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ON farm pre-sowing invigoration seed treatments in onion (*Allium cepa* L.)

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Abstract
Seed priming is proved to be an effective on farm seed enhancement technique to improve seedling establishment and plant performance. The effects of six different pre-sowing invigoration seed treatments on germination and seedling vigour in fresh and aged seed lots of onion cv. Agri found Dark Red were studied. Seed priming with GA_3 @100ppm for 6 hrs showed significant effect on enhancing the germination behaviour seedling characteristics compared to control. The response of aged seeds to priming was more pronounced than the fresh seed lot, with an expression of 21% increased germination,13.34% improvement in speed of germination, with a decrease of 12.32 % in mean germination time resulting in 3.82% increased seedling vigour I and 69.74 % increased seedling vigour II compared to control. This indicates that the aged or low vigour seed could be benefited more than the fresh seed lot with the priming treatment.

Keywords: GA_3, onion, PEG, seedling vigour, seed priming

Introduction
Onion (*Allium cepa* L.) belongs to the family Amaryllidaceae is the most important bulb crop cultivated commercially all over the world and it is the second most important horticultural crop after tomato in the world. Onion is also known as "Queen of the Kitchen" (Selvaraj, 1976) [21]. Indian onions are famous for their pungency due to the presence of a volatile oil 'Allyl propyl disulphide' ($C_6H_{12}S_2$) and are available round the year. It has diversified ailments, *viz*., lowering blood sugar, cardiovascular problems, fighting cholera, prevents hair loss, tooth disorders, urinary disorders, prevention of blood clot etc. There is a lot of demand for Indian Onion in the world, the country has exported 24 lakh MT of fresh onion to the world for the worth of Rs. 3,106.50 crores (APEDA, 2017) [5].
Seed priming is one of the pre-sowing seed management techniques where the seeds are partially soaked and subsequently dried back for invigorative effect that expresses on field emergence and extend up to yield. Priming applications contribute to significant improvement in seed germination and seedling growth in vegetables (Dursun and Ekinci, 2010; Korkmaz, 2005; Korkmaz and Pill, 2003) [10, 13]. The key basis of all pre sowing is to hydrate the seed under controlled conditions, so that they become physiologically active.
Onion seeds usually have a low quality, resulting in slow and asynchronous germination as well as seeds producing a high number of abnormal seedlings, (Borowski and Michałek, 2006) [8]. Seedling establishment is an important factor in bulb production of onion and largely depends on the seed germination and vigour.
Due to unavailability of fresh seed, farmers are forced to use aged seed of low germination percentage and so to overcome this problem seed priming is the best option. However, the response of aged seeds to priming was more pronounced than the fresh seed lot. Hence improved seed invigoration techniques are well known to reduce emergence time, accomplish uniform emergence and give better crop stand in many horticultural crops and these includes hydro priming, osmo conditioning, hormonal priming and soaking before sowing (Ashraf and Foolad, 2005) [6].
The present study was conducted to access the efficacy of different priming treatments on germination and seedling characteristics in onion.

Materials and Methods
The experiment was laid out as Completely Randomized Design (CRD) in a factorial arrangement and replicated four times which was conducted at Department of Seed Science and Technology, PJTSAU, Rajendranagar, Hyderabad. Seed of fresh and aged seed lots of onion cv. Agri found Dark Red having an initial germination of 92 per cent (high vigour) and 70 percent (low vigour) were subjected to six pre-sowing invigoration seed treatments.

Seed Treatments: Following seed treatments were employed hydro priming, halo priming, osmo priming, sand matric priming and GA3 priming at different durations. Hydro priming with distilled water for 24 hrs (T1), Halo priming with 3% KNO3 for 12hrs (T2), Osmo priming with PEG 6000 (-1.0 MPa) for 24 hrs (T3), Sand matric priming with 80% WHC for 24 hrs (T4), GA3 priming @100ppm for 6 hrs (T5) and Control (T6). The non-primed seeds were used as control. The seeds were primed on wetted blotter papers with the above mentioned priming solutions and then seeds were shade dried at room temperature back to their original moisture content.

