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Standardizing the Priming duration in Coriander (*Coriandrum sativum* L.): A Comprehensive Study

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ABSTRACT: Coriander (*Coriandrum sativum* L.), an annual herb, experiences rapid seed quality decline during storage, affecting crop vigor and establishment. With a minimum germination requirement of 60%, seed priming becomes crucial for enhancing germination and crop stand. The current study focused on standardizing the priming period for the DW-3 coriander variety. Under a Completely Randomized Design, the experiment involved 21 treatments with varied durations (4, 8, 12, 16, and 20 hours) of priming using hydropriming, vermiwash (5%), nano-urea (5%), GA3 at 50 ppm, and a control. Regardless of medium or concentration, GA3 priming for 12 hours resulted in significantly higher germination (80.33%), shoot length (17.47 cm), root length (15.30 cm), seedling length (32.77 cm), and seedling vigour index (26.32) compared to the control. This study highlights the critical impact of priming duration and seed treatment on coriander seed yield and quality, emphasizing the need for optimal priming durations and effective seed treatment techniques in coriander cultivation.

Keywords: Coriander, GA3, priming duration, vermiwash.

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is a globally cultivated annual herbaceous plant within the *Apiaceae* family, native to the Eastern Mediterranean region (Bhat *et al*., 2014; Laribi *et al*., 2015). Exhibiting and romonoecious characteristics, it produces both staminate and perfect flowers on the same plant, arranged in compound terminal umbels. The distinctive fruit is a spherical, ribbed, yellowish-brown schizocarp (Diwan *et al*., 2018).

Having a rich history since 5000 BC, coriander is renowned for its versatility in culinary applications, with leaves known as Chinese Parsley and essential oil (0.03 to 2.6%) (Nadeem *et al*., 2013) from seeds containing d-linalool, coriandrol, α-pinene, p-cymene, and phellandrene. Recognized for its medicinal properties, coriander has demonstrated anti-inflammatory, anti-diabetic, and cholesterol-lowering effects, addressing various conditions (Diwan *et al*., 2018). Research has unveiled its biological activities, including antibacterial action against Escherichia coli, Staphylococcus aureus, and Bacillus subtilis, as well as anticarcinogenic, antioxidant, and anti-diabetic properties (Scandar *et al*., 2023).

India, renowned as the "Home of Spices," leads global coriander production, with key cultivating states such as Rajasthan, Gujarat, Madhya Pradesh, Andhra Pradesh, and Tamil Nadu. The country's annual production stands at 1.40 million metric tonnes, securing the first position worldwide, with Madhya Pradesh leading in coriander seed volume. Other major global producers include Morocco, Canada, Romania, Russia, and Ukraine. Coriander commerce is estimated between 0.85 and 1 lakh tonnes annually, with significant exporting countries being India, Turkey, Egypt, Romania, Morocco, Iran, and China (Anon., 2023).

Seed priming, identified as a cost-effective hydration technique, plays a pivotal role in enhancing germination rates and seedling emergence under adverse field conditions (Heydecker, 1973). This controlled hydration and drying process synchronize germination, reduce fertilizer use, and induce systemic resistance in plants. Coriander, a pivotal winter seed spice, holds culinary and medicinal significance globally. Recognized for its health benefits and medicinal applications (Matasyoh *et al*., 2009; Begnami *et al*., 2010), coriander is used as a remedy for ailments like cold, fever, and stomach disorders. Despite its pharmaceutical use primarily involving masking the taste of medicinal compounds or soothing stomach irritation caused by certain medications, the seeds and plant parts contribute to household medicines, emphasizing its multifaceted utility.

This study focuses on seed priming, a controlled hydration process initiating essential biological processes for germination without actual germination, promoting metabolic activity. The experiment titled " Standardizing the Priming duration in Coriander (*Coriandrum sativum* L.): A Comprehensive Study" aims to assess the impact of different priming media and durations on coriander's germination, growth, yield, and essential oil content. It addresses gaps in understanding germination behavior, field establishment, and their subsequent influence on yield and quality, contributing valuable insights to coriander cultivation practices.

