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Short communication

Effect of water and salinity stress on germination and seedling characters in onion

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ABSTRACT

The purpose of this study was to investigate the effect of water and salt stress on seed germination (germination per cent, mean germination time, germination synchrony and germination uncertainty) and seedling characters (seedling length, seedling fresh and dry weight and seedling vigor) in onion. Four water stress levels induced by PEG-6000 (0, -0.2, -0.4 and -0.6 MPa) and six salt stress levels of NaCl (0, 50, 100, 150, 200 and 250 mM) were studied and results revealed that increasing level of stress caused a gradual and significant decrease in germination and seedling growth. Water stress reduced germination by 22 to 83% and it was delayed by 2.19 to 4.69 days and salt stress also showed similar trend and prolonged the germination time by 0.46 to 4.68 days and reduced the germination by 3 to 57%.

Key words: *Allium cepa*, seedling characters, variety, water stress.

Onion (*Allium cepa* L.) is one of the important export-oriented vegetable crops. Its yields, however, are low as it is prone to various kinds of abiotic and biotic stresses. One of the major obstacles to high yield and production is abrupt weather and poor soil conditions which results in poor seed germination and seedling establishment (Kutty *et al*., 5). Seed germination and seedling growth are the two critical stages for the establishment of crops and these stages are most sensitive to abiotic stresses. Water and salt stress at germination stage severely affects seedling emergence and establishment which leads to reduction in marketable yield. Dehghan *et al*. (2) reported that approximately 20% of world's cultivated area and 50% of irrigated lands are affected by salinity. It is most widespread in arid, semi-arid, coastal regions and also irrigated lands because of low precipitation, high evaporation, drainage issues and irrigation with saline waters. Similarly, majority of cultivated areas are often threatened by drought stress. Keeping this in view the present investigation was carried out to study the effect of varying levels of water and salt stress on germination and seedling characters of onion and to identify varieties tolerant to different levels of water and salt stress.

Eight selected onion varieties *viz.,* N-2-4-1, Bhima Super, Bhima Shweta, Bhima Shubra, Bhima Shakti, Bhima Red, Bhima Raj and Bhima Kiran were used to study the effect of water and salt stress on seed germination and seedling characters at ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune. The seeds were surface sterilized with 2% sodium hypochlorite solution followed by thorough washing with distilled water. To induce drought stress, PEG-6000 (Polyethylene glycol) was used as per method described by Michel and Kaufmann (7). Four different concentration *viz.,* 0 (control), -0.2, -0.4 and -0.6 MPa were tested. Similarly, six different concentration of NaCl *viz.,* 0 (control), 50, 100, 150, 200 and 250 mM were used.

Seeds were placed in a 9 cm petri plate containing a filter paper moistened with PEG solutions and NaCl solutions respectively. Each treatment was replicated four times (100 seeds per replication) and data on seed germination were recorded daily. Percent germination, mean germination time, germination synchrony and germination uncertainty were calculated as per the method suggested by Ranal *et al*. (8).

Ten seedlings from each petri plate were selected randomly after 14 days in order to record the seedling length using caliber measuring tool. Similarly, ten seedlings were selected randomly to measure seedling fresh and dry weight. For recording the seedling dry weight, the samples were kept in oven at 75ºC for 48 hrs. Seed vigor index was calculated following the method suggested by Baki and Anderson (1). Data were analyzed by factorial analysis using SPSS 16.0 and the means were separated by Tukey's HSD test. For percent germination arc sine transformed data were used.