Laboratory observations on seed germination percentage, seedling length and seedling dry weight was assessed as per the standard procedures (Anonymous, 2001) [4]. The speed of germination (Maguire, 1977) [16], mean germination time (Ellis and Roberts, 1981) [11] and seedling vigour index (Abdul-Baki and Anderson, 1973) were determined. The data obtained were analysed for 'F' test of significance following the methods described by Panse and Sukhatme (1985) [19]. The critical differences (CD) were calculated at 5 per cent probability level.

Results and Discussion

Among the two seed lots studied, primed seed of fresh seed lot expressed higher germination percentage and seedling vigour indices in the lab conditions over the primed seed of aged seed lot.

Germination percentage

The fresh and aged seed lots had significant effect on Germination percentage. The fresh seed lot had highest germination (95.33%) than the aged seed lot (90.71%). Among the treatments, T_5 had the highest mean germination 97.5% and T_2 with 95.88% was on par with T_5. Lowest mean germination percentage was observed in unprimed seeds with 81% (table 1). The percent increase in germination of GA_3 priming over the control was 6% for the fresh seed lot while, it was 27% in the aged seed lot which indicates that GA_3 priming given to aged seed lot has responded up to 21% more germination than the fresh seed lot. Such differences in physiological processes of germination in primed seeds might be due to the use of GA_3 and KNO_3 which help in breaking seed dormancy and promote faster seed germination. The results of Maurya and Lal (1972) [18], Vaganangamudi *et al*. (1988) [23], Yarnia and Tabrizi (2012) [24] corroborate our finding showing increase in germination behaviour by application of gibberellic acid.

Speed of germination

Highest mean value of speed of germination was exhibited by T_5 treatment, *i.e*., 32.79 followed by T_2 with 31.77 and T_3 with 30.70. The speed of germination was least in control with 27.30 (table 1). GA_3 priming in the fresh seed lot has recorded 14.13% and aged seed lot has recorded 27.47% increase in speed of germination over the control. Early germination might occur due to high synthesis of DNA, RNA and protein during priming. These results are in line with Kumar and Singh (2013) [15] who reported that when bitter gourd seeds primed with 100 ppm GA_3 for 24 hours gave better germination, speed of emergence, seedling length and vigour index-I over the control.

Table 1: Effect of seed priming on germination percentage and speed of germination in onion

Parameter	Germination percentage			Speed of germination		
Treatment	Fresh seed lot(S_1)	Aged seed lot(S_2)	Mean	Fresh seed lot(S_1)	Aged seed lot(S_2)	Mean
T_1-Hydro priming	95.00	94.00	94.50	31.47	26.95	29.21
T_2-Halo priming	96.50	95.25	95.88	33.83	29.70	31.77
T_3-Osmo priming	95.75	95.00	95.38	33.37	28.02	30.70
T_4-Sand matric	94.75	93.00	93.88	30.79	25.27	28.03
T_5-GA_3 priming	98.00	97.00	97.50	34.41	31.18	32.79
T_6-Control	92.00	70.00	81.00	30.15	24.46	27.30
Mean	95.33	90.71		32.34	27.60	
	S	T	S×T	S	T	S×T
SE(m)±	0.34	0.58	0.82	0.19	0.96	0.47
CD at 5%	0.96	1.67	2.36	0.55	0.33	1.35

Mean germination time (days)

The least mean germination time was recorded by the GA_3 priming treatment with 2.62 days followed by halo priming 3.15 days. The longest time for mean germination was recorded by the unprimed seed with 3.56 days (table 2). A percent decrease of 32.64% in fresh seed lot and 20.32% in aged seed lots with GA_3 priming over the control *i.e*., the decrease of 12.32 % in mean germination time of aged seed lot over fresh lot indicate that the aged seed lot responded well to priming. The probable reason for early germination of primed seed may be the early completion of pre-germinative metabolic activities making seed ready for radical protrusion and the seed germination (Basra *et al*., 2005 and Abdi and Arefi, 2001).