MATERIAL AND METHODS

The study was executed at the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad, Karnataka, using a Completely Randomized Design with three replications. Coriander seeds (DW-3), obtained from the Seed Unit at UAS, Dharwad, underwent a meticulous seed preparation process, involving a 16-hour soaking period followed by drying to restore the original 8% moisture content. Subsequently, the seeds were exposed to 21 distinct seed priming treatments in various combinations, as outlined in the accompanying table.

Treatment	Details	Treatment	Details
T_1	Control	T_{12}	Seed priming with Nano urea @ 0.5 % (4 h)
T_2	Hydropriming (4 h)	T_{13}	Seed priming with Nano urea @ 0.5 % (8 h)
T_3	Hydropriming (8 h)	T_{14}	Seed priming with Nano urea @ 0.5 % (12 h)
T_4	Hydropriming (12 h)	T_{15}	Seed priming with Nano urea @ 0.5 % (16 h)
T_5	Hydropriming (16 h)	T_{16}	Seed priming with Nano urea @ 0.5 % (20 h)
T_6	Hydropriming (20 h)	T_{17}	Seed priming with GA_3 @ 50 ppm (4 h)
T_7	Seed priming with Vermiwash @ 5 % (4 h)	T_{18}	Seed priming with GA_3 @ 50 ppm (8 h)
T_8	Seed priming with Vermiwash @ 5 % (8 h)	T_{19}	Seed priming with GA_3 @ 50 ppm (12 h)
T_9	Seed priming with Vermiwash @ 5 % (12 h)	T_{20}	Seed priming with GA_3 @ 50 ppm (16 h)
T_{10}	Seed priming with Vermiwash @ 5 % (16 h)	T_{21}	Seed priming with GA_3 @ 50 ppm (20 h)
T_{11}	Seed priming with Vermiwash @ 5 % (20 h)		

Seed quality parameters, including seed germination (%), speed of germination (%), root length (cm), shoot length (cm), seedling length (cm), seedling vigor indices, field emergence (%), seedling dry weight (g), and seed infection (%), were recorded from three replications.

RESULTS AND DISCUSSION

The assessment of the different seed quality parameters in the coriander variety DW-3 showed a significant response to various seed priming treatments and durations. Notably, T19 (GA3 @ 50 ppm for 12 hrs) exhibited the highest germination percentage (80.33%), comparable to T7 (vermiwash @ 5% for 4 hrs) at 79.67%, while the lowest germination (54.33%) was observed in T6 (hydropriming for 20 hrs). Gibberellic acid (GA3), a potent endogenous plant hormone, naturally occurs in plants and exerts significant effects on cell growth and elongation, playing a crucial role in influencing germination, vigor, and nutrient uptake. The substantial accumulation of nucleic acid in seeds subjected to GA3 priming, leading to an accelerated germination process (Islam *et al*., 2012). The speed of germination followed a similar trend, with T19 and T7 demonstrating significantly higher rates (24.00% and 17.00%, respectively) compared to T11 (vermiwash @ 5% for 20 hrs) at 4.67% which exhibited lowest speed of germination (Table 1 and Fig. 1). Similarly, higher rates of germination after priming were also reported by Ramón Zulueta-Rodríguez *et al*., 2015; Salve, 2021).

