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Effect of different priming treatments on germination, growth and development of seedlings of China aster [*Callistephus chinensis* (L.) Nees] cv. Phule Ganesh purple

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Abstract
An experiment on "Effect of different Priming treatments on Germination, Growth and Development of Seedlings of China Aster [*Callistephus Chinensis* (L.) Nees] cv. Phule Ganesh Purple" was conducted at the Centre of Excellence Protected Cultivation & Precision Farming, IGKV, Raipur (C.G), during *Rabi* (2022-23) season. The experiment was laid out in Completely Randomized Design (CRD) with three replications. There were 15 treatments *viz.*, P_0 (Control non primed seeds), P_1 (Hydropriming Tap water), P_2 (GA_3 100 ppm), P_3 (GA_3 200 ppm), P_4 (GA_3 300 ppm), P_5 (KNO_3 0.1%), P_6 (KNO_3 0.5%), P_7 ($KNO_3$1%), P_8 ($CaCl_2$ 0.1%), P_9 ($CaCl_2$ 0.5%), P_{10} ($CaCl_2$ 1%), P_{11} (*Trichoderma* @ 10 g/Kg seed), P_{12} (*Trichoderma* @ 1×10^5 cfu/ml) P_{13} (GA_3 200 ppm + *Trichoderma* @ 10 g/Kg Seed) and P_{14} (GA_3 200 ppm + *Trichoderma* @ 1×10^5 cfu/ml). Findings revealed that seed priming with P_3 (GA_3 200 ppm) performed best in terms of minimum days taken to seed germination (9.06 days) and germination percentage (94.33%) which was statistically at par with P_4 (GA_3 300 ppm) in terms of minimum days taken to seed germination (11 days) and germination percentage (92.33%).
P_4 (GA_3 300 ppm) performed best in terms of days required to reach 4-6 leaf stage (22.99 days), Shoot length (9.3 cm), Root length (4.73 cm), Seedling length (13.56 cm), Seedling fresh weight (0.79 g), Seedling Dry weight (111.66 mg) Seed vigor index-I (850.49), Seed vigour index-II (10,219.90), followed by P_3 (GA_3 200 ppm).

Keywords: China aster, seed priming, GA_3, $CaCl_2$, KNO_3, *Trichoderma*

Introduction
The Asteraceae family includes the valuable annual flower known as the China Aster (*Callistephus chinensis* (L.) Nees), which is *native* to both China and Europe. Greek words Kalistos, which means "most beautiful," and Stephus, means "a crown," are combined to form the name Callistephus. Cassini gave the name China Asteras *Callistephus hortensis*. Linnaeus gave it the first name *Aster chinensis*, which Nees later modified to *Callistephus chinensis* (Janakiram, 2006) [6]. China Asteris commercially grown in the Indian subcontinent by marginal and small farmers in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, and West Bengal.
Seed germination is considered as critical stage in the whole life of a plant (Yang *et al*., 2008) [13] Seed priming indicate an enhancement in seed accomplishment by any physicochemical or postharvest treatment and controlled hydro-priming resulting in high-grade seed storability, enhanced germination% and growth performance in field over a broad spectrum of climatic situations. Advanced seed priming methods are utilized to overcome emergence time, accomplish uniform emergence. The purpose of priming in China Aster is to increase germination percent, reduce germination time and improving growth and vigour of seedling at very wide favour and unfavoured environmental conditions. In China Aster, some of the cultivars show poor germination.
In Zinnia when seeds were hydroprimed significant effect observed hydroprimed improved germination percentage and decreased the percentage of diseased seedlings and dead seeds (Szopinska and Wojtaszek, 2011) [12]. Seed priming of China Aster with GA_3 at 300 ppm improved seed germination, vegetative and flowering growth, and shelf life (Bhandari R. *et al*., 2022) [3]. Cockscomb Seed priming with KNO_3 of 0.2% found maximum seed germination percentage (Ghaleh *et al*., 2017) [5]. Seed priming of *Gerbera jamesonii* and *Zinnia elegans* with treatment on 50 mM $CaCl_2$ enhanced uniformity and improved seed germination (Ahmad

et al., 2017) [1, 5]. Bio-priming with *T. harzianum* has shown good results in germination, growth, flowering and seed attributes of Antirrhinum (Bhargava, B., 2015) [4].

