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INFLUENCE OF VARIOUS TREATMENTS ON PRE AND POST GERMINATION PROPERTIES OF *CALLISTEPHUS CHINENSIS* (L.) NEES CV. POWDERPUFF

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Abstract

Seeds of China aster cv. Powderpuff were subjected to two conditioning techniques *viz*, hydro-conditioning and halo-conditioning at different levels of concentrations and subjected time durations, constituting a total of 16 treatment combinations (P_1 - P_{15}) along with control (P_0). Hydro-priming for 12 hrs and the halo-priming with 2 % KNO_3 for 12 hrs significantly improved germination, mean germination time, germination index, germination rate index and growth attributes of China aster cv. Powderpuff. Hydro-priming being simple economical and eco/subject friendly and safe is recommended for effective germination and growth of China aster cv. Powderpuff.

Introduction

Seed priming is a pre-germination seed treatment in which seeds are held at water potential that allows imbibitions but prevents radicle/root protrusion (Bradford 1986). Seed priming improves seed performance by prompt and uniform germination, normal and vigorous seedlings, which resulted in faster and better germination and emergence in different crops (Ahmad *et al*. 1998, Khan *et al*. 2009). Therefore, the seed germination performance indicators (germinability, germination time, germination rate and synchronization index) are important for successful crop production. Various seed priming techniques have been developed in different media: hydropriming (water), osmopriming (low ψ solutions such as PEG), halo-priming (Chen *et al*. 2010).

In India, Kashmir valley has traditionally been known for production of annual flower seeds. China aster is a summer annual under Kashmir conditions. Seed setting in China aster coincides with dry low rainfall period in the valley thus making it one of the most lucrative crops for flower seed growers.

Thus keeping in view the above facts present investigation was undertaken with the objective to evaluate the influence of various proportionate conditioning treatments on germination and post-germination properties of *Callistephus chinensis* cv. Powderpuff

Materials and Methods

The experiment was conducted at the Plant Tissue Culture Laboratory, Division of FLA, SKUAST-K, Srinagar, J & K. Data were recorded on daily basis for 15 days following seedling evaluation protocol given in the handbook of the Association of Official Seed Analysis (AOSA 1990). At the end of this period, various seed attributes were calculated as shown overleaf.

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Four replications with 50 seeds/replicate were placed in Petri dishes covered with germination papers and then incubated in a seed germinator at 25 ± 1ºC. The Petri dishes were timely moistened with distilled water in order to maintain optimum moisture level. The number of germinated seeds was recorded daily, up to 15 days. Germination percentage was calculated using the formulae (Scott *et al.* 1984) as follows:

$$G\ \% = \frac{n}{N} \times 100$$

where, n = Number of seeds germinated, N = total number of seeds taken per lot.

To evaluate MGT a total of 200 seeds in 4 replications were placed between the germination papers preinstalled in Petri plates. The setup was placed in seed germinator in dark at 25 ± 1ºC. The number of newly germinated seeds was counted at 24 hrs interval for 15 days. MGT was calculated using the formula (Orchard 1977):

$$MGT = \frac{\Sigma\, n.x}{\Sigma\, n}$$

Authors simplified the equation as follows;

$$MGT = \frac{\Sigma\,(t_1 \times n_1 + t_2 \times n_2 + \ldots\ t_i \times n_i}{\Sigma\,(n_1 + n_2 + n_3 \ldots n_i)}$$

where, n = number of newly germinated seeds each day, t = Time from beginning of experiment.

Unit = per day

The GI was calculated using the formula as follows:

$$\mathbf{GI} = \frac{x\,(n_{24} + n_{48} + n_{72}) \ldots}{(n_{24} + 2n_{48} + 3n_{72}) \ldots}$$

where x = Total days taken to complete experiment.

n_{24}, n_{48}, n_{72}... = Number of seeds germinated at 24, 48 and 72 hrs, respectively.

To evaluate the GRI following formula (Esechi 1994) with slight modification was used:

$$GRI = \frac{G_1}{1} + \frac{G_2}{2} + \frac{G_3}{3} + \ldots \frac{G_x}{x}$$

where, G_1 = Germination percentage at first day of experiment, G_2 = Germination percentage at second day. Unit = % per day.

A total of 60 seeds in three replications were placed between the germination papers preinstalled within the Petri plates. The whole setup was placed within the seed germinator at a constant temperature of 25 ± 1°C. The root and shoot length (cm) from all the seedlings were calculated and expressed in total seedling length (root + shoot length). The final seedling vigour index was calculated using the formula (Abdul-Baki and Anderson 1973) as follows;

SVI = Seedling length × G %

where, G % = Germination percentage, and the seedling length was recorded in centimetres.

The experiment was arranged in a completely randomized design (CRD). All the observations recorded were subjected to ANOVA. The differences between the means were compared ($p \leq 0.05$).