In case of root and shoot lengths, the T19 recorded the highest values (17.47 cm and 15.30 cm, respectively), followed by T7 and T8 (Table 2 and Fig. 2). Seedling length and vigor indices were also notably affected, with T19 displaying the highest seedling length and vigor index-I (32.77 cm and 2632, respectively), paralleled by T7. Conversely, T16 (nano urea @ 0.5% for 20 hrs) recorded significantly lower values (Table 3 and Fig. 3). Priming induces the leaching of growth inhibitors, subsequently amplifying the activity of various enzymes such as malate synthase, iso-citrate lyase, and malate dehydrogenase (Lin and Sung 2001). This process also enhances the antioxidative response, reduces lipid peroxidation (Islam *et al*., 2012), facilitates membrane and organelle repair, and mobilizes stored materials (Sarika *et al*., 2013). These cumulative effects contribute to the observed heightened root and shoot lengths. Seedling dry weight and vigor index-II were significantly impacted by seed priming treatments (Table 4 and Fig. 4), with T19 recording the highest values (1.87 g and 150.22, respectively), followed by T7. T20 (GA3 @ 50 ppm for 16 hrs) exhibited a higher vigor index-II (129.75) than T7 (vermiwash @ 5% for 4 hrs). Seed infection percentages varied among treatments, with T19, T7, T4, and T3 showing the lowest values (Table 5 and Fig. 5), and T21 (GA3 @ 50 ppm for 20 hrs) displaying the highest seed infection (5.67%). Field emergence rates also exhibited treatment-dependent variations. T19 and T7 demonstrated the highest emergence rates (68.33% and 67.72%, respectively), while T6 exhibited the significantly lowest rate at 42.10% (Table 5 and Fig. 5). These findings contribute to a comprehensive understanding of the coriander seed response to diverse priming treatments, offering valuable insights for cultivation practices.

The study on seed priming aimed to hasten germination and enhance plant resistance to stress, benefiting agricultural activity. Physiological, biochemical, and molecular events during seed priming play a significant role in aiding seeds to withstand stress conditions. In the laboratory experiment with 21 treatment combinations, T19 (GA3 @ 50 ppm for 12 hrs) stood out, demonstrating superior results in various parameters. These results are in agreement with the findings of Debbarma *et al.* (2018). Both T19 and T7 (vermiwash @ 5% for 4 hrs) showed lower seed infection percentages (4.00%) compared to other treatments.

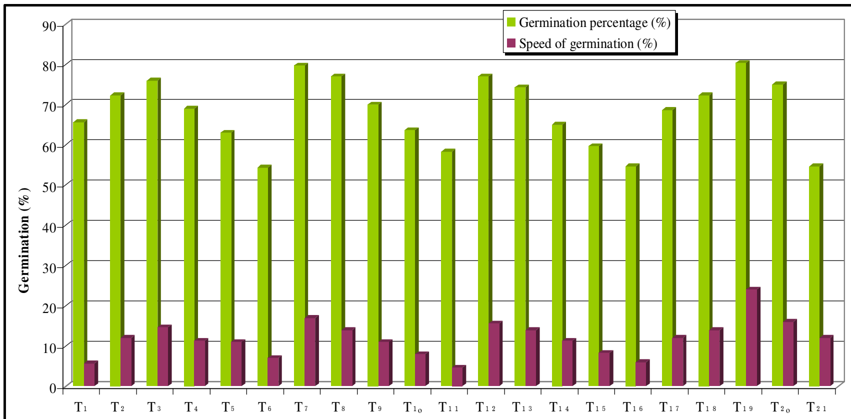
Gibberlic acid and vermiwash seed priming exhibited advantageous outcomes, including increased solubilization of seed storage proteins, essential for nutrient accessibility during germination. The improvement in vigour index was attributed to enhanced germination, stimulated enzymatic activities, and improved food reserve mobilization. Vermiwash, with growth-promoting effects, mimicked Gibberellic acid's impact, showcasing a comparable effect in this study. Priming treatments also showed potential in reducing lipid peroxidation, enhancing seed viability and vigor, aligning with previous studies on *Momordica charantia* L. and *Zea mays* L. seeds (Yeh *et al*., 2005; Randhir and Shetty 2005).

Table 1: Effect of seed priming treatment on Germination percentage (%), Speed of germination, Root length (cm), Shoot length (cm) and Seedling length (cm) in coriander.

