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EVALUATION OF PHYSIOLOGICAL QUALITY OF SEED LOTS VARIABILITY UNDER PEG-INDUCED MOISTURE STRESS IN CHILLI (*Capsicum annuum* L.)

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ABSTRACT

Seed quality varies widely among seed lots of the same cultivar owing to differences in production environment, harvest management and post harvest handling. It poses a major challenge for seed certification and for identifying seed lots suitable for moisture limited sowing conditions. Twenty chilli (*Capsicum annuum* L.) seed lots representing four cultivars (Byadagikaddi, Rudra, Byadagidabbi and Guntur) were collected from major chilli seed production locations of Dharwad district, Karnataka. They were evaluated for germination percentage, seedling root and shoot length, seedling dry weight and seed vigour index-I and II. Germination ranged from 25.00 to 80.00 per cent and a Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) analysis based on all six seed quality traits identified ten seed lots (Lots 2, 5, 7, 11, 12, 14, 15, 17, 18 and 20) as physiologically superior. These ten superior seed lots were further screened under polyethylene glycol (PEG-6000) induced moisture stress at 5, 10 and 15 per cent concentrations to evaluate their tolerance to moisture stress condition. Germination, seedling growth and vigour declined progressively and significantly with increasing PEG concentration in every seed lot. Relative Trait Retention (%) at 15 per cent PEG stress identified Lot 14 (56.89%), Lot 7 (50.28%) and Lot 12 (47.31%) as the moisture stress tolerant seed lots among all the lots, whereas Lots 11 and 17 retained the least. The divergence between ranking under optimal conditions and under moisture stress indicates that standard germination based seed quality assessment alone cannot reliably predict the seed lot performance under moisture limited conditions.

Key words: Chilli, Polyethelene glycol, moisture stress, seed quality

Introduction

Chilli (*Capsicum annuum* L.) is a significant commercial spice and vegetable crop in India, esteemed for its pungency, colour and contribution to export revenue (Azlan *et al.*, 2022). It plays a crucial role in the country's agroprocessing and trade sector. India is the leading global producer, consumer and exporter of chilli, with cultivation spanning approximately 8.07 lakh hectares and an annual production of nearly 26.44 lakh tonnes (Anonymous, 2024). Major chilli growing states in India are Andhra

Pradesh, Telangana, Karnataka, Maharashtra, Odisha, Madhya Pradesh and Tamil Nadu. In Karnataka, the major chilli districts are Dharwad, Ballari, Haveri, Gadag and Raichur. The Byadagi variety, named after Byadagi town in Haveri district, holds a Geographical Indication (GI) tag and is traditionally grown across Dharwad, Haveri, Gadag, Bellary, Raichur, Belagavi, Bagalkot, Shimoga and Chitradurga (Ashoka *et al.*, 2022). The seed for this crop is predominantly produced by numerous small and dispersed seed production units in traditional regions such

as Dharwad in Karnataka. Consequently, seed lots available to farmers or certifying agencies originate from diverse sources, cultivars and production environments.

Seed quality is the most vital input in crop production. The physiological quality of the sown seed lot significantly influences field establishment, seedling vigour and ultimately the yield potential achieved by the crop. Seed quality is not an inherent characteristic of a cultivar. It is also influenced by the genotype (Morris *et al.*, 2016), agro climatic conditions during seed development (Demir and Ellis, 1992), the timing and method of harvest (Alan and Eser, 2008), as well as the processing and storage practices (Satya Srii and Nagarajappa, 2024). Consequently, seed lots of the same cultivar, even those produced within the same locality, often exhibit differences in germination capacity and vigour. This variability among seed lots presents a challenge for seed certification agencies and consumers, as two lots with similar germination percentages under standard laboratory conditions may still vary significantly in the vigour and uniformity of the seedlings they produce.

The field performance of a seed lot is strongly governed by the moisture status prevailing in the seed bed at the time of sowing as well as the moisture content of the soil during transplantation of seedlings along with its germination capacity and seedling vigour (Gunawardena and De Silva 2015). Chilli is particularly sensitive to water deficit conditions during germination and early seedling establishment. Simulating moisture deficit conditions under controlled laboratory conditions therefore provides a more realistic assessment of the field behavior of a seed lot than the standard germination test alone. In this experiment, the osmotic stress was imposed on seed lots of different genotypes to assess the moisture stress tolerance capacity of the collected seed lots.