Seedling length (cm) GA_3 stimulates the hydrolytic enzymes that are needed for the degradation of the cells surrounding the radicle and thus speeds germination by promoting seedling elongation. The highest mean seedling length was recorded by T_5 with 14.66 cm. T_2 with 14.22 cm was on par with T_5 and minimum mean value of seedling length was recorded in the control with 12.07cm (table 2). GA_3 priming has recorded a percent increase of 14.4 over the control in case of fresh seed lot while, 31.14% in case of aged seed lot which indicates that GA_3 priming has showed 16.74 % more effect in the aged seed lot than the fresh seed lot with regard to seedling length. These results are in accordance with Kumar and Singh (2013) [15] in bitter gourd, Saeedipour (2013) in cowpea who Confirmed the positive effect of seed priming in GA_3 with regards to shoot length of seedling.

Table 2: Effect of seed priming on mean germination time (days) and seedling length (cm) in onion

Parameter	Mean germination time			Seedling length		
Treatment	**Fresh seed lot(S_1)**	**Aged seed lot(S_2)**	**Mean**	**Fresh seed lot(S_1)**	**Aged seed lot(S_2)**	**Mean**
T_1-Hydro priming	3.24	3.50	3.37	14.49	11.59	13.04
T_2-Halo priming	3.01	3.30	3.15	15.89	12.56	14.22
T_3-Osmo priming	3.05	3.45	3.25	15.08	11.95	13.51
T_4-Sand matric	3.27	3.57	3.42	14.36	11.14	12.75
T_5-GA_3 priming	2.27	2.98	2.62	15.97	13.35	14.66
T_6-Control	3.37	3.74	3.56	13.96	10.18	12.07
Mean	3.02	3.42		14.96	11.79	
	S	T	S×T	S	T	S×T
SE(m)±	0.02	0.04	0.05	0.12	0.20	0.29
CD at 5%	0.06	0.10	0.14	0.33	0.51	0.82

Seedling dry weight (mg)

Highest mean value of dry weights were recorded in GA_3 priming with 0.028 mg followed by halo priming 0.024 mg while, least dry weight was observed in the control with 0.015 mg (table 3). A percent increase of 72.22% in fresh seed lot and 84.61% in aged seed lots was observed with GA_3 priming over the control i.e., the percentage increase of 12.39 dry weight for the aged over the fresh indicates that priming was more effective in the aged seed lots. Priming with GA_3 resulted in highest seedling dry weight and these results are in lineage with the findings of Yogananda *et al*. (2004) in bell pepper, Yarnia and Tabrizi (2012) [24]in Azarshahr red cultivar onion, Das *et al*. (2014) in fresh bottle gourd seeds.

Coefficient of variation of the germination time

It was calculated as per the procedure given by M.A. Ranal & D.G. Santana, 2006.

Least mean value of CV_t was recorded by GA_3 priming with 21.24, while highest mean CV_t recorded in control with 29.19. A percent decrease of 28.7 % in fresh seed lot and 26.26 % in aged seed lots with GA_3 priming over the control was observed.

Variance of germination time is calculated by the expression,

$$s_t^2 = \frac{\sum_{i=1}^{k} n_i (t_i - \bar{t})^2}{\sum_{i=1}^{k} n_i - 1}$$

Where, $\bar{t}$: mean germination time; t_i: time between the start of the experiment;

i^{th} observation (day for the example); n_i: number of seeds germinated in the i^{th} time, and k: last time of germination.

The variance value will be used to calculate the CV_t

Coefficient of variation of the germination time is calculated by the expression.

$$CV_t = S_t / \bar{t} \times 100$$

Where,

s_t: standard deviation of the germination time and $\bar{t}$: mean germination time.

