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COMPARATIVE EFFICACY OF POLYETHYLENE GLYCOL FOR DROUGHT TOLERANCE ASSESSMENT IN CHILLI VARIETY LCA 625

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ABSTRACT

Chilli (*Capsicum annuum* L.) is an important vegetable crop and its area under production is limited by water scarcity. *In vitro* screening of chilli using polyethylene glycol (PEG) is an alternate way for conducting quick screening. The seed of chilli variety LCA 625 was treated with three levels of PEG 6000 @ 15%, 20%, 25% along with control (0% PEG) under *in vitro* conditions to study the drought tolerance at the seedling emergence stage. The data was recorded at one week and 2 weeks of incubation period i.e., on 7th and 14th day of incubation. All the relative germination parameters like RGI, RGE, RVI and RGE were reduced at 25% PEG concentration (23.05%, 9.40%, 9.99% and 22.90 % respectively) compared to 15% PEG (95.85%, 95.61%, 80.66%, and 95.80% respectively). At 15% PEG, compared to control, seeds still germinated well, whereas at 25% PEG, germination was completely inhibited, which showed the strong stress impact of PEG on relative germination parameters. Hence, PEG 6000@ 20% concentration with moderate stress was considered as optimum PEG concentration to assess chilli genotypes for drought stress.

***Key word*:** Chilli, LCA 625, Drought, PEG concentration, seedling emergence stage

Introduction

Chilli (*Capsicum annuum* L.), the green or dried ripe fruits of pungent form of *Capsicum* species, is an important member of the family Solanaceae. It has unique place in the diet as a vegetable cum spice crop (Gadaginmath *et al*., 1992).

Chilli occupies a considerable share of cultivated area in India and contributes millions of tonnes to overall spice. Low productivity is primarily due to the fact that around 50% of the crop is raised under rainfed conditions, making yields highly vulnerable to rainfall variability (Dorji *et al*., 2005). Water availability and movement into the seeds are very important to promote germination, initial root growth, shoot elongation and therefore at the establishment of a uniform stand (Meneses *et al*., 2011). Drought is one of the major abiotic stresses which resulted in significant reduction in morphological traits such as plant height, plant spread and dry matter accumulation (Kumar *et al*., 2009) affecting the physiological process, thereby causing considerable economic yield loss in the chilli (Sezen *et al*., 2006).

Field experiments related to water stress have been difficult to handle due to significant environmental or drought interactions with other abiotic stresses (Rauf *et*

Table 1: Effect of PEG concentration on germination related parameters in chilli variety LCA 625.

PEG concentration	GE	GI	VI	SL
0% PEG (Control)	65.28(53.87) *	4.99	52.07	10.43
15% PEG	62.41(52.16)	4.78	41.98	8.78
20% PEG	33.86(35.57)	2.93	22.88	7.80
25% PEG	6.14(14.32)	1.15	5.20	4.52
S. Em ±	0.20	0.05	0.47	0.04
C.D. at 5%	0.61	0.15	1.42	0.12
CV (%)	1.15	3.25	3.43	1.10

GE: Germination energy (%); **GI:** Germination index; **VI:** Vitality index; **SL:** Seedling length (cm)
variety LCA 625
*Values in parenthesis are angular transformed

al., 2008). An alternative approach is to induce water stress through polyethylene glycol for the screening of the germplasm (Kulkarni *et al*., 2007). PEG 6000 is one of the dependable approaches for selecting desirable genotypes on the basis of plant germination indices. PEG 6000 molecules are small enough to influence the osmotic potential but large enough to be absorbed by plants, therefore closely mimics the dry soil (Govindaraj *et al*., 2010). Therefore, an experiment was carried out in chilli LCA 625 variety in order to find out an optimum concentration of PEG to create similar drought stress condition which can be adopted for screening chilli genotypes for drought.