Materials and Methods

The investigation was conducted at the Centre of Excellence Protected Cultivation & Precision Farming, College of Agriculture, IGKV, Raipur (C.G), during *Rabi* (2022-23). The seeds of China Asterwere primed for 24 hours with 15 treatments *viz*., P_0 (Control non primed seeds), P_1 (Hydropriming Tap water), P_2 (GA_3 100 ppm), P_3 (GA_3 200 ppm), P_4 (GA_3 300 ppm), P_5 (KNO_3 0.1%), P_6 (KNO_3 0.5%), P_7 ($KNO_3$1%), P_8 ($CaCl_2$ 0.1%), P_9 ($CaCl_2$ 0.5%), P_{10} ($CaCl_2$ 1%), P_{11} (*Trichoderma* @ 10 g/Kg seed), P_{12} (*Trichoderma* @ 1×10^5 cfu/ml), P_{13} (GA_3 200 ppm + *Trichoderma* @ 10 g/Kg Seed)), P_{14} (GA_3 200 ppm + *Trichoderma* @ 1×10^5 cfu/ml). 200 seeds were kept in 10 cm petri dish on filter paper and moistened with 5ml of different priming solution. All the petri dishes were kept at 23 °C for 24 hours the seeds were taken out and spread in a thin layer on blotting paper for drying under room conditions. The healthy, pure and disease-free primed seeds of China Aster cv. “Phule Ganesh Purple” were sown in protrays @ 1 per cell with convenient media of cocopeat. Then protrays are kept in germination chamber till germination begins.

Results and Discussion

The significant difference was found with all the parameters in seedling stage due to various priming treatments (Table 1, Table 2).

1. Days taken to seed germination

Days taken to seed germination was found to be minimum (9.06 days) with treatment P_3 (GA_3 200 ppm) which was statistically at par (11.00days) with P_4 (GA_3 300 ppm) followed by P_{13} (11.33 days), whereas more days to seed germination (15.5 days) was noticed in P_0 (Control).

GA_3 might have increased the á- amylase activity for breaking starch stored in seeds to alter the physiology of embryo and activated enzymes which accelerate various developmental processes (Basra *et al.*, 2005) [2]. These results are in close proximity with the studies of Selvakumari *et al*. (2007) [10], (Pangtu *et al*., 2017) [9] who observed the lesser time taken to germination of seeds with GA_3 (100 ppm) in China Aster, Bhandari rekha *et al.* (2022) [3] in China Aster,

2. Percentage germination (%)

Maximum germination percentage (94.33%) was noticed in seeds treated with P_3 (GA_3 200 ppm) and it was found to be statistically at par with P_4 (92.33%) and P_{13} (91.43%). However, it was minimum (68.66%) as observed in P_0 (Control)

GA_3 activated the enzymes that digested the endosperm carbohydrates rapidly and efficiently and reduced the mechanical restraints of endosperm thus, providing energy to start and sustain embryo growth. Similar findings were reported earlier by Selvakumari *et al*. (2007) [10], (Zahedi *et al.*, 2012) [14], (Pangtu *et al*., 2017) [9], Bhandari Rekha *et al.* (2022) [3] in China Aster.

3. Days required to reach 4- 6 leaf stage (days)

minimum days required to reach 4-6 leaf stage (22.99 days) was noticed in seeds treated with P_4 (GA_3 300 ppm) followed by P_{13} (24.66), maximum days required to reach 4- 6 leaf stage (33.16 days) was observed in P_0 (Control).

Pre-sowing hydration might have softened the seed coat that allowed the leakage of germination inhibitors in the seed and this might have contributed to the enhancement of seed germination and early transplanting of the seedlings. Similar findings were reported by (Pangtu *et al*., 2017) [9], in China Aster.

4. Shoot length (cm)

Maximum Shoot length was observed in seeds treated with P_4 (GA_3 300 ppm) resulted in maximum shoot length (9.3 cm) which was found to be statistically at par with P_3 (8.3 cm), P_{14} (7.96 cm), P_6 (7.96 cm) and P_{13} (7.90 cm), it was minimum (5.63 cm) in P_0 (Control).

The increasing in shoot length priming with GA3 might be due to the higher rate of cell division in the root and shoot tips incited by the application of GA3 and these studies are in conformity with the work of Montero *et al*. (1990) [7] in Antirrhinum. Similar findings were reported by Pangtu *et al*. (2017) [9], Sidana G *et al*. (2019) [11] in China Aster.

5. Root length (cm)

Maximum Root length (4.73 cm) was recorded under the treatment P_4 (GA_3 300 ppm) which was found to be statistically at par with P_3 (GA_3 200 ppm) (3.83) and, whereas it was minimum (1.86 cm) in P_0 treatment (Control).