Materials and Methods

Twenty chilli (*Capsicum annuum* L.) seed lots representing cultivated varieties were collected from major chilli seed production locations of Dharwad district, Karnataka, India, during the 2024-25 cropping season. The seed lots were collected directly from farmers after harvest and stored under ambient laboratory conditions until further evaluation. Each seed lot was assigned a unique identification number, i.e., Lot 1-Lot 20 (Table 1), and used for subsequent seed quality assessment. The laboratory experiment was conducted at the Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India. The experiment was laid out in a Completely Randomized Design (CRD). Seed quality parameters

Table 1: List of chilli genotypes collected from different locations of chilli seed production.

Sl. No.	Location of collection	Lot No. allotted	Genotype Name
1	Kamadolli	1	Byadagikaddi
2	Kundagola	2	Byadagikaddi
3	Devanoora	3	Byadagikaddi
4	Kamadolli	4	Byadagikaddi
5	Kundagola	5	Byadagikaddi
6	Devanoor	6	Byadagikaddi
7	Harakone	7	Rudra
8	Devanoora	8	Rudra
9	Kundagola	9	Rudra
10	Devanoor	10	Rudra
11	Kundagola	11	Rudra
12	Kundagola	12	Rudra
13	Harakone	13	Byadagidabbi
14	Harakone	14	Byadagidabbi
15	Kamadolli	15	Byadagidabbi
16	Kamadolli	16	Byadagidabbi
17	Harakone	17	Byadagidabbi
18	Devanoora	18	Byadagidabbi
19	Harakone	19	Guntur
20	Kamadolli	20	Guntur

were evaluated according to the International Rules for Seed Testing (ISTA, 2024). Four replications of 100 seeds from each seed lot were subjected to the standard germination test using the between paper (BP) method. Germination papers were moistened with distilled water and incubated in a seed germinator maintained at 25 ± 1°C. Normal seedlings were counted on the 14th day and germination percentage was calculated based on the number of normal seedlings obtained (ISTA, 2024). Following the final germination count, ten normal seedlings were randomly selected from each replication for recording seedling growth parameters. Seedling root length was measured from the collar region to the tip of the primary root, while shoot length was measured from the collar region to the tip of the apical bud using a graduated ruler and expressed in centimeters. The seedlings used for growth measurements were dried in a hot air oven maintained at 80 ± 2°C for 24 h until a constant weight was achieved. The dried seedlings were weighed using an electronic analytical balance, and the seedling dry weight was expressed as mg per ten seedlings (ISTA, 2024). Seed vigour was assessed by calculating Seed Vigour Index-I (SVI-I) and Seed Vigour Index-II (SVI-II) following the method of Abdul-Baki and Anderson (1973).

Seed Vigour Index-I (SVI-I) = Germination (%) × (Root length + Shoot length) (cm)

Table 2: Seed germination per cent, root length, shoot length, seedling dry weight and seed vigour indices of 20 chilli genotypes collected from different chilli seed production locations.

Lot No.	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling dry weight (mg/10 seedlings)	Seed Vigour Index-I	Seed Vigour Index-II
1	46.50 (42.99)	7.95	6.73	24.2	684	1126
2	68.75 (56.01)	8.76	5.76	28.6	998	1967
3	46.00 (42.71)	6.25	5.67	23.6	537	1083
4	25.00 (30.00)	4.85	5.35	18.2	255	456
5	56.00 (48.45)	8.60	5.60	27.2	796	1524
6	30.50 (33.52)	6.10	5.76	21.4	365	654
7	80.00 (63.43)	9.64	6.64	32.5	1303	2600
8	45.00 (42.13)	8.05	5.75	24.8	621	1117
9	46.25 (42.85)	5.47	4.08	22.1	442	1022
10	42.75 (40.83)	5.73	5.99	23.3	501	996
11	62.00 (51.94)	8.89	5.89	26.3	916	1629
12	67.00 (54.94)	9.75	6.75	30.7	1106	2056
13	34.50 (35.97)	7.33	5.58	19.4	446	669
14	71.25 (57.58)	8.59	5.59	22.8	1010	1624
15	70.00 (56.79)	9.75	6.75	31.4	1155	2198
16	42.25 (40.54)	6.70	5.70	20.8	524	878
17	62.25 (52.09)	9.16	6.16	26.8	954	1669
18	73.75 (59.18)	9.64	6.64	30.1	1200	2218
19	44.00 (41.55)	7.43	6.97	23.9	632	1052
20	61.75 (51.80)	9.09	6.55	25.8	967	1594
S.Em ±	1.08	0.26	0.24	0.406	29.514	45.962
C.D. at 1%	4.06	0.99	0.92	1.529	111.040	172.917
<i>*Values in parentheses indicate arc sine transformed values.</i>						