Treatment details	Germination percentage (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)
T_1: Control	65.67 (54.13) *	05.67 (13.76)	09.84	07.56	17.40
T_2: Hydropriming 4 h	72.33 (58.26)	12.00 (20.26)	14.57	10.77	25.34
T_3: Hydropriming 8 h	76.00 (60.67)	14.67 (22.50)	16.11	12.36	28.47
T_4: Hydropriming 12 h	69.00 (56.17)	11.33 (19.85)	10.51	08.66	19.16
T_5: Hydropriming 16 h	63.00 (52.54)	11.00 (19.36)	09.60	07.88	17.48
T_6: Hydropriming 20 h	54.33 (47.48)	07.00 (15.36)	08.70	06.31	15.01
T_7: Seed priming with Vermiwash @ 5 % 4 h	79.67 (63.20)	17.00 (24.34)	16.83	14.45	31.27
T_8: Seed priming with Vermiwash @ 5% 8 h	77.00 (61.34)	14.00 (21.96)	16.05	14.17	30.22
T_9: Seed priming with Vermiwash @ 5 % 12 h	70.00 (56.79)	11.00 (19.36)	13.14	11.25	24.39
T_{10}: Seed priming with Vermiwash @ 5 % 16 h	63.67 (52.93)	08.00 (16.41)	08.87	07.41	16.28
T_{11}: Seed priming with Vermiwash @ 5 % 20 h	58.33 (49.80)	04.67 (12.46)	08.40	06.70	15.10
T_{12}: Seed priming with Nano urea @ 0.5 % 4 h	77.00 (61.34)	15.67 (23.30)	16.47	14.21	30.68
T_{13}: Seed priming with Nano urea @ 0.5 % 8 h	74.33 (59.56)	14.00 (21.96)	15.25	13.64	28.89
T_{14}: Seed priming with Nano urea @ 0.5 % 12h	65.00 (53.73)	11.33 (19.65)	10.08	08.98	19.06
T_{15}: Seed priming with Nano urea @ 0.5 % 16h	59.67 (50.58)	08.33 (16.77)	09.70	08.01	17.71
T_{16}: Seed priming with GA_3 @ 50 ppm 20 h	54.67 (47.68)	06.00 (14.15)	08.40	06.43	14.83
T_{17}: Seed priming with GA_3 @ 50 ppm 4 h	68.67 (55.96)	12.00 (20.26)	10.58	09.57	20.15
T_{18}: Seed priming with GA_3 @ 50 ppm 8 h	72.33 (58.26)	14.00 (21.96)	14.57	12.38	26.95
T_{19}: Seed priming with GA_3 @ 50 ppm 12 h	80.33 (63.67)	24.00 (29.32)	17.47	15.30	32.77
T_{20}: Seed priming with GA_3 @ 50 ppm 16 h	75.00 (60.00)	16.00 (23.55)	15.73	13.87	29.61
T_{21}: Seed priming with GA_3 @ 50 ppm 20 h	54.67 (47.68)	12.00 (20.20)	08.57	06.36	14.92
Mean	**68.16**	**11.89**	**12.35**	**10.30**	22.65
S. Em. ±	**0.44**	**0.60**	**00.39**	**00.41**	0.98
SC. D. @ 1 %	**1.71**	**2.31**	**1.48**	**01.54**	3.42

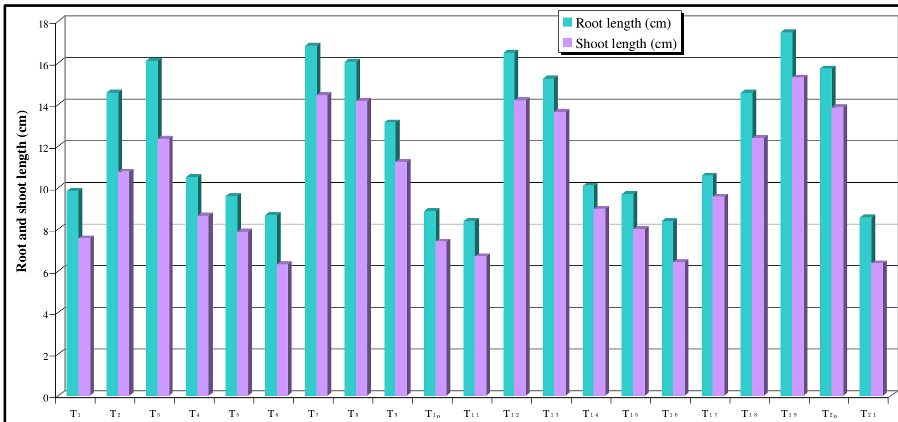
Table 2: Effect of seed priming treatment on Seedling vigour index I, Seedling dry weight (g), Seedling vigour index II, Field emergence (%) and Seed Infection (%) in coriander.

