

Short communication

Seed priming treatments for better plant stand establishment in onion

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Seed priming treatments have been widely used for enhancing seed performance by improving the rate and uniformity of germination and decreasing seed sensitivity to external factors [1-3]. Seed priming allows the seed to imbibe moisture using various protocols of osmo, halo and hydro-priming, followed by re-drying to permit routine handling [4]. This process controls hydration to a level that allows germination activity but does not permit radicle protrusion through seed coat. Onion seeds have a short life span amongst the vegetable crops and lose viability rapidly after harvest. The main reasons of low quality of onion seeds include long flowering period resulting in different stages of seed maturity in the umbel, very fast reduction of seed viability if stored in suboptimal conditions and seed infestation with fungi [5]. This poses a serious problem for the carry-over stocks, unless special precautions are taken during its storage. The soaking-drying treatments (seed priming) with water or dilute solutions of salts and plant growth regulators have been found to enhance the germination, vigour and field emergence [6-8] as well as storage potential [9] of the onion seeds. However, there are conflicting reports about the efficacy of seed priming treatments in promoting plant stand establishment. Hence, the present investigations were undertaken for the identification of suitable priming treatment for quick and uniform field emergence.

Freshly harvested, untreated seeds of onion cultivar, Agrifound Dark Red were obtained from three locations viz. Indore, Rajkot and Lasargaon through National Horticultural Research and Development Foundation, New Delhi and assessed for different seed quality parameters, viz., moisture content, germination percentage, vigour attributes and associated mycoflora. Depending upon the germination percentage and incidence of mycoflora, the seed lot from Rajkot was selected for further studies. The seeds were dried to 8 percent seed moisture content and subjected to specific gravity separation. The seed was divided into five different grades, namely G1 (heaviest), G2 (heavy), G3 (medium), G4 (light) and G5 (lightest) and further investigated for germination and vigour attributes. The G4 grade (light) seeds, having an initial germination percentage of 69.5 per cent were used for the priming experiments, as it is known that the medium vigour seeds exhibit better response to priming. The duration of priming was standardized by placing the onion seeds between filter papers, wetted with distilled water. The seeds were removed at 2 hours interval, upto 24 hours and the data on water imbibition was recorded. Thereafter, the imbibed seeds were placed on the dry filter paper to remove the excess moisture and respective weights were taken for the determination of per cent water imbibition (difference between initial and final wet

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weight). The soaking for eight hours was adjusted as optimum, based on imbibition pattern and visual observation.

Further, 50 gm seeds each were soaked in dilute solutions of different chemicals at room temperature for 8 hours. The quantity of solution was twice the weight of seed *i.e.* seed and solution in the proportion 1:2 (w/v). The given quantity of each chemical was weighed and dissolved in one liter of distilled water to obtain a stock solution of 1000 ppm. From this stock solution, desired quantity of aliquot was taken and further diluted with distilled water to prepare solutions of different concentrations. The chemicals used for seed priming were; Gibberellic Acid (20, 40, 60, 80 and 100 ppm) and Mono Sodium Hydrogen Phosphate - NaH_2PO_4 (50, 100, 150 and 200 ppm). The seeds soaked in distilled water and non-primed seeds served as positive and negative control, respectively. The primed seeds were dried back in shade to their original moisture content and assessed for seed quality parameters *viz.*; germination percentage, mean germination time, seedling dry weight, vigour indices and field emergence.

The germination percentage was determined using Top of the Paper method, following ISTA rules [10]. One hundred seeds in four replicates were kept for germination in a Petriplate and placed in the germination chamber at 20°C. After twelve days of incubation, the seedlings were evaluated for normal, abnormal seedlings and fresh ungerminated and dead seeds. However, the germination percentage was recorded based on the total number of normal seedlings only. The seedling length was estimated on linear scale, by randomly selecting ten normal seedlings from each replication of the standard germination test for root and shoot length measurement. For determination of the seedling dry weight, ten normal seedlings

from each replicate of the germination test were selected at random and kept in oven for drying overnight at 90°C temperature. The vigour indices were assessed based on germination percentage; seedling length and seedling dry weight [11].