Results and Discussion

Among the various priming treatments the treatment P_2 (hydropriming 12 hrs), significantly improved the germination percentage (92.50 %), the results were at par with that of treatment P_{14} (2% KNO_3 for 12 hrs). Compared to the other treatments the germination percentage was lowest in untreated seeds (P_0) i.e. 60.00 (Table 1). Hydro-conditioning stimulates the early stages of germination process in three stages. Step (I) is the imbibitions of water where there is quick and rapid uptake of water due to low water potential (ψ) of seeds. In step (II), there is less uptake of water, but physiological activities associated with germination are initiated, including synthesis of proteins by translation of new mRNAs and synthesis of mitochondria. In step (III) again there is a rapid uptake of water and the process of germination is completed with the emergence of radicle (Varier *et al*. 2010). On the other hand, the significant effect of KNO_3 is attributed to its improved nitrate reductase (NR) activity by *de novo* synthesis (Somers *et al*. 1983), hence improved germination percentage.

Table 1. Influence of various proportionate conditioning treatments on germination percentage (G.%), Mean germination time (MGT), germination index (GI) and germination rate index (GRI) on *Callistephus chinensis* cv. Powderpuff.

Treatment	G. %		MGT		GI		GRI	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
P_0	60.00	10.00	9.70	0.20	1.64	0.09	7.27	1.47
P_1	82.50	2.50	7.48	0.23	1.95	0.01	17.67	0.17
P_2	92.50	25.00	5.79	0.11	2.60	0.05	26.82	1.25
P_3	85.00	5.00	6.49	0.32	2.39	0.05	21.45	1.25
P_4	65.00	5.00	8.46	0.04	1.70	0.07	11.69	0.61
P_5	67.50	2.50	8.26	0.05	1.82	0.01	13.17	0.36
P_6	70.00	5.00	8.76	0.09	1.72	0.02	13.09	0.69
P_7	60.00	5.00	7.75	0.02	1.94	0.01	10.03	0.67
P_8	65.00	5.00	8.54	0.47	1.77	0.10	10.04	2.09
P_9	70.00	5.00	9.16	0.31	1.67	0.06	8.67	0.90
P_{10}	75.00	5.00	7.90	0.40	1.91	0.10	13.43	2.50
P_{11}	70.00	5.00	8.40	0.53	1.80	0.12	14.72	3.75
P_{12}	72.50	7.50	8.24	0.61	1.84	0.14	16.32	3.33
P_{13}	77.50	7.50	7.66	0.42	1.97	0.11	16.29	4.11
P_{14}	87.50	7.50	5.90	0.21	2.55	0.09	25.89	1.69
P_{15}	82.50	7.50	6.74	0.13	2.23	0.05	20.33	2.13
C.D.	**17.63**		**0.95**		**0.23**		**6.21**	
SE(m)	5.83		0.31		0.08		2.06	
SE(d)	8.24		0.44		0.11		2.91	
C.V.	11.16		5.66		C.V.	5.40	C.V.	18.83

Mean germination time (MGT) is an accurate gauge of time taken by seed lot to germinate, but it does not correlate well with the uniformity or time spread of germination. Among the all evaluated treatments (Table 1, Fig. 2) hydro-conditioning for 12 hrs significantly improved (05.79) the mean rate of germination time (MGT), the results are at par with that of treatment P_{14} (05.90) i.e. 2% KNO_3 for 12 hrs. Maximum MGT was observed in control (09.70). Hydro-conditioning promotes the occurrence of pre-germinative metabolic events enabling embryo growth, and thus increasing the speed of germination and thus reduced MGT (Afzal *et al*. 2012). On the other hand, improved MGT with KNO_3 attributes to its role in impacting the turgidity of cell wall and leads to activation of many enzymes associated with protein synthesis and carbohydrate metabolism. Besides, the nutrient potassium is having influence in osmoregulation. Similar results of improved MGT, and Germination rate with KNO_3 priming were reported in *Gladiolus alatus* (Mushtaq *et al.* 2012), and *Brassica napus* L. (Abdollahi and Jafari 2012).

Fig. 1. Visual differences of various treatments on seedling vigour.

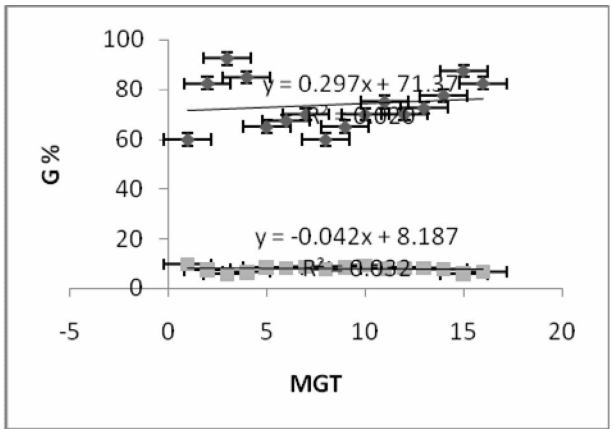

Fig. 2. Curve (with errors bars with standard error) between G % and MGT.