The results showed significant effect of water stress on all seed germination (Fig. 1) and seedling growth characters (Fig. 2). Seed germination was

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reduced by 22 to 83% and germination was delayed by 2.19 to 4.69 days by various levels of water stress. The maximum percent germination (84.98%) was recorded in control. This was followed by PEG induced water stress at -0.2 MPa (65.69%), -0.4 MPa (42.61%) and -0.6 MPa (13.75%) (Fig. 1(A)). Reduction in germination percent and seedling growth is mainly due to osmotic stress induced by PEG. The maximum germination time was 6.80 days at -0.6 MPa, whereas the minimum mean germination time of 2.11 days was in control treatment (Fig. 1(B)) indicating that water stress suppresses and delays the germination. Germination synchrony was also higher (0.40) in control compared to other treatments (Fig. 1(C)) indicating that germination percent and synchronization decreases as the level of stress increases. Similarly, maximum germination uncertainty (2.57 bits) was found at higher level of water stress (-0.6 MPa) and lowest (0.78 bits) in control (Fig. 1(D)). Our results confirm the findings of Mantovani and Iglesias (6) that water stress induced by PEG lowered the rate of germination and synchrony by delaying the germination process. Increase in PEG concentration markedly decreased the seedling length, seedling fresh weight, dry weight and vigor index (Fig. 2). Reduction in root and shoot length at higher levels of water stress is reported to be due to reduced cellular division during germination (Frazer *et al*., 3). A non-significant variation among the onion varieties at different levels of water stress for important germination and seedling characters (germination percent, mean germination time, seedling length and vigor index) was noticed (Fig. 1 and 2).

Salinity stress is yet another decisive abiotic factor that restricts the plant growth. There was a significant influence of salinity stress on germination and seedling characters at different levels of salinity (Fig. 3 and 4). Increase in level of salt stress notably decreased the germination percent by 3 to 57%. It also delayed the germination time by 0.46 to 4.68 days at various levels of salinity stress. Maximum percentage of seed germination was observed at 50 mM NaCl (83.34%) followed by control (82.48%) and 100 mM NaCl (79.92%), but at higher levels of salt the germination percentage significantly decreased (Fig. 3(A)). The mean germination time recorded maximum (7.47 days) in 250 mM concentration and minimum

