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Impact of seed priming on vigour in onion (*Allium cepa* L.)

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Abstract

An investigation was undertaken to identify the effect of seed priming on vigour in fresh and aged seeds of onion (var. Arka Kalyan). It was observed that seed priming with GA_3 (50 ppm), KNO_3 (3 %) and PEG (-1.5 Mpa) had significant impact on germination and vigour. Aged seeds responded to the priming treatments effectively than fresh seeds. Among various treatments studied, there was an increase of germination in fresh seeds to the extent of 5 % due to treatment with GA_3, whereas in aged seeds it was to the extent of 11 % due to PEG treatment.

Key words: Onion seeds, seed priming, seed vigour, seed ageing

Introduction

Seeds are the beginning and end of the most agricultural practices, the way in which seeds functions their germination process is critically important for agriculture success. One of the major constraints in onion is the limited availability of vigorous seeds at the time of sowing due to rapid declining in the vigour under fluctuating environmental conditions. This has become a major bottle neck in successful cultivation of onion as sowing less viable seeds lead to poor crop stand establishment and thus resulting low yields. Maintaining of desired levels of vigour in seeds is a great concern in tropical and subtropical regions. Hence, development of cost effective methods to enhance the vigour is one of the major research in India (Pandita and Nagarajan, 2001).

Seed priming is a pre-sowing treatment that involves controlled hydration of seeds, sufficient to allow pre-germinative metabolic events without radicle protrusion (Heydecker *et al*., 1973). Hydro-priming is soaking seeds in water for a precise time followed by re-drying, Osmopriming involves soaking of seeds in different Osmo-regulators (Polyethylene glycol, mannitol, sorbitol, glycerol, *etc*.), Chemopriming refers to the soaking of seeds in different inorganic salt solutions (KNO_3, $CaCl_2$, KH_2PO_4, *etc*.) and/or plant growth regulators (GA_3, Cycocel, *etc*.). Seed priming is one of the most simple and economical intervention to enhance the vigour of low quality seeds, it can influence speed, synchronization and percentage of germination (Brocklehurst and Dearman, 1984; Khan and Passam, 2005). Seed priming technology plays a crucial and vital role in providing right seedling for better crop establishment even under adverse conditions (Bhanuprakash, 2010). Arin *et al*., 2010 reported improved rate of germination and seedling stands as a result of seed priming. Variation in the results depends on temperature, priming duration, concentration of the chemical and the crop type (Selvarani and Umarani, 2011; Yarina and Tabrizi, 2012). Although the benefits of seed priming are documented, less research work has been carried out either to know how and/or at what concentration priming rejuvenate and exhibit vigour in onion (Umesha, 2013). It is however essential to find out, whether priming equally influences all manifestation of seed vigour, or whether specific process get enhanced, while others are unaffected or adversely influenced. At this juncture, reviving seed viability of less viable seeds like onion through seed priming appears to be the best option with less investment.

Materials and methods

Seed material: Freshly harvested onion (var. Arka Kalyan) seeds were obtained from ICAR-Indian Institute of Horticultural Research, Bengaluru.

Accelerated ageing: Seeds were aged to obtain 60% viability by exposing the seeds to 45 ^oC and 75 % RH (as per ISTA accelerated ageing test).

Seed priming: Seeds (fresh and aged) were subjected to various priming chemicals (for 24 h at 25 ^oC) at two different concentrations of each treatment.

Germination (%): The standard germination test was done as per ISTA (2006) using between paper method. Fifty seeds of each four replications were placed equidistantly on moist germination paper and allowed to germinate at 20±1^oC. The first and final counts were taken on 6th and 12th day and the final germination was considered.

Seedling vigour index: Seedling vigour index-I (SVI-I) was calculated as per Abdul-Baki and Anderson (1973) and expressed as whole number. The formula is as follows:

SVI-I = Germination (%) x mean seedling length (cm)

Mean germination time (days): Mean germination time (MGT) was calculated according to the Ellis and Robert (1981) and expressed in days.

$$MGT = \sum D\,n / \sum n$$

Where, "D" is the number of days counted from the beginning of the test and "n" is the number of seeds that germinate on day 'D'.

Results and discussion

The results obtained are presented in Tables 1 to 3. Seed priming

significantly improved all vigour parameters and significant differences were also observed among priming treatments. It was observed that aged seeds responded more to the priming treatments than fresh seeds and higher responses were obtained at higher concentrations of the chemicals used for priming.

Among various priming treatments PEG and GA_3 recorded highest seed germination followed by KNO_3 and other treatments. Due to PEG and GA_3 treatments, seed germination increased from 76 to 82 %. In fresh seeds, it was increased from 91 to 96 due to treatment with GA_3, whereas in aged seeds it was increased from 60 to 71 due to PEG treatment. GA_3 (50 ppm) recorded highest seed germination percentage as compared to all other treatment combinations. Among all the priming treatments GA_3 recorded highest seedling vigour which increased from 911 to 1342. In fresh seeds seedling vigour increased from 1396 to 1930 due to GA_3 treatment whereas in aged seeds it was increased from 427 to 893 by PEG. However, GA_3 (50 ppm) showed highest seedling vigour when compared to rest of the treatment combinations.

Among all the treatments priming with KNO_3 recorded significantly lowest MGT followed by Cycocel. Due to priming with KNO_3, MGT was reduced from 4.22 to 3.54 days. In fresh seeds, MGT was reduced from 2.85 to 2.40 days due to KNO_3 treatment whereas in aged seeds it reduced from 5.60 to 4.68 days. KNO_3 (3%) was found to be the best combination in reducing mean germination time.