Materials and Methods

The experiment was conducted at the Regional Horticultural Research Station, Lam, Guntur, Andhra Pradesh under the aegis of Dr.YSRHU. Various concentrations of PEG were tested for germination in chilli variety LCA 625. The seed was procured from Regional Horticultural Research Station, Lam, Guntur. Optimum concentration of PEG was standardised using three levels of PEG 6000 concentrations (15%, 20% and 25%) along with control (distilled water-0% PEG) and replicated five times. Data was recorded on 14th day of incubation.

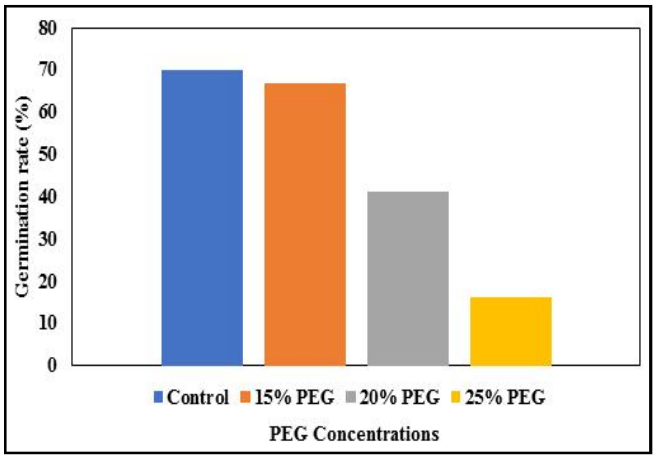

Fig. 1: Effect of PEG concentrations on germination rate in chilli variety LCA 625.

Twenty-five healthy and good quality seeds of LCA 625 chilli variety were placed in petri plates with varying PEG concentrations. Observations on germination related parameters *viz*., germination rate, germination energy, germination index, seedling length, vitality index were calculated (Li *et al*., 2008).

Germination rate (GR) = a/b × 100

Germination energy (GE) = c/b × 100

Germination index (GI) = ÓGt/day t

Vitality index (VI) = GI × SL

Where,

a = Total number of germinated seeds in PEG or distilled water in 14 days

b = Total number of seeds kept for germination study

c = Total number of germinated seeds in PEG concentration or distilled water in 7 days

Gt = Germinated seeds in day t, t = 1, 2, 3....., 14

SL = Seedling length (cm)

Relative germination parameters like relative germination index, relative germination energy, relative vitality index and relative germination rate were calculated by the following formulas (Molla *et al*., 2019).

Relative germination rate (RGR) = GR in PEG/GR in distilled water × 100

Relative germination energy (RGE) = GE in PEG/ GE in distilled water × 100

Relative germination index (RGI) = GI in PEG/GI in distilled water × 100

Relative vitality index (RVI) = VI in PEG/VI in distilled water × 100

The data recorded was statistically analysed as per analysis of variance (ANOVA) technique for CRD. The test of significance among the treatments was computed at 0.05 probability as per the standard procedure **(**Panse and Sukhatame, 1989).

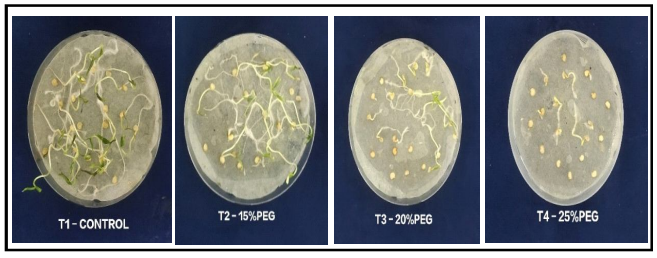

Plate 1: Effect of PEG concentrations on seed germination rate in chilli variety LCA 625

Results and Discussion

Germination parameters

Different concentrations of polyethylene glycol (PEG) significantly influenced various germination parameters like germination rate, germination energy, germination index, vitality index and seedling length (Fig. 1, Plate 1 and Table 1).

Germination rate (%)

Germination rate was significantly influenced by different PEG concentrations (Fig. 1 and Plate 1). Significantly highest germination rate was observed in control, whereas the lowest was recorded in the 25% PEG concentration, showing a steep decline as stress level increased**.** Decline in germination percentage might be due to the fact that PEG 6000 decreases the water potential gradient between seeds and the surrounding medium, thereby reduced germination (Dodd *et al.*, 1999). Similar results were reported by Poobalan *et al.*, (2019) in chilli.