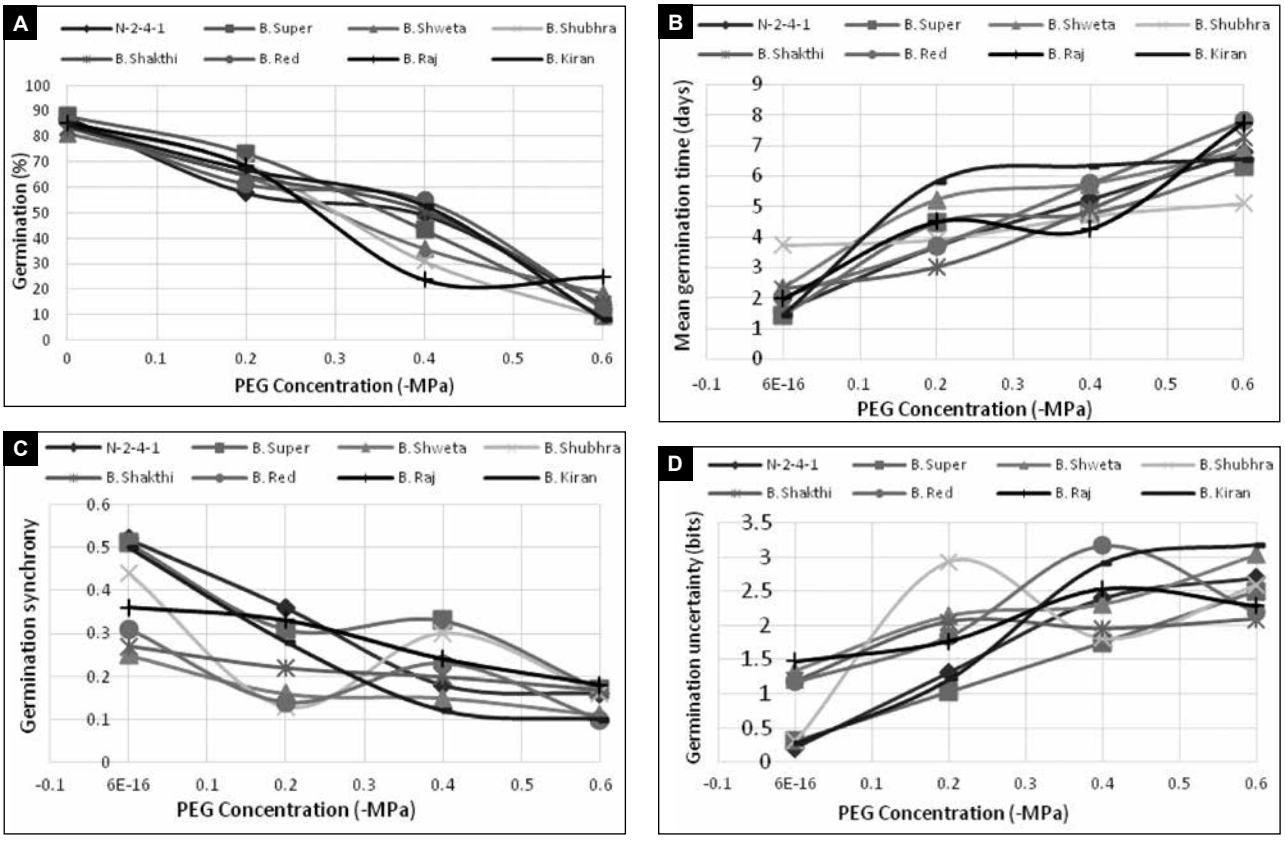

Fig. 1. Effect of water stress (PEG) and variety on germination characters in onion: (A) Germination (%), (B) Mean germination time (days), (C) Germination synchrony, (D) Germination uncertainty (bits).