Vigour index I = Germination% \times Seedling length (cm)

Vigour index II = Germination% \times Seedling dry weight (mg)

Field emergence was estimated by sowing of one hundred seeds in four replications; the observations were recorded on 15th day after sowing and the values were expressed as percentage of seedling emerged. Mean Germination Time (MGT) was calculated by counting normal seedlings and removing them daily, until no further germination was observed.

$$\text{MGT} = \frac{\sum (nt)}{\sum n} [12].$$

where,

n = number of seeds newly germinating at time t

t = days from sowing/plating.

The data was subjected to univariate analysis of variance using SPSS statistical package. The percentage values were subjected to arc sine transformation prior to analysis. Post hoc tests were conducted for multiple comparisons of factor means and the least significant difference (LSD) or critical difference (CD) was calculated in each case. The treatment means were grouped into homogenous subsets using Duncan's multiple range tests for effective comparison.

The moisture content of the three seed lots was observed to be ranging between 8.96 to 9.53 percent, seedling length between 13.58 to 14.11 mm and seedling dry weight between

20.90 to 21.68 mg whereas, Vigour index I and II varied between 1219 to 1309 and 1876 to 2011, respectively. Further, the total number of seed borne fungi associated with the seeds ranged between 13.0 to 23.5 percent. The perusal of data revealed that the seed quality parameters were positively influenced by different seed priming treatments and an overall improvement in seed quality was observed over the untreated seeds (Table 1). A progressive increase in water imbibition from 38 to 92 per cent was recorded, as the seed priming duration was increased from 2 hour to 24 hours. The priming treatments were found to enhance the germination percentage as well as seedling emergence significantly. However, GA3 and Mono Sodium Hydrogen Phosphate (MSHP) indicated superiority over distilled water and untreated seeds. Amongst treatments, GA3 100 ppm fared better in enhancing seed germination and seedling establishment over other treatments, followed by GA3 80 ppm and MSHP150 ppm. The stimulative action of applied gibberellins (GA) on seed germination has been reported for a large number of species in the past three decades. They are reported to trigger the hydrolysis of reserve food material in seeds and directly affect the growth potential of the embryo [13]; thereby enhancing the germination in GA3 primed seeds. Hydro and osmotic priming, hardening and gibberellic acid application were effective in reducing the incidence of abnormal seedlings compared with untreated seeds [14]. These treatments recorded higher germination to the tune of 7, 5.75 and 5.25 per cent in GA3 100 ppm, GA3 80 ppm and MSHP 150 ppm, respectively over the control. These treatments were also characterized with better seedling emergence as compared to control. The improvement in field emergence recorded was 9 percent in GA3 100 ppm (73.5) and 6.75 percent in GA3 80 ppm (71.25) and MSHP 150 ppm (71.25) over the control (64.5). GA3 treatment enhances amylase synthesis

with helps in conversion of reserve food material into amino acids and their translocation via phloem into the young roots and shoots causing emergence of seedlings. It may be pertinent to add that all the primed seeds registered a germination percentage above the IMSCS (70 per cent). Similar increase in seed germination was also reported by previous workers [15-16].

The rate of germination calculated as the Mean Germination Time was found to be significantly influenced by the priming treatments. Priming treatments with GA3 100 and 80 ppm indicated better results in terms of mean germination time *i.e.* 3.37 and 3.42, respectively. However, unprimed seeds registered slower germination rate and maximum values. All priming treatments, including hydro-priming, had significantly higher rate of germination as compared to the unprimed treatments. Higher speed of germination with GA3 primed seeds may be due to increased metabolic activities during seed germination process. Priming allows seeds to imbibe water and undergo first stage of germination and hence, primed seeds germinate rapidly and emerge faster. The benefits include increased germination rate, uniform emergence and satisfactory field stand over a range of environments and improved seedling growth [17] sugars and DNA content, whereas there was an increase in RNA content [18]. The beneficial effect of osmo-priming is associated with an increase in respiratory activity [19] as well as an increase in synthesis of protein and DNA [20]. The reported benefit of priming is to repair damages incurred during storage, which would in consequence improved the vigour of aged seeds [21-22].