Treatment details	Seedling vigour index I	Seedling dry weight (g)	Seedling vigour index II	Field emergence (%)	Seed Infection (%)
T_1: Control	1143	1.30	85.37	53.61 (47.07) *	5.33 (13.34) *
T_2: Hydropriming 4 h	1833	1.37	99.09	60.41 (51.01)	5.00 (12.88)
T_3: Hydropriming 8 h	2164	1.43	108.68	64.29 (53.31)	4.00 (11.48)
T_4: Hydropriming 12 h	1323	1.30	89.70	57.14 (49.11)	4.00 (11.48)
T_5: Hydropriming 16 h	1101	1.27	80.01	50.96 (45.11)	4.67 (12.46)
T_6: Hydropriming 20 h	815	1.20	65.20	42.10 (40.45)	5.00 (12.88)
T_7: Seed priming with Vermiwash @ 5 % 4 h	2492	1.60	127.47	67.72 (55.38)	4.00 (11.48)
T_8: Seed priming with Vermiwash @ 5% 8 h	2327	1.57	120.89	64.91 (53.68)	4.33 (12.00)
T_9: Seed priming with Vermiwash @ 5 % 12 h	1707	1.33	93.10	58.19 (49.71)	4.67 (12.46)
T_{10}: Seed priming with Vermiwash @ 5 % 16 h	1037	1.27	80.86	51.71 (45.98)	5.00 (12.88)
T_{11}: Seed priming with Vermiwash @ 5 % 20 h	881	1.17	68.25	46.29 (42.87)	5.33 (13.34)
T_{12}: Seed priming with Nano urea @ 0.5 % 4 h	2362	1.57	120.89	65.11 (53.80)	4.33 (12.00)
T_{13}: Seed priming with Nano urea @ 0.5 % 8 h	2147	1.47	109.27	62.33 (52.15)	5.00 (12.00)
T_{14}: Seed priming with Nano urea @ 0.5 % 12h	1239	1.37	89.05	52.99 (46.71)	5.00 (12.88)
T_{15}: Seed priming with Nano urea @ 0.5 % 16h	1057	1.33	79.36	47.70 (43.68)	5.00 (12.88)
T_{16}: Seed priming with GA_3 @ 50 ppm 20 h	811	1.23	67.24	42.66 (40.78)	5.00 (12.88)
T_{17}: Seed priming with GA_3 @ 50 ppm 4 h	1384	1.47	100.94	56.66 (48.83)	4.67 (12.46)
T_{18}: Seed priming with GA_3 @ 50 ppm 8 h	1949	1.53	110.66	60.51 (51.07)	5.00 (12.88)
T_{19}: Seed priming with GA_3 @ 50 ppm 12 h	2632	1.87	150.22	68.33 (55.76)	4.00 (11.48)
T_{20}: Seed priming with GA_3 @ 50 ppm 16 h	2220	1.73	129.75	62.99 (52.40)	4.33 (12.00)
T_{21}: Seed priming with GA_3 @ 50 ppm 20 h	816	1.70	92.94	42.66 (40.78)	5.67 (13.76)
Mean	1639	**1.43**	**98.52**	**56.16**	**4.73**
S. Em. ±	66	**0.08**	**5.37**	**0.55**	**0.67**
C. D. @ 1 %	253	**0.29**	**20.51**	**2.11**	**2.55**