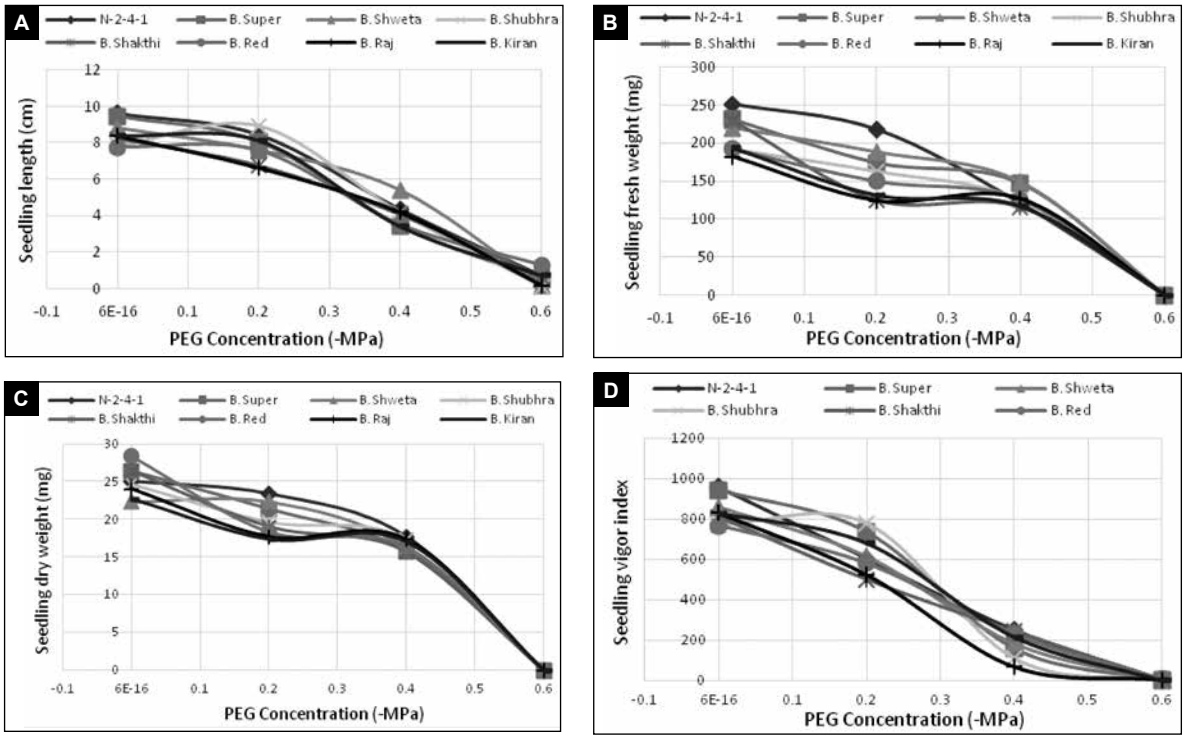

Fig. 2. Effect of water stress (PEG) and variety on seedling characters in onion: (A) Seedling length (cm), (B) Seedling fresh weight (mg/10 seedlings), (C) Seedling dry weight (mg/10 seedlings), (D) Seedling vigor index.

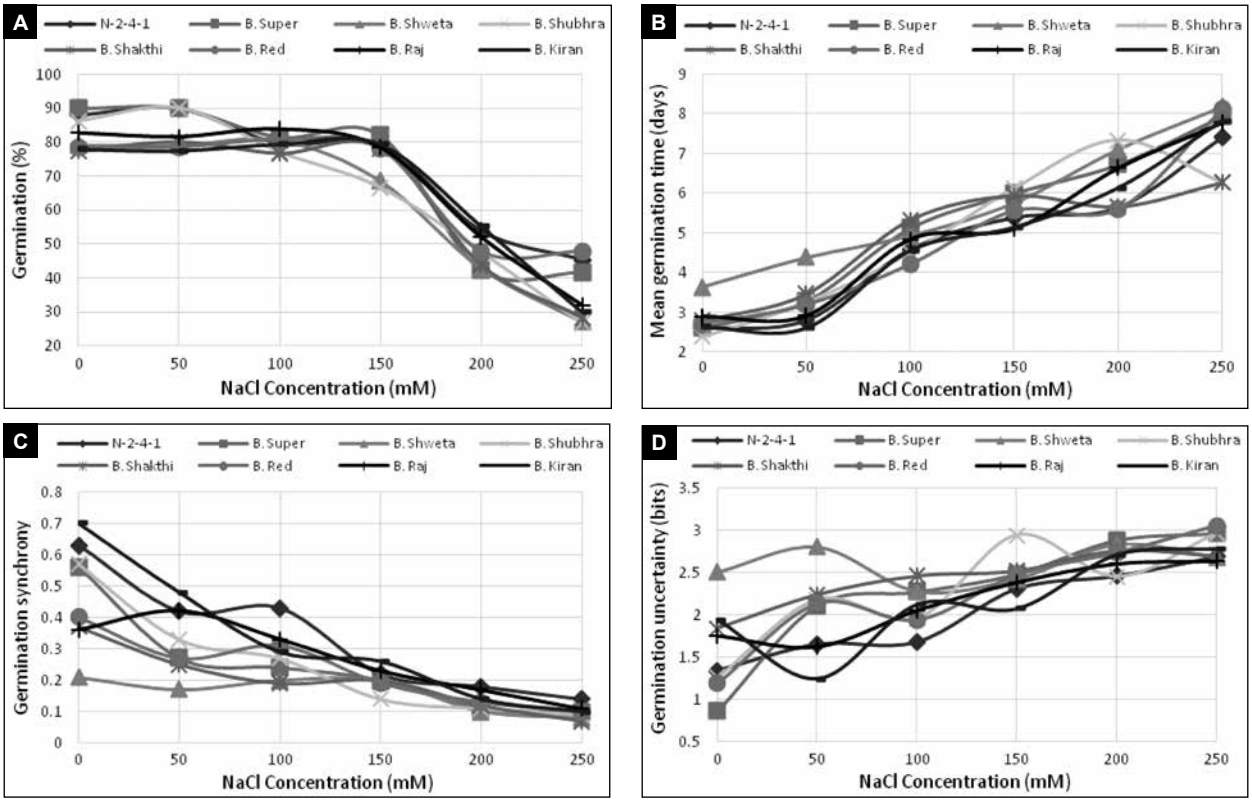

Fig. 3. Effect of salinity stress (NaCl) and variety on germination characters in onion: (A) Germination (%), (B) Mean germination time (days), (C) Germination synchrony, (D) Germination uncertainty (bits).