Seed Vigour Index-II (SVI-II) = Germination (%) × Seedling dry weight (mg)

The overall seed quality of the seed lots were evaluated using multi criteria decision making method (Hwang & Yoon, 1981). It was applied to all the six physiological traits a composite closeness coefficient for each lot was derived. Ten superior seed lots were selected.

PEG induced moisture stress screening

The ten superior seed lots were further subjected to PEG induced moisture stress to evaluate their moisture stress tolerance. Polyethylene glycol - 6000 solutions were prepared at 5, 10 and 15 per cent concentration. Three replications of 100 seeds of each of the ten selected seed lots were incubated between the germination papers which were moistened with the respective PEG solution (or distilled water for the control) in a seed germinator maintained at $25 \pm 1^\circ\text{C}$. The germination papers were re moistened periodically with fresh solution of the corresponding concentration to maintain a near constant osmotic potential throughout the test period. Germination percentage, seedling root length, seedling shoot length, seedling dry weight, SVI-I and SVI-II were recorded for each PEG concentration following the procedures

described above (ISTA, 2024; Abdul-Baki and Anderson, 1973).

The extent to which each seed lot retained its physiological quality under the most severe stress level imposed was quantified by calculating the Relative Trait Retention (%) for each of the six seed quality parameters as the value recorded under 15 per cent PEG stress expressed as a percentage of the corresponding value recorded under the control (0% PEG):

$$\text{Relative Trait Retention (\%)} = \frac{\text{Trait value under 15\% PEG}}{\text{Trait value under control}} \times 100$$

The mean of the six trait wise retention values was computed for each seed lot as the Mean Retention (%), which served as an integrated index of overall moisture-stress tolerance, with higher values indicating superior retention of seed quality under moisture stress.

Statistical analysis

The experimental data on seed quality of the twenty seed lots under non-stress conditions were subjected to analysis of variance (ANOVA) appropriate for a Completely Randomized Design as described by Gomez and Gomez (1984). The data generated from the PEG-induced moisture stress experiment, involving ten seed lots (L) and four moisture levels (M) in a factorial CRD

Table 3: Effect of PEG-induced moisture stress on seed germination (%) of selected chilli seed lots.

Lot No.	M1	M2	M3	M4	Mean
Lot 2	72.33 (58.27)	64.00 (53.13)	43.33 (41.17)	33.33 (35.26)	53.25 (46.86)
Lot 5	62.66 (52.34)	54.66 (47.68)	41.66 (40.19)	28.67 (32.37)	46.91 (43.23)
Lot 7	88.00 (69.85)	72.33 (58.26)	61.00 (51.35)	46.00 (42.70)	66.83 (54.84)
Lot 11	64.00 (53.14)	60.33 (50.96)	42.33 (40.59)	25.33 (30.22)	48.00 (43.85)
Lot 12	64.33 (53.33)	52.00 (46.15)	43.66 (41.35)	38.33 (38.25)	49.58 (44.76)
Lot 14	60.33 (50.97)	52.33 (46.34)	43.39 (41.20)	36.00 (36.87)	48.01 (43.86)
Lot 15	72.00 (58.05)	56.33 (48.64)	45.33 (42.32)	42.33 (40.59)	54.00 (47.29)
Lot 17	60.33 (50.96)	48.00 (43.85)	39.66 (39.03)	22.33 (28.18)	42.58 (40.73)
Lot 18	64.66 (53.53)	52.00 (46.15)	43.00 (40.98)	35.33 (36.47)	48.75 (44.28)
Lot 20	62.66 (52.33)	54.33 (47.48)	45.66 (42.51)	28.67 (32.37)	47.83 (43.76)
Mean	67.13 (55.38)	56.20 (48.86)	44.40 (42.07)	33.63 (35.33)	
Analysis of variance (S.Em ± and C.D. at 1%) for main effects and interaction:					
	L	M	L×M		
S.Em ±	0.299	0.189	0.597		
C.D. at 1%	1.115	0.705	2.23		
*Values in parentheses indicate arc sine transformed values.					
M1: Control (M1); M2: 5% PEG (M2); M3: 10% PEG (M3); M4: 15% PEG (M4)					