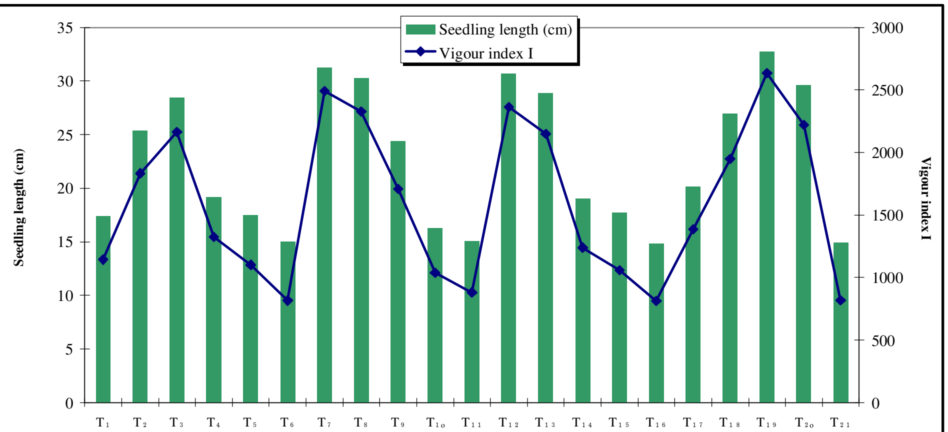
T_1: Control
T_2: Hydropriming 4 h
T_3: Hydropriming 8 h
T_4: Hydropriming 12 h
T_5: Hydropriming 16 h
T_6: Hydropriming 20 h
T_7: Seed priming with Vermiwash @ 5 % 4 h
T_8: Seed priming with Vermiwash @ 5% 8 h
T_9: Seed priming with Vermiwash @ 5 % 12 h
T_{10}: Seed priming with Vermiwash @ 5 % 16 h
T_{11}: Seed priming with Vermiwash @ 5 % 20 h
T_{12}: Seed priming with Nano urea @ 0.5 % 4 h
T_{13}: Seed priming with Nano urea @ 0.5 % 8 h
T_{14}: Seed priming with Nano urea @ 0.5 % 12h
T_{15}: Seed priming with Nano urea @ 0.5 % 16h
T_{16}: Seed priming with GA_3 @ 50 ppm 20 h
T_{17}: Seed priming with GA_3 @ 50 ppm 4 h
T_{18}: Seed priming with GA_3 @ 50 ppm 8 h
T_{19}: Seed priming with GA_3 @ 50 ppm 12 h
T_{20}: Seed priming with GA_3 @ 50 ppm 16 h
T_{21}: Seed priming with GA_3 @ 50 ppm 20 h

Fig. 1. Effect of seed priming treatment on Germination percentage (%) and Speed of germination (%) in coriander