Table 3: Effect of seed priming on seedling dry weight (mg) and Coefficient of variation of the germination time in onion

Parameter	Seedling dry weight			Coefficient of variation of the germination time		
Treatment	**Fresh seed lot(S_1)**	**Aged seed lot(S_2)**	**Mean**	**Fresh seed lot(S_1)**	**Aged seed lot(S_2)**	**Mean**
T_1-Hydro priming	0.021	0.016	0.019	22.48	29.79	26.14
T_2-Halo priming	0.029	0.020	0.024	19.07	27.55	23.31
T_3-Osmo priming	0.026	0.019	0.022	21.50	28.25	24.88
T_4-Sand matric	0.020	0.014	0.017	23.25	33.20	28.23
T_5-GA_3 priming	0.031	0.024	0.028	16.94	25.53	21.24
T_6-Control	0.018	0.013	0.015	23.75	34.62	29.19
Mean	0.024	0.018		21.17	29.82	
	S	T	S×T	S	T	S×T
SE(m)±	0.006	0.002	0.001	0.227	0.386	0.545
CD at 5%	0.002	0.003	0.004	0.639	1.106	1.565

Seedling vigour index I

Seedling vigour index is an important quality parameter that determines the stand establishment potential of a seed lot. T_5 recorded significantly highest mean seedling vigour index I of 1433.59 and T_2 with 1413.72 was on par with T_5. Lowest mean seedling vigour index I was observed in unprimed seeds with 1243.16 (table 2). The percent increase of GA_3 priming effect over the control was 13.55 in case of fresh and 17.37 in aged seed lot, by a difference of 3.82 % in improving the seedling vigour. This might be due to GA_3 which plays important role on several physiological and developmental processes, control of the cell cycle, including morphogenesis of shoots and roots, lateral root initiation, stem elongation, leaf and cotyledon expansion and regulation of senescence (Al- Khassawneh *et al*., 2006; Taiz and Zeiger, 2010; Kerbauy, 2012) [3, 22].

Seedling vigour index II

The highest mean value of seedling vigour index II was recorded in the GA_3 priming treatment with 2.73 and halo priming with 2.33 was on par with GA_3 treatment. Mean seedling vigour index II was minimum in the control *i.e*., 1.25 (table 4). The percent increase of seedling vigour index II with GA_3 priming in the fresh seed lot was 95.03 whereas, it was 164.77 for the aged seed lot over the control. Yogananda *et al*. (2004) [25] noticed that bell pepper seeds invigorated with GA_3 recorded higher germination and seedling vigour index over control.

Table 4: Effect of seed priming on seedling vigour index I and seedling vigour index II in onion

Parameter	Seedling vigour index I			Seedling vigour index II		
Treatment	**Fresh seed lot(S_1)**	**Aged seed lot(S_2)**	**Mean**	**Fresh seed lot(S_1)**	**Aged seed lot(S_2)**	**Mean**
T_1-Hydro priming	1456.89	1257.39	1357.14	2.00	1.50	1.75
T_2-Halo priming	1481.73	1345.71	1413.72	2.78	1.88	2.33
T_3-Osmo priming	1457.55	1271.97	1364.76	2.45	1.76	2.10
T_4-Sand matric	1445.77	1152.40	1299.08	1.85	1.33	1.59
T_5-GA_3 priming	1514.83	1352.36	1433.59	3.14	2.33	2.73
T_6-Control	1334.10	1152.23	1243.16	1.61	0.88	1.25
Mean	1448.48	1255.34		2.30	1.61	
	S	T	S×T	S	T	S×T
SE(m)±	6.66	11.53	16.31	0.05	0.09	0.13
CD at 5%	19.10	33.09	46.80	0.15	0.27	0.38

Conclusion

As influenced by different priming treatments, the aged or low vigour seed could be benefited more than the fresh seed lot with the priming treatment. Finally it could be concluded that seed priming with GA_3 @100ppm for 6 hrs has showed better effect in improving all the seedling characters studied in both the fresh and aged seed lots over the control. Followed by halo priming treatment with 3% KNO_3 for 12 hrs will also help in enhancing the seedling quality parameters in onion.

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