Germination index (GI) appears to be most remarkable and comprehensive measurement attribute, articulating both G% and speed at with the germination occurs like MGT. On the basis of numerical values (Table 1, Fig. 3), it magnifies the variation among the seed lot. It was observed that the hydro priming for 12 hrs significantly improved the GI values (2.60) and was highest among all the treatment assessed followed by 2% KNO_3 for 12 hrs, (02.55). The lowest germination index was observed in treatment P_0 (control). However, GRI depicts the percentage of germination per day (G%/day), so higher the percentage shorter the duration, thus higher the GRI. Since there is an empirically direct proportionate relationship between GI and GRI, so the similar trend was observed in GRI as that in GI. The highest GRI (26.82) was recorded in treatment P_2 (hydro priming 12 hrs) which was at par with that of P_{14} (25.89). The probable reason for enhancement of GI and GRI of the hydro primed seed may be due to the completion of pre-germination processes like synthesis and repair of nucleic acids (DNA and mRNA), proteins and repair of cell membrane, improved turgidity (Jowkar *et al.* 2012) and stimulation of wide range of biochemical changes, enzymatic activations (Wattanakulpakin *et al*. 2012). KNO_3 priming of *Lycopersicon esculentum* seeds depicted improved germination, emergence of seedlings and the initial growth of various plant species (Zhang *et al*. 2012). Halo priming with KNO_3 was more effective in improving the germination speed of tomato than PEG method of priming (Frett *et al*. 1991).

Table 2. Influence of various proportionate conditioning treatments on seedling fresh weight (SFW), seedling dry weight (SDW) and seedling vigour index (SVI) on *Callistephus chinensis* cv. Powder-puff.

Treatment	SFW mg		SDW mg		SVI	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
P_0	126.20	5.20	1.24	0.04	230.25	32.25
P_1	128.95	5.95	1.43	0.03	356.03	24.78
P_2	195.80	1.40	1.86	0.01	499.53	92.33
P_3	132.60	8.20	1.47	0.02	381.59	26.39
P_4	151.55	2.25	1.55	0.02	295.30	29.50
P_5	153.10	1.50	1.61	0.03	336.12	5.27
P_6	154.20	0.50	1.63	0.04	332.15	18.85
P_7	156.50	1.40	1.65	0.01	273.85	61.55
P_8	162.75	1.55	1.70	0.04	309.05	2.45
P_9	165.70	3.30	1.72	0.03	328.02	47.22
P_{10}	168.20	0.90	1.73	0.03	369.45	31.35
P_{11}	182.85	5.95	1.76	0.00	334.94	19.82
P_{12}	187.70	4.30	1.76	0.03	343.20	62.40
P_{13}	193.95	0.95	1.80	0.00	397.95	66.15
P_{14}	194.90	1.49	1.81	0.00	433.50	15.00
P_{15}	143.85	0.75	1.54	0.01	412.98	7.33
C.D.	**11.03**		**0.07**		**126.66**	
SE(m)	3.65		0.02		41.89	
SE(d)	5.16		0.03		59.24	
C.V.	3.18		2.08		16.82	

In the present study, seed priming has been demonstrated as a successful and effective strategy for improving the seedling growth and seedling vigour index (SVI) of *Callistephus chinensis*. SVI of hydro-primed (P_2 = 499.53) and halo-primed (P_{14} = 433.5) seeds were statistically higher compared to control (Table 2, Fig. 1). Hydro and halo-conditioning enables earlier embryo protrusion, and thus increasing the seedling length and SVI (Afzal *et al*. 2012).

Maximum SFW (195.8 mg) and SDW (1.86 mg) were recorded in treatment P_2, the results were at par with the treatment P_{14} i.e. 194.9 and 1.81 mg, respectively (Table 2). The minimum SFW (126.2 mg) and SDW (1.24 mg) were observed in treatment control. The probable reason for increase in SFW may be due to the improved seedling vigour, cell division (Basra *et al*. 2003).

The nitrate from KNO_3 could be easily absorbed and metabolised, being used in the metabolism of the embryo, through the enzyme nitrate reductase thus improved both SFW and SDW (Lara *et al*. 2014).

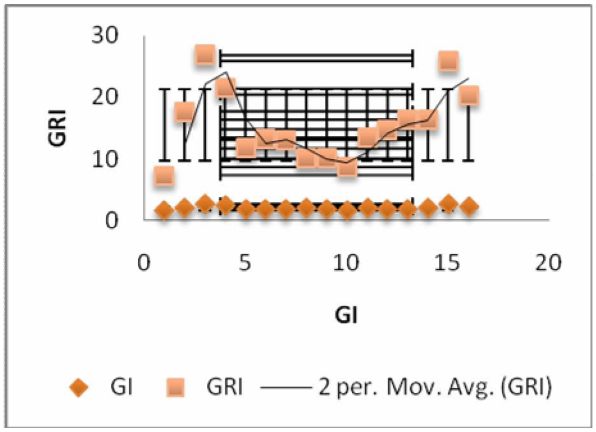

Fig. 3. Curve (error bars with 1 Sd) between GI and GRI.

All the treatments influenced the germination attributes of China aster; however treatments P_2 and P_{14}, significantly improved the germination, germination rate index, germination index and the mean germination time. From growers perspective authors fully endorse the hydro-priming treatment of China aster seeds especially cv. Powderpuff. It's economical, user/environment friendly, and safe.

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