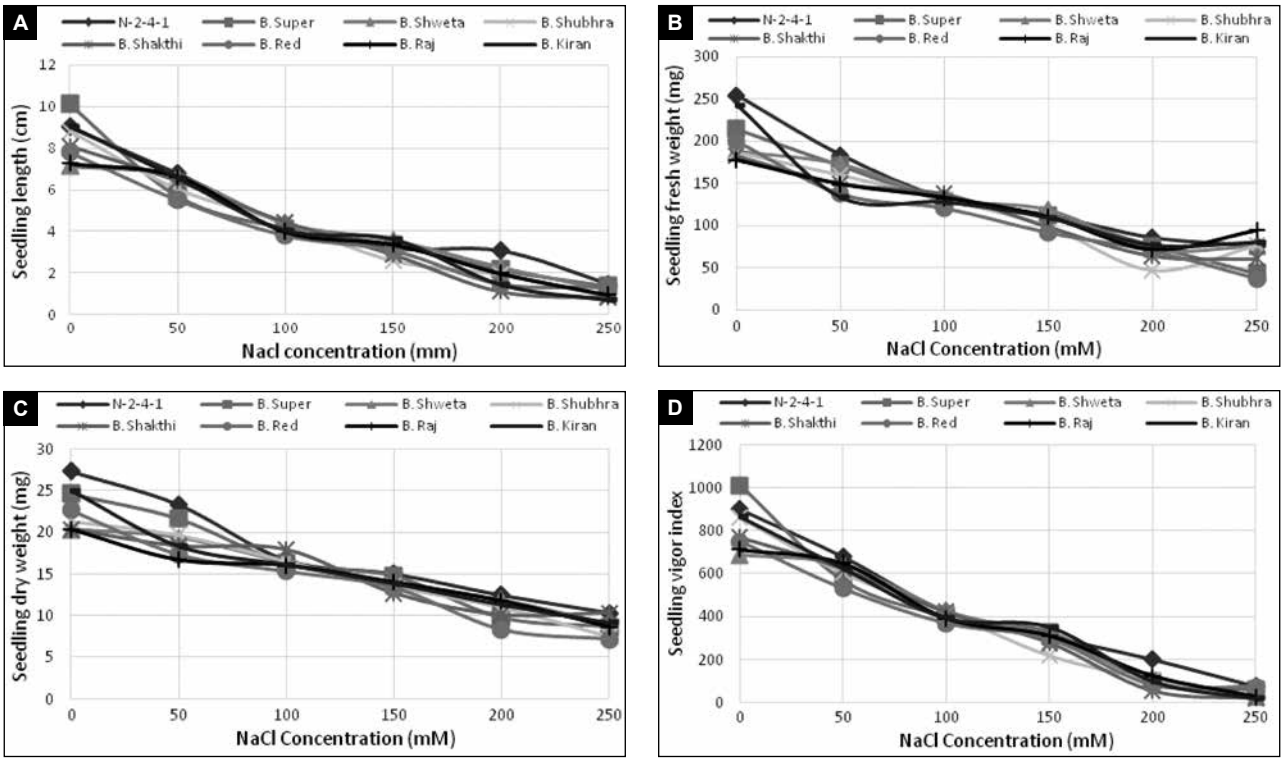

Fig. 4. Effect of salinity stress (NaCl) and variety on seedling characters in onion: (A) Seedling length (cm), (B) Seedling fresh weight (mg/10 seedlings), (C) Seedling dry weight (mg/10 seedlings), (D) Seedling vigor index.