with three replications, were analysed using two-factor ANOVA. In both cases, the significance of treatment differences was tested and treatment means were compared using the Critical Difference (CD) at the 1% level of significance. Statistical analyses were performed using OPSTAT statistical software.

Multi-criteria ranking of seed lots (TOPSIS)

The overall seed quality of the twenty seed lots was further evaluated using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981; Oliveira *et al.*, 2022), a multi-criteria decision making method that ranks alternatives on the basis of their relative closeness to an ideal solution. The decision matrix comprised six seed quality parameters, i.e., germination percentage, root length, shoot length, seedling dry weight, Seed Vigour Index-I and Seed Vigour Index-II, as criteria, and the twenty seed lots as alternatives. Each criterion was normalized by vector

normalization and assigned equal weight (1/6), since all six traits were considered equally important indicators of seed lot quality. The Euclidean distance of each seed lot from the ideal-best solution (S+) and the ideal-worst solution (S-) was computed, and the closeness coefficient (Ci) for each lot was derived as $C_i = S^- / (S^+ + S^-)$. Seed lots were ranked in descending order of Ci, with values closer to 1 indicating superior overall seed quality.

Results

Twenty chilli seed lots representing the cultivars Byadagi Kaddi, Rudra, Byadagidabbi and Guntur were collected from different seed production locations in Dharwad (Fig. 1). Variations were observed among the twenty seed lots for germination percentage, root length, shoot length, seedling dry weight, Seed Vigour Index-I and Seed Vigour Index-II (Table 2). Germination percentage varied significantly from 25.00 per cent in Lot 4 to 80.00 per cent in Lot 7, which recorded the highest germination, followed by Lot 18 (73.75%), Lot 14 (71.25%) and Lot 15 (70.00%). In contrast, Lots 4, 6 and 13 exhibited poor germination, ranging from 25.00 to 34.50 per cent. Root length ranged from 4.85 cm in Lot 4 to 9.75 cm in Lots 12 and 15, while shoot length varied from 4.08 cm in Lot 9 to 6.97 cm in Lot 19. Seedling dry weight ranged between 18.2 in Lot 4 and 32.5 mg per ten seedlings in Lot 7. Similarly, Seed Vigour Index-I ranged from 255 in Lot 4 to 1303 in Lot 7, whereas Seed Vigour Index-II varied from 456 in Lot 4 to 2600 in Lot 7. The same group of seed lots, particularly Lots 7, 12, 15 and 18, consistently ranked among the best performers across most vigour parameters, whereas Lot 4 consistently recorded the lowest values.

The overall performance of the seed lots was further evaluated using the TOPSIS multi-criteria decision making approach and the composite scores and corresponding ranks are presented in Fig. 2. The closeness coefficient (Ci) ranged from 0.08 in Lot 4 to 0.98 in Lot 7, confirming its superiority based on the combined evaluation of all six seed quality traits. Lot 18 (Ci = 0.86), Lot 15 (Ci = 0.84), Lot 12 (Ci = 0.79) and Lot 2 (Ci = 0.72) also ranked among the top-performing seed lots. Lots 17 and 14