Seed priming using various treatments in fresh and aged onion seeds, a perusal of data pertaining to seed germination and vigour clearly indicated that priming treatments differed in their effect. The seed priming thus alleviated physiological process in aged seeds with higher intensity than in the fresh seeds. PEG and KNO_3 were found to be more effective in improving vigour of aged onion seeds.

The results obtained in our investigation indicating variation in effectiveness among priming chemicals and between fresh and aged seeds are in accordance with the experimentation conducted by Brocklehurst and Dearman (1983) in carrot, celery, leek and onion; Gurushinge *et al*. (2002), Tajbakhsh *et al*. (2004), Khan and Passam (2005), Arin *et al*. (2010), Yarina and Tabrizi (2012) and Umesha *et al*. (2013) in onion.

Seed priming has been shown to have beneficial effects on the germination and emergence in onion. Therefore the use of priming for improvement of seed quality is both of academic and economic interest. Thus priming can be employed as simple and most economical tool to enhance seed vigour.

Table 1. Impact of seed priming on germination (%)

Treatments (A)	Conc. (B)	Fresh (C)	Aged (D)	Mean			
				(A)	(A x C)	(A x D)	(A x B)
GA_3	20ppm	95.75	66.50	82.18	96.12	68.25	81.12
	50ppm	96.50	70.00				83.25
Cycocel	20ppm	93.00	68.00	80.31	92.87	67.75	80.00
	50ppm	92.75	67.50				80.12
$CaCl_2$	0.5%	92.50	67.00	79.31	92.62	66.00	79.75
	1%	92.75	65.00				78.87
KNO_3	1%	92.50	70.00	81.93	95.37	68.50	82.75
	3%	95.25	67.00				81.25
KH_2PO_4	50 ppm	95.50	69.00	81.68	94.87	68.50	81.62
	100 ppm	95.50	68.00				81.75
PEG (6000)	-0.5 Mpa	94.25	70.00	82.37	93.25	71.50	81.87
	-1.5 Mpa	92.75	73.00				82.87
Hydro-priming		93.25	66.50	79.37	92.25	66.50	79.31
Control -		91.00	60.50	75.75	91.00	60.50	75.75
Mean		93.54	67.18				

LSD (P=0.01): Treatments (A): 1.18; Concentrations (B): NS; Seeds (C & D): 0.59; Seeds x Treatments: 1.68; Seeds x Concentrations: NS; Treatments x Concentrations: 1.68; Seeds x Treatments x Concentrations: 2.37

Table 2. Impact of seed priming on seedling vigour index-I (SVI-I)

Treatments (A)	Conc. (B)	Fresh (C)	Aged (D)	Mean			
				(A)	(A x C)	(A x D)	(A x B)
GA_3	20ppm	1843	759	1342	1930	754	1301
	50ppm	2016	748				1382
Cycocel	20ppm	1738	695	1226	1727	725	1217
	50ppm	1717	755				1236
$CaCl_2$	0.5%	1714	786	1256	1720	793	1250
	1%	1725	800				1262
KNO_3	1%	1807	865	1319	1807	832	1336
	3%	1807	799				1303
KH_2PO_4	50ppm	1759	882	1333	1792	874	1320
	100ppm	1825	866				1345
PEG (6000)	-0.5Mpa	1678	882	1293	1693	893	1280
	-1.5Mpa	1708	904				1306
Hydro priming		1458	656	1057	1458	656	1057
Control		1396	427	911	1396	427	1911
Mean		169	744				

LSD (P=0.01): Treatments (A): 33.35; Concentrations (B): NS; Seeds (C & D): 16.67; Seeds x Treatments: 47.16; Seeds x Concentrations: NS; Treatments x Concentrations: 47.16; Seeds x Treatments x Concentrations: 66.70

Table 3. Impact of seed priming on mean germination time (MGT)

Treatments (A)	Conc. (B)	Fresh (C)	Aged (D)	Mean			
				(A)	(A x C)	(A x D)	(A x B)
GA_3	20ppm	2.47	5.21	3.73	2.44	5.03	3.84
	50ppm	2.41	4.85				3.63
Cycocel	20ppm	2.57	4.69	3.62	2.54	4.69	3.63
	50ppm	2.52	4.69				3.60
$CaCl_2$	0.5%	2.61	4.87	3.70	2.51	4.88	3.74
	1%	2.41	4.90				3.65
KNO_3	1%	2.39	4.74	3.54	2.40	4.68	3.56
	3%	2.41	4.62				3.51
KH_2PO_4	50ppm	2.53	5.15	3.71	2.55	4.87	3.84
	100ppm	2.56	4.59				3.58
PEG (6000)	-0.5Mpa	2.67	5.28	3.83	2.72	4.93	3.97
	-1.5Mpa	2.78	4.59				3.68
Hydro priming		2.81	4.82	3.81	2.81	4.82	3.81
Control		2.85	5.60	4.22	2.85	5.60	4.22
Mean		2.60	4.94				

LSD (P=0.01): Treatments (A): 0.09; Concentrations (B): 0.04; Seeds (C & D): 0.04; Seeds x Treatments: 0.13; Seeds x Concentrations: 0.06; Treatments x Concentrations: 0.13; Seeds x Treatments x Concentrations: 0.19

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