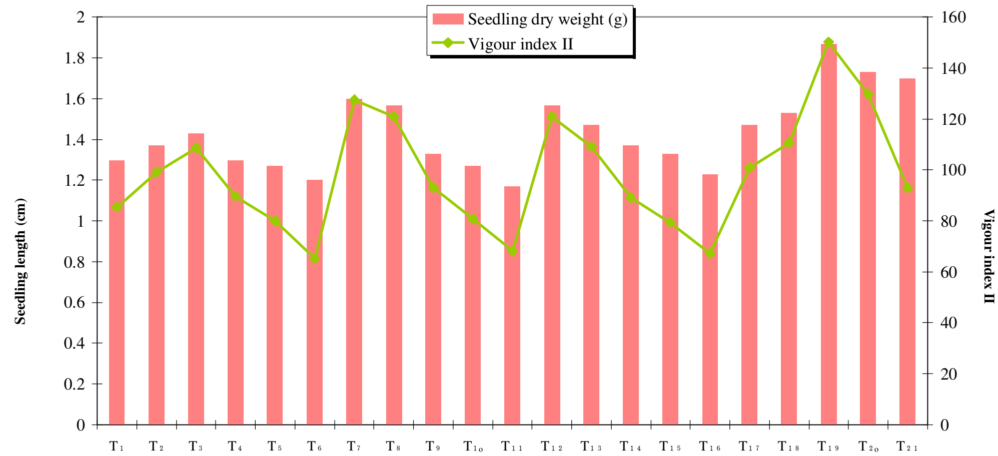
T_1: Control
T_2: Hydropriming 4 h
T_3: Hydropriming 8 h
T_4: Hydropriming 12 h
T_5: Hydropriming 16 h
T_6: Hydropriming 20 h
T_7: Seed priming with Vermiwash @ 5 % 4 h
T_8: Seed priming with Vermiwash @ 5% 8 h
T_9: Seed priming with Vermiwash @ 5 % 12 h
T_{10}: Seed priming with Vermiwash @ 5 % 16 h
T_{11}: Seed priming with Vermiwash @ 5 % 20 h
T_{12}: Seed priming with Nano urea @ 0.5 % 4 h
T_{13}: Seed priming with Nano urea @ 0.5 % 8 h
T_{14}: Seed priming with Nano urea @ 0.5 % 12h
T_{15}: Seed priming with Nano urea @ 0.5 % 16h
T_{16}: Seed priming with GA_3 @ 50 ppm 20 h
T_{17}: Seed priming with GA_3 @ 50 ppm 4 h
T_{18}: Seed priming with GA_3 @ 50 ppm 8 h
T_{19}: Seed priming with GA_3 @ 50 ppm 12 h
T_{20}: Seed priming with GA_3 @ 50 ppm 16 h
T_{21}: Seed priming with GA_3 @ 50 ppm 20 h

Fig. 2. Effect of seed priming treatment on Rooth length (cm) and Shoot length (cm) in coriander



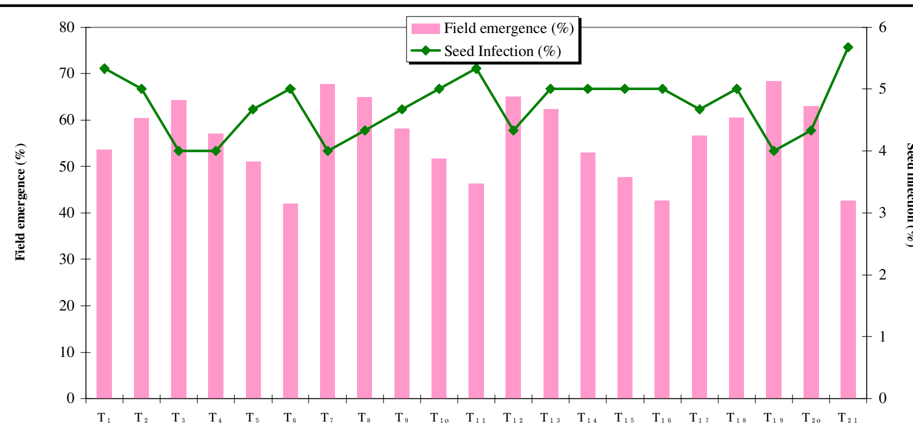
T_1: Control
T_2: Hydropriming 4 h
T_3: Hydropriming 8 h
T_4: Hydropriming 12 h
T_5: Hydropriming 16 h
T_6: Hydropriming 20 h
T_7: Seed priming with Vermiwash @ 5 % 4 h
T_8: Seed priming with Vermiwash @ 5% 8 h
T_9: Seed priming with Vermiwash @ 5 % 12 h
T_{10}: Seed priming with Vermiwash @ 5 % 16 h
T_{11}: Seed priming with Vermiwash @ 5 % 20 h
T_{12}: Seed priming with Nano urea @ 0.5 % 4 h
T_{13}: Seed priming with Nano urea @ 0.5 % 8 h
T_{14}: Seed priming with Nano urea @ 0.5 % 12h
T_{15}: Seed priming with Nano urea @ 0.5 % 16h
T_{16}: Seed priming with GA_3 @ 50 ppm 20 h
T_{17}: Seed priming with GA_3 @ 50 ppm 4 h
T_{18}: Seed priming with GA_3 @ 50 ppm 8 h
T_{19}: Seed priming with GA_3 @ 50 ppm 12 h
T_{20}: Seed priming with GA_3 @ 50 ppm 16 h
T_{21}: Seed priming with GA_3 @ 50 ppm 20 h