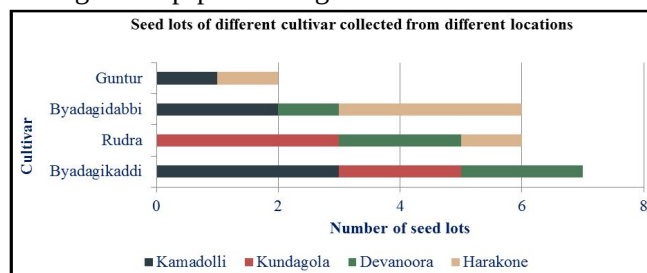


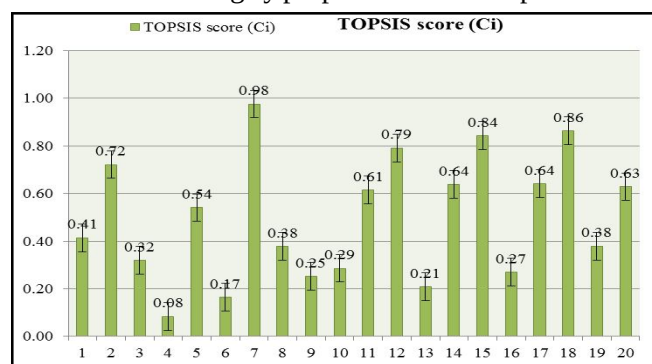
Fig. 1: Representation of seed lots of different cultivars collected from different locations of Dharwad.

Table 4: Effect of PEG-induced moisture stress on seedling shoot length (cm) of selected chilli seed lots.

Lot No.	M1	M2	M3	M4	Mean
Lot 2	8.13	7.20	6.45	4.36	6.54
Lot 5	7.36	6.64	5.44	3.56	5.75
Lot 7	6.84	7.54	7.45	5.64	6.87
Lot 11	7.32	6.51	5.94	3.27	5.76
Lot 12	7.13	6.61	6.79	4.78	6.33
Lot 14	6.56	6.17	6.08	4.96	5.94
Lot 15	7.86	6.91	6.08	4.73	6.40
Lot 17	7.42	6.87	5.78	3.26	5.83
Lot 18	8.36	7.10	6.28	4.56	6.58
Lot 20	6.98	6.30	6.50	5.23	6.25
Mean	7.396	6.785	6.279	4.435	
Analysis of variance (S.Em ± and C.D. at 1%) for main effects and interaction:					
	L	M	L×M		
S.Em ±	0.134	0.085	0.267		
C.D. at 1%	0.499	0.316	0.998		
M1: Control (M1); M2: 5% PEG (M2); M3: 10% PEG (M3); M4: 15% PEG (M4)					

recorded identical composite scores ($C_i = 0.64$) and were ranked sixth and seventh, followed by Lot 20 ($C_i = 0.63$), Lot 11 ($C_i = 0.61$) and Lot 5 ($C_i = 0.54$). At the other end of the ranking, Lot 4 ($C_i = 0.08$), Lot 6 ($C_i = 0.17$) and Lot 13 ($C_i = 0.21$) recorded the lowest composite scores, which was consistent with their poor performance across the individual seed quality parameters. Based on the mean composite score ($C_i = 0.50$) as the selection criterion, ten seed lots (2, 5, 7, 11, 12, 14, 15, 17, 18 and 20) were classified as superior, while the remaining ten were categorized as inferior.

The distribution of the ten superior seed lots among cultivars and collection locations is presented in Fig. 3. Among the cultivars, Byadagidabbi contributed the highest number of superior seed lots (four), followed by Rudra (three), Byadagi Kaddi (two) and Guntur (one). This distribution was largely proportional to the representation

**Fig. 2:** Scoring of different seed lots based on their physiological seed quality parameters (TOPSIS composite score and rank).**Table 5:** Effect of PEG-induced moisture stress on seedling root length (cm) of selected chilli seed lots.

Lot No.	M1	M2	M3	M4	Mean
Lot 2	9.63	8.25	6.41	5.73	7.51
Lot 5	7.89	7.36	6.19	4.74	6.55
Lot 7	10.98	10.23	7.97	6.39	8.89
Lot 11	10.30	9.00	6.90	5.39	7.90
Lot 12	12.14	11.53	7.37	6.54	9.40
Lot 14	7.95	7.38	6.10	5.84	6.82
Lot 15	10.36	9.05	7.15	4.15	7.68
Lot 17	9.42	8.98	8.29	6.34	8.26
Lot 18	9.79	8.05	6.65	4.26	7.19
Lot 20	9.56	8.03	6.86	5.43	7.47
Mean	9.80	8.79	6.99	5.48	
Analysis of variance (S.Em ± and C.D. at 1%) for main effects and interaction:					
	L	M	L×M		
S.Em ±	0.154	0.098	0.309		
C.D. at 1%	0.577	0.365	1.153		
M1: Control (M1); M2: 5% PEG (M2); M3: 10% PEG (M3); M4: 15% PEG (M4)					