Germination energy (%)

The values of germination energy were significantly differed and ranged from 6.14% to 65.28% (Table 1). Significantly highest germination energy (65.28%) was recorded in control over all PEG concentrations. Seeds germinated more rapidly and uniformly in the control, while energy dropped drastically in all PEG concentrations, particularly at 25% PEG. Similar results were reported by Molla *et al.*, (2019) in chilli.

Germination index

Among the PEG concentrations, germination index showed significant variation (Table 1). Germination index varied from 1.15 to 4.99. Significantly highest germination index (4.99) was observed in control, whereas lowest germination index was observed at 25% PEG (1.15). Among PEG concentrations, a sharp decline was observed at 20% and 25% PEG concentrations, reflecting slower and less efficient germination. Similar observations were reported by Poobalan *et al.*, (2019) in chilli.

Vitality index

Vitality index exhibited a wide range of variation, with a maximum of 52.07 in the control and a minimum of 5.20 at 25% PEG concentration (Table 1). Significantly highest reduction in vitality index was observed in 25 % PEG over control. The reduction in vitality index with increased PEG concentrations, induced stress which clearly indicated that seedlings under osmotic stress lacked vigor and establishment potential (Ghosh *et al.*,

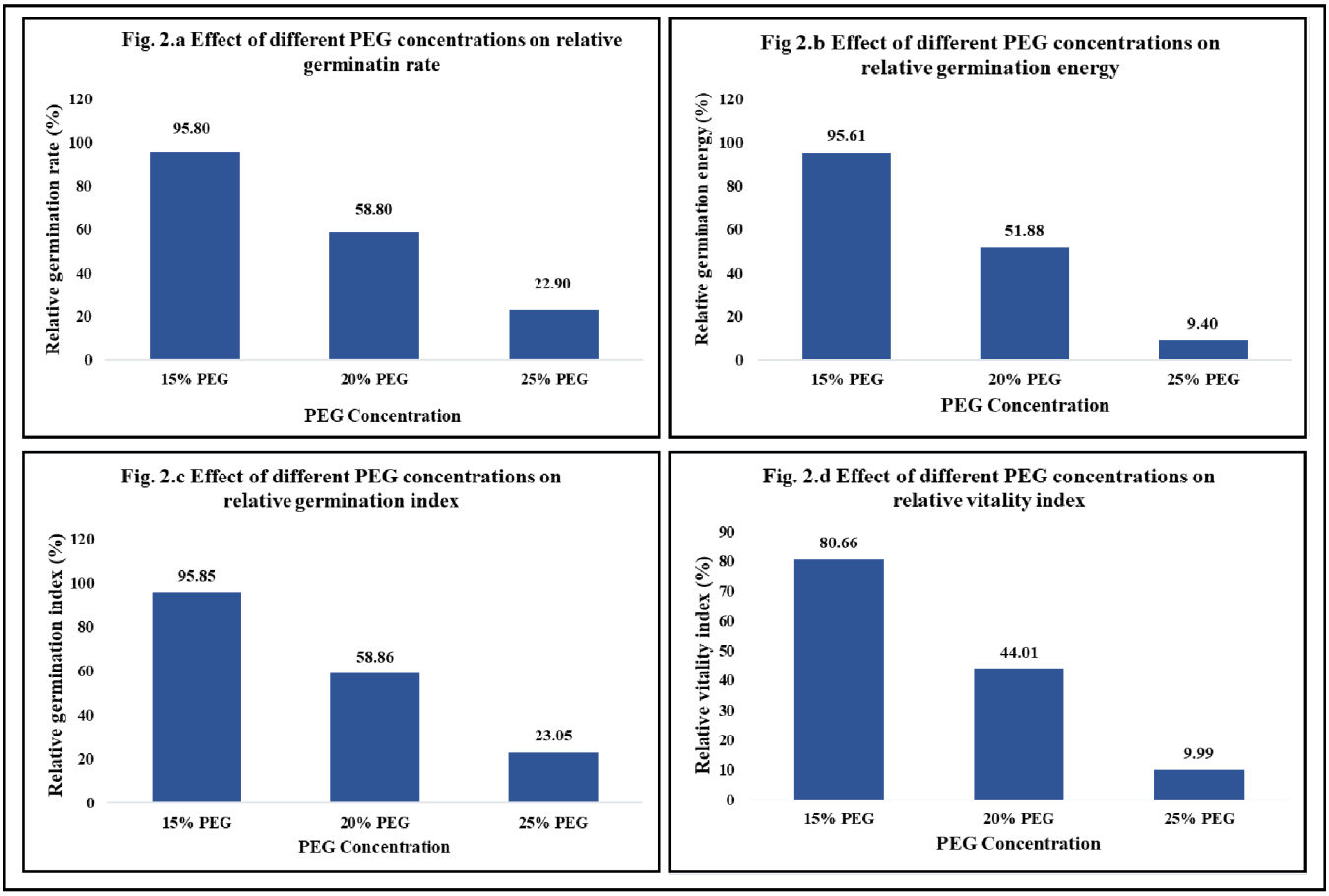

Fig. 2: Effect of PEG concentrations on relative germination parameters in chilli variety LCA 625.

2020). Similar results were reported by Poobalan *et al*., (2019) in chilli.

Seedling length (cm)

Seedling length significantly reduced from 10.43 cm in control to 4.52 cm at 25% PEG concentration (Table 1). Seedlings under control conditions attained nearly double the length of those grown under 25% PEG, demonstrating that higher osmotic stress severely restricted elongation and overall seedling growth. Similar observations were found by Gangotri *et al*., (2022), Manivannan *et al*., (2017) in chilli.

Relative germination parameters

Different concentrations of PEG influenced various relative germination parameters like Relative germination index (RGI), Relative germination energy (RGE), Relative vitality index (RVI) and Relative germination rate (RGR) (Fig. 2).