in control (Fig. 3(B)) suggesting that increase in salt concentration not only affects germination percent but it also delays the germination process. This result was supported by Joshi and Sawant (4) who reported that increase in salt concentration delays the germination in onion. Germination synchrony was maximum (0.47 bits) in control and minimum (0.10 bits) in 250 mM NaCl induced salt stress treatment (Fig. 3(C)) but germination uncertainty showed opposite trend (Fig. 3(D)). Salt stress inhibited seedling characters like seedling vigor, seedling length, and seedling fresh and dry weight (Fig. 4). Seedling length (8.41 cm), seedling fresh weight (205.63 mg), seedling dry weight (22.75 mg) and seedling vigor index (819.62) was maximum in control compared to other treatments (Fig. 4). The results are in accordance with Sudha and Riazunnisa (10) who stated that the germination percentage, seed vigor, length of plumule and radicle decrease with increase in salinity concentration. The decrease in seedling characters at increased salt concentration is mostly due to osmotic effect and toxic ionic effect which led to unbalanced nutrient uptake by the seedlings (Saadat *et al*., 9).

With regard to varieties performance, significant difference for all the studied characters, among eight varieties was noticed (Fig. 3 and 4). The variety, N-2-4-1 significantly outpaced other varieties in germination percent under stress (Fig. 3(A)). The minimum mean germination time was 4.74 days in the variety N-2-4-1 and maximum was 5.67 days in Bhima Shweta (Fig. 3(B)). Lowest germination uncertainty was found in N-2-4-1 (2.02 bits) (Fig. 3(D)). Maximum seedling length (4.66 cm) was recorded in N-2-4-1, while minimum seedling length (3.83 cm) was noticed in Bhima Red (Fig. 4(A)). The variety N-2-4-1 recorded the highest seedling fresh weight and dry weight followed by Bhima Super (Fig. 4(B) and 4(C)). Thus, N-2-4-1 performed better in germination parameters than other varieties under salt stress.

REFERENCES

1. Baki, A. A. and Anderson, J. D. 1970. Viability and leaching of sugars from germinating barley. *Crop Science*, **10**: 31-34.

2. Dehghan, G., Rezazadeh, L. and Habibi, G. 2011. Exogenous ascorbate improves antioxidant defense system and induces salinity tolerance in soyabean seedlings. *Acta Biologica Szegediensis*, **55**: 261-64.

3. Frazer, T. E., Silk, W. K. and Rost, T. L. 1990. Effect of low water potential on cortical cell

length in growing region of maize roots. *Plant Physiology*, **93**: 648-51.

4. Joshi, N. and Sawant, P. 2012. Response of Onion (*Allium cepa* L.) Seed Germination and Early Seedling Development to Salt Level. *Int. J. Veg. Sci.* **18**: 3-19.

5. Kutty, M. S., Gowda, R. V. and Rao, N. K. S. 2014. Genotypic variability for physiological, biochemical and morphological responses to drought stress in onion (*Allium cepa* L.). *Trop. Agric.* **91**: 202-21.

6. Mantovani. A. and Iglesias, R. R. 2010. The effect of water stress on seed germination of three terrestrial bromeliads from restinga. *Brazilian J. Botany*, **33**: 201-205.

7. Michel, B. E. and Kaufmann, M. R. 1973. The osmotic potential of polyethylene glycol 6000. *Plant Physiology*, **51**: 914-16.

8. Ranal, M. A., Santana, D. G., Ferreira, W. R. and Rodrigues, C. M. 2009. Calculating germination measurements and organizing spread sheets. *Brazilian J. Botany*, **32**: 849-55.

9. Saadat, S., Badakhshan, P., Sattarzadeh, A. and Soula, S. 2012. Effect of salinity on germination and seedling growth of 4 sugar beet genotypes (*Beta Vulgaris* L.). *J. Appl. Sci. Engi. and Tech.* **2**: 615-19.

10. Sudha, S. G. and Riazunnisa, K. 2015. Effect of salt stress (NaCl) on morphological parameters of onion (*Allium cepa* L.) seedlings. *Int. J. Plant, Animal and Environ. Sci.* **5**: 125-28.

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