of each cultivar in the original collection, where six seed lots each belonged to Byadagi Kaddi, Rudra and Byadagidabbi, while Guntur was represented by only two seed lots. Location wise analysis showed that Kundagola contributed the highest number of superior seed lots (four out of five), followed by Harakone (three), Kamadolli (two) and Devanoora (one). However, the superiority of seed lots was not restricted to a particular cultivar or location. For instance, the superior Byadagidabbi seed lots originated from Harakone, Kamadolli and Devanoora, while the superior seed lots from Kundagola belonged to both Byadagi Kaddi and Rudra cultivars. Interestingly, locations such as Kundagola and Harakone, despite contributing the highest number of superior seed lots, also produced poor quality seed lots (e.g., Lots 9 and 13, respectively), indicating that seed quality varied considerably within locations and was influenced by factors beyond geographical origin alone.

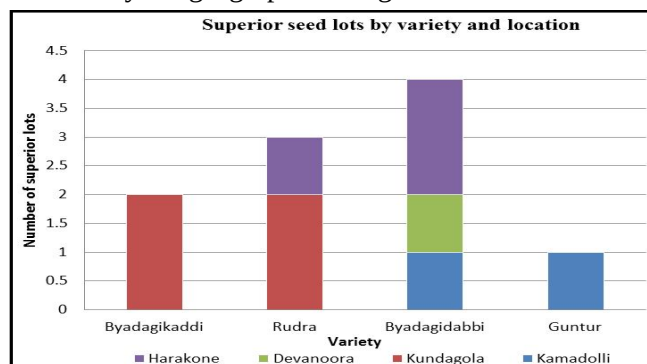
**Fig. 3:** Distribution of the ten superior seed lots (identified by TOPSIS) by cultivar and location.

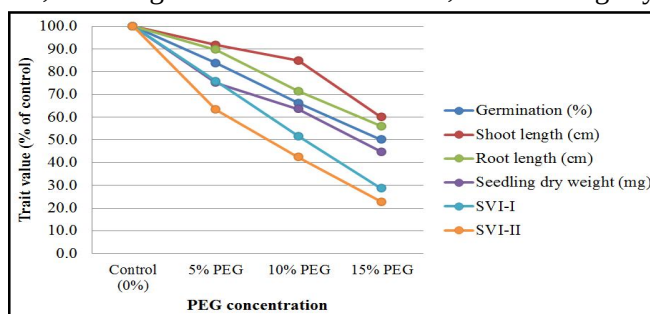
Table 6: Effect of PEG-induced moisture stress on seedling dry weight (mg) of selected chilli seed lots.

Lot No.	M1	M2	M3	M4	Mean
Lot 2	32.933	22.733	19.900	14.767	22.58
Lot 5	25.733	20.900	16.967	11.600	18.80
Lot 7	34.300	26.400	21.500	16.600	24.70
Lot 11	25.633	22.567	18.100	10.100	19.10
Lot 12	32.333	23.100	19.533	13.900	22.22
Lot 14	26.567	20.467	16.200	14.700	19.48
Lot 15	32.433	21.700	19.400	12.433	21.49
Lot 17	28.367	21.033	17.500	11.367	19.57
Lot 18	29.333	21.900	18.733	12.033	20.50
Lot 20	27.333	20.733	19.433	14.467	20.49
Mean	29.50	22.15	18.73	13.20	
Analysis of variance (S.Em ± and C.D. at 1%) for main effects and interaction:					
	L	M	L×M		
S.Em ±	0.362	0.229	0.723		
C.D. at 1%	1.349	0.853	2.699		
M1: Control (M1); M2: 5% PEG (M2); M3: 10% PEG (M3); M4: 15% PEG (M4)					

Effect of PEG induced moisture stress on seed quality of superior seed lots

Progressive imposition of PEG induced moisture stress resulted in a gradual reduction in seed germination, seedling growth and seed vigour in all ten superior seed lots (Tables 3-8). Mean germination decreased from 67.13 per cent under the control to 56.20, 44.40 and 33.63 per cent under 5, 10 and 15 per cent PEG, respectively (Table 3). Among the seed lots, Lot 7 consistently recorded the highest germination across all stress levels, ranging from 88.00 to 46.00 per cent, resulting in the highest overall mean germination (66.83%). In contrast, Lot 17 exhibited the greatest reduction under moisture stress, declining to 22.33 per cent at 15 per cent PEG and recording the lowest mean germination (42.58%).