The priming treatments also exhibited improvement in seedling length, particularly in seeds treated with GA3, followed by MSHP. The increased in seedling length can

Table 1. Effect of priming treatments on the seed quality parameters of onion

Priming	Germination treatments	Seedling percentage	Mean Germination Emergence Time (days)	Seedling length (mm)	Vigour Index Idry	Seedling weight	Vigour Index II
Distilled water	57.60 ^{ab} (71.25)	55.89 ^{ab} (68.50)	3.61 ^e	17.16 ^b	1223 ^{ab}	11.68 ^a	832 ^{ab}
GA ₃ 20 ppm	58.08 ^{ab} (72.00)	55.89 ^{ab} (68.50)	3.72 ^f	17.05 ^b	1228 ^{ab}	11.74 ^a	845 ^{ab}
GA ₃ 40 ppm	58.40 ^{ab} (72.50)	56.35 ^{ab} (69.25)	3.51 ^d	17.12 ^b	1241 ^{ab}	11.82 ^a	857 ^{ab}
GA ₃ 60 ppm	59.05 ^{ab} (73.50)	57.13 ^{ab} (70.50)	3.37 ^a	17.84 ^b	1342 ^b	12.46 ^a	938 ^b
GA ₃ 80 ppm	59.87 ^b (74.75)	57.60 ^b (71.25)	3.44 ^{bcd}	17.32 ^b	1290 ^b	11.92 ^a	888 ^{ab}
GA ₃ 100 ppm	60.70 ^b (76.00)	59.05 ^b (73.50)	3.49 ^{cd}	17.24 ^b	1267 ^b	11.75 ^a	864 ^{ab}
MSHP 50 ppm	58.56 ^{ab} (72.75)	56.20 ^{ab} (69.00)	3.42 ^{abc}	17.46 ^b	1270 ^{ab}	11.78 ^a	857 ^{ab}
MSHP 100 ppm	58.72 ^{ab} (73.00)	56.51 ^{ab} (69.50)	3.40 ^{ab}	17.58 ^b	1283 ^b	12.05 ^a	880 ^{ab}
MSHP 150 ppm	59.54 ^{ab} (74.25)	57.60 ^b (71.25)	3.62 ^e	17.36 ^b	1280 ^b	12.28 ^a	906 ^b
MSHP 200 ppm	59.05 ^{ab} (73.50)	57.45 ^b (71.00)	3.48 ^{cd}	17.42 ^b	1280 ^b	12.11 ^a	890 ^{ab}
Control	56.20 ^a (69.00)	53.46 ^a (64.50)	3.84 ^g	15.85 ^a	1094 ^a	11.23 ^a	802 ^a
CD (0.05)	2.13	2.23	0.04	NS	88.87	NS	65.88

Note: Figures in parentheses are the actual percentage germination values

Treatment means with same letters are at par

GA₃ = Gibberellic acid; MSHP = Mono Sodium Hydrogen Phosphate

be attributed to the fact that GA3 increased the enzymatic activities during seed germination and resulted in increased seedling length. The seedling vigour is an important criterion for the germination study and it was expressed in terms of seedling length and seedling dry weight. The vigour attributes were influenced significantly due to seed priming and the values were higher in all the treatments as compared to the control. Priming facilitates *denovo* synthesis of alpha amylase, which increases the metabolic activities in seeds, resulting in higher seedling vigour. Thus, higher vigour of the primed seeds relates to metabolic activities in seeds due to increased amylase activity. In these studies, the low vigour seeds were used in the priming experiments as the hydration-dehydration treatments are effective only in medium vigour (4-5 month old seed stock) seeds and shows adverse effect in high-vigour seeds [23]. There was no significant invigoration could be obtained in highly vigorous seeds or seeds with a low germination percentage. This indicated that seed vigour in viable seeds has a limit which cannot be over-reached [24].

Conclusion

Based on the results presented above, it can be concluded that the germination of sub-standard seed lots of onion can be improved by hydro-priming with GA3 (100 ppm) for 8 hours, followed by drying of seeds to 8 percent.

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