Fig. 3. Effect of seed priming treatment on Seedling length (cm) and Vigour index I in coriander



T1: Control
T2: Hydropriming 4 h
T3: Hydropriming 8 h
T4: Hydropriming 12 h
T5: Hydropriming 16 h
T6: Hydropriming 20 h
T7: Seed priming with Vermiwash @ 5 % 4 h
T8: Seed priming with Vermiwash @ 5% 8 h
T9: Seed priming with Vermiwash @ 5 % 12 h
T10: Seed priming with Vermiwash @ 5 % 16 h
T11: Seed priming with Vermiwash @ 5 % 20 h
T12: Seed priming with Nano urea @ 0.5 % 4 h
T13: Seed priming with Nano urea @ 0.5 % 8 h
T14: Seed priming with Nano urea @ 0.5 % 12h
T15: Seed priming with Nano urea @ 0.5 % 16h
T16: Seed priming with GA_3 @ 50 ppm 20 h
T17: Seed priming with GA_3 @ 50 ppm 4 h
T18: Seed priming with GA_3 @ 50 ppm 8 h
T19: Seed priming with GA_3 @ 50 ppm 12 h
T20: Seed priming with GA_3 @ 50 ppm 16 h
T21: Seed priming with GA_3 @ 50 ppm 20 h

Fig. 4. Effect of seed priming treatment on Seedling dry weight (g) and Vigour index II in coriander



T1: Control
T2: Hydropriming 4 h
T3: Hydropriming 8 h
T4: Hydropriming 12 h
T5: Hydropriming 16 h
T6: Hydropriming 20 h
T7: Seed priming with Vermiwash @ 5 % 4 h
T8: Seed priming with Vermiwash @ 5% 8 h
T9: Seed priming with Vermiwash @ 5 % 12 h
T10: Seed priming with Vermiwash @ 5 % 16 h
T11: Seed priming with Vermiwash @ 5 % 20 h
T12: Seed priming with Nano urea @ 0.5 % 4 h
T13: Seed priming with Nano urea @ 0.5 % 8 h
T14: Seed priming with Nano urea @ 0.5 % 12h
T15: Seed priming with Nano urea @ 0.5 % 16h
T16: Seed priming with GA_3 @ 50 ppm 20 h
T17: Seed priming with GA_3 @ 50 ppm 4 h
T18: Seed priming with GA_3 @ 50 ppm 8 h
T19: Seed priming with GA_3 @ 50 ppm 12 h
T20: Seed priming with GA_3 @ 50 ppm 16 h
T21: Seed priming with GA_3 @ 50 ppm 20 h

Fig. 5. Effect of seed priming treatment on Field emergence (%) and Seed Infection (%) in coriander

CONCLUSIONS

The investigation into the standardization of seed priming durations in coriander unveiled notable disparities in seed quality parameters resulting from diverse seed priming treatments. Specifically, the seed priming treatment involving GA3 at 50 ppm for a duration of 12 hours (denoted as T19) exhibited superior outcomes across various metrics, including germination rate, speed of germination, root length, shoot length, seedling vigor index-I, seedling dry weight, seedling vigor indices, field emergence, and displayed the lowest seed infection percentage. These findings emphasize the significant efficacy of 12-hour GA3 priming in enhancing coriander seed quality, suggesting promising implications for improving crop establishment and early-stage growth.

FUTURE SCOPE

These findings highlight the potential of a 12-hour GA3 priming method to enhance coriander seed quality, offering promising prospects for improving crop establishment and early-stage growth.

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Conflict of Interests. None.

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