that could significantly lower the EC of seed leachates. Minimum electrical conductivity was observed in seeds primed with gibberellic acid and salicylic acid. The lower the EC of seed leachate for the primed seeds is an indication of better membrane repair during controlled hydration. Similar findings were reported by Maskari *et al*. (2003) [18] in carrot and Khan *et al*. (2005) [13] in turnip.

Table 1: Effect of seed priming on seed germination, speed of germination and root length of chia

Treatment	Seed germination (%)	Speed of germination	Root length (cm)
T_1: Control (without soaking)	81.00	25.86	4.11
T_2: Hydro priming	87.00	28.98	4.42
T_3: Seed priming with KNO_3 (1%)	88.00	30.07	4.60
T_4: Seed priming with KNO_3 (2%)	86.00	28.65	4.40
T_5: Seed priming with GA_3 (100 ppm)	92.00	34.85	5.80
T_6: Seed priming with GA_3 (200 ppm)	90.00	33.68	5.03
T_7: Seed priming with ethrel (50 ppm)	89.25	32.75	4.92
T_8: Seed priming with ethrel (100 ppm)	88.25	31.12	4.80
T_9: Seed priming with α-tocopherol (0.5%)	85.00	29.90	4.73
T_{10}: Seed priming with α-tocopherol (1%)	87.25	30.87	4.50
T_{11}: Seed priming with ascorbic acid (50 ppm)	84.00	28.25	4.30
T_{12}: Seed priming with ascorbic acid (100 ppm)	84.50	30.24	4.68
T_{13}: Seed priming with glutathione (0.05%)	82.00	27.92	4.25
T_{14}: Seed priming with glutathione (0.1%)	82.50	28.75	4.55
T_{15}: Seed priming with salicylic acid (1 mM)	91.00	34.16	5.11
Mean	86.52	30.40	4.70
S.Em±	1.02	0.84	0.06
C.D @ 1%	2.92	2.39	0.18

Table 2: Effect of seed priming on shoot length, seedling length and seedling dry weight of chia

Treatment	Shoot length (cm)	Seedling length (cm)	Seedling dry weight (mg)
T_1: Control (without soaking)	5.13	9.24	9.60
T_2: Hydro priming	5.85	10.27	9.90
T_3: Seed priming with KNO_3 (1%)	6.05	10.65	10.15
T_4: Seed priming with KNO_3 (2%)	5.78	10.18	10.03
T_5: Seed priming with GA_3 (100 ppm)	6.87	12.67	12.20
T_6: Seed priming with GA_3 (200 ppm)	6.60	11.63	11.92
T_7: Seed priming with ethrel (50 ppm)	6.40	11.32	11.81
T_8: Seed priming with ethrel (100 ppm)	6.20	11.00	11.37
T_9: Seed priming with α-tocopherol (0.5%)	6.10	10.83	10.65
T_{10}: Seed priming with α-tocopherol (1%)	5.90	10.40	10.24
T_{11}: Seed priming with ascorbic acid (50 ppm)	5.75	10.05	9.70
T_{12}: Seed priming with ascorbic acid (100 ppm)	6.15	10.83	10.47
T_{13}: Seed priming with glutathione (0.05%)	5.65	9.90	10.11
T_{14}: Seed priming with glutathione (0.1%)	5.88	10.43	10.09
T_{15}: Seed priming with salicylic acid (1 mM)	6.72	11.83	12.10
Mean	6.10	10.75	10.69
S.Em±	0.06	0.10	0.08
C.D @ 1%	0.18	0.29	0.22

Table 3: Effect of seed priming on seedling vigour index I, seedling vigour index II and electrical conductivity of chia

Treatment	Seedling vigour index I	Seedling vigour index II	Electrical conductivity (dSm^{-1})
T_1: Control (without soaking)	748	778	0.789
T_2: Hydro priming	893	861	0.701
T_3: Seed priming with KNO_3 (1%)	937	894	0.646
T_4: Seed priming with KNO_3 (2%)	875	862	0.685
T_5: Seed priming with GA_3 (100 ppm)	1166	1123	0.612
T_6: Seed priming with GA_3 (200 ppm)	1046	1073	0.622
T_7: Seed priming with ethrel (50 ppm)	1010	1054	0.633
T_8: Seed priming with ethrel (100 ppm)	971	1004	0.644
T_9: Seed priming with α-tocopherol (0.5%)	921	905	0.653
T_{10}: Seed priming with α-tocopherol (1%)	907	894	0.663
T_{11}: Seed priming with ascorbic acid (50 ppm)	844	815	0.739
T_{12}: Seed priming with ascorbic acid (100 ppm)	915	885	0.675
T_{13}: Seed priming with glutathione (0.05%)	812	829	0.760
T_{14}: Seed priming with glutathione (0.1%)	861	832	0.714
T_{15}: Seed priming with salicylic acid (1 mM)	1077	1100	0.616
Mean	932	914	0.677
S.Em±	14.62	51.53	0.004
C.D @ 1%	41.77	147.25	0.012

Conclusion

Seed priming with GA_3 @ 100 ppm for 10 h was found to be ideal for obtaining the highest physiological and biochemical parameters.

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