The increased root length following priming with GA_3 might be due to the higher rate of cell division in the root and shoot tips incited by the application and these studies are in confirmation with the work of Montero *et al.* (1990) [7] in Antirrhinum, These results are in close proximity with the studies of (Pangtu *et al*., 2017) [9] in China Asterwho observed maximum root length with GA_3 100 ppm and Sidana G *et al*. (2019) [11] in China Aster.

6. Seedling length (cm)

As regards the effect of different seed priming treatments, maximum seedling length (13.56 cm) was noticed in seeds treated with P_4 (GA_3 300 ppm) followed by P_3 (11.6) whereas, it was minimum (7.53cm) in P_0 (Control).

Maximum seedling length observed when seeds were treated with GA_3 (300 ppm) This might be ascribed to the fact that this increase in root and shoot length of the seedlings could be positively be correlated with respect to an increase in seedling length. Similar findings were reported by of (Pangtu *et al*., 2017) [9] in China Asterand Sidana G *et al*. (2019) [11] in China Aster.

7. Seedling fresh weight (mg)

Effect of different seed priming treatments, maximum seedling fresh weight (0.79 g) was noticed in seeds treated with P_4 (GA_3 300 ppm) which was found to be statistically at par with P_3 (0.72 g) and P_7 (0.66 g) whereas, it was minimum (0.31 g) in P_0 (Control).

This might be due to increased water uptake of the growing seedlings with response of GA_3 which might have activated the enzymes with accumulation of carbohydrate and thus strong seedlings were achieved as a result of better embryo growth, which further leads to increased fresh weight of seedlings. The obtained results were found closer to results observed by Pangtu *et al.* (2017) [9] in China Aster Sidana G *et al*. (2019) [11] in China Aster.

8. Seedling dry weight (mg)

Effect of different seed priming treatments, maximum seedling dry weight (111.66) was noticed in seeds treated with P_4 (GA_3 300 ppm), followed by P_3 (82.00).it was minimum (33.00) in P_0 (Control).

Maximum seedling dry weight was observed in GA_3 (300 ppm) primed seeds. This might be ascribed to the fact that GA_3 is known to enhance the water uptake of the seedlings which might have activated the enzymes with an accompanying mobilization of reserve materials in the embryo and thus strongest seedlings were obtained as a result of better embryo growth. This increases the fresh weight of the seedlings which is positively correlated further with the increase in the dry weight of the seedlings. These studies got support from the earlier findings of Muhammad and Rha (2007) [8] who observed the maximum dry weight in Sugar beet seeds on priming with GA_3 (100 ppm). Similar findings were reported by Sidana G *et al.* (2019) [11] in China Aster.

9. Seed vigour index-I

Maximum seed vigour index-I (850.49) was recorded with treatment P_4 (GA_3 300 ppm) and it was found to be statistically at par with P_3 (782.06), it was minimum (386.43) in seeds collected from the plants of P_0 (Control) treatment.

Among priming treatments, highest vigour index-I was observed with GA_3 (300 ppm). It might be due to production of the longer seedlings. Similar findings were reported by Pangtu *et al.* (2017) [9] in China Aster, Sidana G *et al.* (2019) [11] in China Aster.

10. Seed vigour index-II

Among different seed priming treatments, maximum seed vigour index-II (10,219.90) was noticed in seed treated with P_4 (GA_3 300 ppm), followed by P_3 (5,448.00).it was minimum (2,270.00) in P_0 (Control) treatments.

It might be due to increased á-amylase activity for breaking the starch stored in seeds by growth regulators (Basra *et al*., 2005) [2]. Priming caused de novo synthesis of á-amylase increasing metabolic activities in seeds, which resulted in higher seed vigour. Similar findings were reported by Pangtu *et al.* (2017) [9] in China Aster, Sidana G *et al.* (2019) [11] in China Aster.