Relative germination rate (RGR)

Among different PEG concentrations, RGR values ranged from 22.90% to 95.80% (Fig. 2a). Highest RGR (95.80%) was recorded at 15% PEG and lowest (22.90%) was recorded at 25% PEG.

Relative germination energy (RGE)

RGE influenced by PEG concentrations and ranged from 9.40% to 95.61% (Fig. 2b). Maximum RGE (95.61%) was recorded at 15% PEG and lowest (9.40%) was recorded at 25% PEG.

Relative germination index (RGI)

PEG concentration at 15% recorded highest RGI of 95.85% showing strong germination activity up to 14 days of incubation (Fig. 2c). The highest PEG concentration tested @25%, markedly inhibited germination, with RGI of only 23.05%.

Relative vitality index (RVI)

Different PEG concentrations influenced RVI (Fig. 2d). The values ranged from 9.99% to 80.66% with highest RVI (80.66%) at 15% PEG and lowest at 25% PEG (9.40%).

Considering all the relative germination parameters, increased PEG concentration severely hampered seed germination, likely due to the osmotic stress impeding water uptake (Sharma *et al*., 2024). However, at 20% PEG concentration, all parameters were reduced over 15% PEG, and recorded 58.80% RGR, 51.88% RGE, 58.86% RGI, 44.01% RVI, and were moderately inhibited. The results demonstrated that lower PEG concentrations at 15 % PEG were less detrimental to seed germination and vitality, whereas higher concentrations at 25% PEG markedly inhibited these processes. The above findings conformed with the results of Molla *et al*., (2019) in chilli and Ghebremarian *et al*., (2013) in tomato genotypes.

Conclusion

PEG acts as an osmotic stress agent, which reduced the water availability to seeds. Among PEG concentrations, at low PEG concentration (15%), seeds still germinated well, compared to control. While at high PEG concentration (25%), germination was completely inhibited, which showed the strong stress impact of PEG on relative germination parameters. Hence, PEG 6000@ 20% concentration with moderate stress could be selected to distinguish tolerant and susceptible genotypes for screening in chilli under *in vitro* condition.

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