Similar declining trends were observed for shoot length, root length and seedling dry weight (Tables 4-6). The mean shoot length decreased from 7.396 to 4.435 cm, root length from 9.80 to 5.48 cm, and seedling dry weight

**Fig. 4:** Relative decline of seed quality traits under PEG-induced moisture stress.**Table 7:** Effect of PEG-induced moisture stress on Seed Vigour Index-I of selected chilli seed lots.

Lot No.	M1	M2	M3	M4	Mean
Lot 2	1286	990	558	337	793
Lot 5	956	763	484	237	610
Lot 7	1566	1278	946	553	1086
Lot 11	1127	936	544	219	707
Lot 12	1240	943	618	435	809
Lot 14	875	655	503	338	593
Lot 15	1312	899	600	375	797
Lot 17	1016	761	558	214	637
Lot 18	1175	788	556	311	708
Lot 20	1036	779	609	305	682
Mean	1159	879	598	332	
Analysis of variance (S.Em ± and C.D. at 1%) for main effects and interaction:					
	L	M	L×M		
S.Em ±	14.905	9.427	29.81		
C.D. at 1%	55.62	35.177	111.24		
M1: Control (M1); M2: 5% PEG (M2); M3: 10% PEG (M3); M4: 15% PEG (M4)					

weight from 29.50 to 13.20 mg with increasing PEG concentration. Seed vigour index-I and Seed vigour index-II also decreased progressively from 1159 to 332 and 1999 to 453, respectively (Tables 7-8). When expressed as percentage retention over the control, all the measured traits declined with increasing moisture stress. However, the reduction was more pronounced for the vigour indices than for germination and seedling growth parameters (Fig. 4). At 15 per cent PEG, SVI-I and SVI-II retained only 28.7 and 22.7 per cent of their respective control values, whereas germination, shoot length, root length and seedling dry weight retained 44.7- 60.0 per cent, indicating that the vigour indices were more sensitive to moisture stress.

The Lot × Moisture stress (L × M) interaction was significant for all the studied parameters (Tables 3-8), indicating that the seed lots differed in their response to increasing moisture stress. This was further evident from the relative trait retention values at 15 per cent PEG (Table 10). Lot 14 recorded the highest overall retention (56.89%), followed by Lot 7 (50.28%) and Lot 12 (47.31%), indicating better tolerance to moisture stress. In contrast, Lot 11 (35.12%) and Lot 17 (37.33%) recorded the lowest retention, suggesting greater sensitivity to stress. Interestingly, although Lot 14 was not the highest ranked seed lot under non-stress conditions, it exhibited the greatest ability to maintain seed quality under moisture stress. Conversely, Lot 17, despite being classified as a superior seed lot under optimum conditions, showed comparatively poor tolerance under stress. Overall, Lots 7, 14 and 12 maintained relatively

tolerance than germination percentage alone. Likewise, Kulkarni and Deshpande (2007) reported that PEG based screening effectively distinguished drought tolerant genotypes from those performing well only under favourable conditions. The present findings therefore emphasize the importance of supplementing conventional germination tests with PEG induced moisture stress screening for identifying seed lots with superior drought tolerance

Conclusion

The present study demonstrates that chilli seed lots of the same cultivars, even when sourced from the same locality, differ substantially in physiological quality, with germination ranging from 25.00 to 80.00 per cent and TOPSIS-based composite scores separating the twenty lots into clearly superior and inferior groups. This confirms that seed lot quality in Dharwad's chilli seed production system is governed primarily by lot specific production rather than cultivar identity or collection location. Subjecting the ten physiologically superior seed lots to PEG-induced moisture stress further revealed that germination, seedling growth and vigour all declined progressively with increasing PEG concentration, with the vigour indices proving the most sensitive indicators of stress induced deterioration. Importantly, performance under optimal conditions did not reliably predict performance under moisture stress. Lot 14, which was not the top ranked lot under non stress conditions, showed the greatest Relative Trait Retention (56.89%) under 15 per cent PEG stress, while Lot 17, despite qualifying among the superior lots initially, proved comparatively moisture stress susceptible. Lots 7, 14 and 12 combined high absolute seed quality with above average moisture stress tolerance.

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