Table 1: Effect of seed priming on Days taken to Seed Germination, Percentage Germination (%), Days Required to reach 4- 6 leaf stage (days) of China Aster

Treatments	Days taken to seed germination	Percentage germination (%)	Days required to reach 4- 6 leaf stage (days)	Shoot length (cm)	Root length (cm)	Seedling length (cm)
P_0: Control (non primed seeds)	15.50	68.66	33.16	5.63	1.86	7.53
P_1: Hydropriming (Tap water)	13.93	73.33	28.66	6.20	1.90	8.70
P_2: GA_3 (100 ppm)	12.30	78.00	27.88	7.13	2.46	9.56
P_3: GA_3 (200 ppm)	9.06	94.33	24.99	8.30	3.83	11.60
P_4: GA_3 (300 ppm)	11.00	92.33	22.99	9.30	4.73	13.56
P_5:KNO_3 (0.1%)	13.46	74.66	28.25	6.83	2.26	8.90
P_6: KNO_3 (0.5%)	12.10	82.66	26.44	7.76	2.90	10.66
P_7: KNO_3 (1%)	12.03	83.00	26.03	7.96	3.33	10.60
P_8: $CaCl_2$ (0.1%)	11.86	81.16	26.77	7.20	2.70	10.20
P_9: $CaCl_2$ (0.5%)	12.50	80.70	27.47	7.30	2.83	10.63
P_{10}: $CaCl_2$ (1%)	11.70	80.00	26.88	7.16	2.70	9.10
P_{11}: Trichoderma @ 10 g/Kg seed	11.86	72.33	30.4	6.73	1.96	8.83
P_{12}: Trichoderma @ 1×10^5 cfu/ml	12.46	77.66	30.06	6.86	2.46	9.40
P_{13}: GA_3 (200 ppm) + Trichoderma @ 10 g/Kg Seed	11.33	91.43	24.66	7.90	3.00	10.76
P_{14}: GA_3 (200 ppm) + Trichoderma @ 1×10^5 cfu/ml	11.76	85.33	25.10	7.96	3.10	10.86
S.Em±	0.762	1.255	0.345	0.483	0.414	0.552
C.D. at 5%	2.212	3.643	1.00	1.402	1.202	1.602

Table 2: Effect of Seed Priming on Seedling Fresh weight (g), Seedling Dry weight (mg), Seed Vigour index-I, Seed Vigour index-II of China Aster

Treatments	Seedling fresh weight (g)	Seedling dry weight (mg)	Seed vigour index-I	Seed vigour index-II
P_0: Control (non primed seeds)	0.31	33.00	386.43	2,270.00
P_1: Hydropriming (Tap water)	0.34	40.66	454.93	2,980.00
P_2: GA_3 (100 ppm)	0.44	49.66	555.86	3,876.33
P_3: GA_3 (200 ppm)	0.72	82.00	782.06	7,730.33
P_4: GA_3 (300 ppm)	0.79	111.66	850.49	10,219.90
P_5:KNO_3 (0.1%)	0.39	47.66	510.60	3,574.00
P_6: KNO_3 (0.5%)	0.52	56.66	641.96	4,689.67
P_7: KNO_3 (1%)	0.66	69.00	661.66	5,764.67
P_8: $CaCl_2$ (0.1%)	0.50	50.00	583.70	4,052.00
P_9: $CaCl_2$ (0.5%)	0.52	53.33	588.55	4,298.17
P_{10}: $CaCl_2$ (1%)	0.49	50.00	572.33	4,034.00
P_{11}: *Trichoderma* @ 10 g/Kg seed	0.38	44.33	485.90	3,215.00
P_{12}: *Trichoderma* @ 1×10^5 cfu/ml	0.40	48.66	533.26	3,795.33
P_{13}: GA_3 (200 ppm) + *Trichoderma* @ 10 g/Kg Seed	0.64	58.66	729.83	5,419.67
P_{14}: GA_3(200 ppm) + *Trichoderma* @ 1×10^5 cfu/ml	0.65	64.00	679.50	5,448.00

S.Em±	0.062	6.535	39.16	568.949
C.D. at 5%	0.181	18.96	114.04	1,651.19

Conclusion

On the basis of findings summarized above, it can be concluded that seed priming with P_3 (GA_3 200 ppm) performed best in terms of minimum days taken to seed germination and germination percentage, which was statistically at par with P_4 (GA_3 300 ppm), followed by P_{13} (GA_3 200 ppm + *Trichoderma* @ 10 g/Kg Seed).

P_4 (GA_3 300 ppm) performed best in terms of days require to reach 4-6 leaf stage, Shoot length, Root length, Seedling length, Seedling fresh weight, Seedling Dry weight, Seed vigor index-I and Seed vigour index-II, followed by P_3 (GA_3 200 ppm).

Some of the cultivars of China Astershow lower seed germination, to mitigate the problem of a poor and slow rate of seed germination it is recommended that seed priming with P_4 (GA_3 300 ppm), followed by P_3 (GA_3 200 ppm), P_{13} (GA_3 200 ppm + *Trichoderma* @ 10 g/Kg Seed) perform best for production of successful flower cultivation.

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