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Assessment of seed deterioration in varied storage environments through seedling root potentiality of lentil seed

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Abstract
The storability pattern of Lentil seed was documented on six phases of seed storage duration (2 months interval) under 7 variable storage conditions with special emphasis to rhizosphere prototype comprising young roots. In assessment of seed storability, the most promising young root initials developed from primary or secondary root should be supportive for nutrient absorption from Rhizospheric zone in soil that is strictly adhered to the enhancement of root surface area and total root length. As nutrient uptake predominantly dependent on lower diameter containing young root, the emphasis must be given on it for measurement of seed quality. The seedling roots were helpful to plant stand as well as nutrient uptake in association of water. The assessment of quality seed through characterization of root at seed storability pattern, the plastic container (P4) and polythene packet (P7) showed greatest influence for retaining seed quality allied to progression of seed storage through young root growth though an opposite manner was observed in average root diameter by involving its accommodating nature in plant stand especially in stress. Considering all storage containers, the rate of seed deterioration was noticeably higher in M4 (8 months) and M5 (10 months) stages though a trend of declining was observed in every step. Therefore, the specific storage container (P4) must be integrated in post harvest handling in continuance of seed quality of Lentil.

Keywords: Storage container, storability, rhizosphere, lentil

Introduction

The post-harvest handling of seed especially at stored position monitors the seed quality. In eastern India, lentil seeds are to pass a lot of environmental inconsistency in both pre and post-harvest predominantly a very high relative humidity of rainy season at stored phase. Therefore, the excellent seed also cannot express full potentiality due to their deterioration at stored phase. Descent of stored seed is influenced by physical (temperature, humidity), biological (micro-flora) and technical (storage conditions, methods and duration) factors. Sufferers due to stored grain pests (insects, molds and fungi) may exceed 43% of potential production per year in developing countries mainly due to improper management (Ahmed and Grainge, 1986) [2]. The heterotrophic seedling growth can be considered as the consequence of three components: initial seed weight, the partitioning of seed reserves, and the transformation efficiency of mobilized seed reserves to seedling tissues (Mohammadi *et al.*, 2011) [16]. The seed moisture content, relative humidity and the storage temperature have been shown to notable changes in acidity, pH, free amino nitrogen, crude protein, and reduced protein quality. The effect of various components can influence root development through deterioration of their seedling potentiality in field. Root information on alternate crops may help producers to advance crop rotation systems with upgraded resource use efficiency due to the inclusion of crops with different rooting patterns in a cropping system may improve water and nutrient use efficiency (Black *et al.*, 1981; Fageria *et al.*, 2011) [4, 10]. The plan of present observation was to assess the outcome of storability of lentil seed in dissimilar micro-environment containing storing devices considering inconsistent deviation in addition to deterioration pattern of seedling root qualifying parameters of pulse crop, Lentil.

Material and Methods

The experiment was documented considering two varieties of Lentil i.e. B77 (V1) and WBL58 (V2) in the year 2016. The variable pattern of seed storage was applicable to identify the suitable system in addition to observation on deterioration in various stages of storage through critical root study. The variable storage environments for retaining the seed quality were - Ambient condition at room as P1 (control); CO_2 incubator (1% CO_2 + normal O_2) with 32±1 °C as P2; Seed Drier with 34±1 °C as P3; Plastic container (700 gauge) as P4; Cotton Bag as

P5; Earthen pot as P6 and Polythene packet (40 micron) as P7. The harvested lentil seed was stored in various environments to judge the seed storing competence and these were assessed from 4th month with a continuation of 2 months interval representing 4, 6, 8, 10, 12 months as M2, M3, M4, M5, M6 respectively in comparison to harvest stage (0 days) as M1. The study was related to root growth and rhizosphere pattern of seedling crucial for seedlings establishment in field condition. The changeable duration of stored seed under diverse storing were assessed through Glass-plate technique (Chakraborti, 2010) [6] to measure the rhizosphere pattern of seedling at the day of final count i.e. 8 DAS (days after sowing). Measurements involved total root length, average root diameter, surface area, as well as root length measurements as a function of different root diameter classes.

The Root Image Analyser, WIN RHIZO (PRO BASIC STD4800 was utilizing for this comprehensive study on seedling roots considering the previous observations of Pierret *et al.* (2013) [17]. The scanning procedures were done by using the flat-bed scanners (Epson Expression/STD 1600 scanner). The output as grey-scale images were analysed with WinRHIZO (Regent Instrument Inc.) using a method of automatic global thresholding (Anon. 2000) [1]. One way analysis of variance was undertaken for analysis at 1% level of significance using SPSS (version 10.0, 1990).

Result

To regulate the seed quality, the root characterization was vibrant as its prime significance in seedling establishment (). Root initials developed from primary or secondary root should be supportive for nutrient absorption from rhizospheric zone of the soil that is closely linked to surface area for more absorption and eventually enriched in total root length.

Mean treatment effects on total root length (Table 1) indicated a considerable variation among diverse treatments, where P4 (plastic container) confirmed best effect followed by P7 (polythene packet) and P2 (1% CO_2, 32º±2ºC). V2 (WBL 58) showed superior effect over V1 (B77) in non-significant manner. The different storage durations also showed a significant declination in all steps however its rate was high up in M3 (6 months of storage) followed by M5 (10 months). The equivalent observation was highlighted in external surface area of total root system; an important character of seedling particularly at initial periods where a signal of variable nature was highlighted among diverse treatments. The superiority of P4 was detected in both V1 (B77) and V2 (WBL 58) in consideration of significant demarcation though the values of P7 and P2 indicted better among the rest treatments. Similarly, the rate of deterioration was maximum in M3 followed by M5 specifically in genotype V1 while M6 (12 months of storage) was highest in V2.

Another parameter, average root diameter (mm) in rhizosphere may be favorable for root/plant establishment particularly in plant stress. Significant variable response of treatments was observed in which P7 followed by P4 showed the encouraging nature with a top significant of demarcation in V2. The storage duration indicated a noteworthy demarcation for each phase. The maximum frequency of deterioration was observed in M4 (8 months storage) in both V1 and V2. In interaction of variety, treatment and storage duration, an indication of significant delineation was highlighted in progression of storage.

The root length containing 0.0 – 1.5 mm diameter was greatly imperative in operative nutrient uptake predominantly at initial phase. The root length was adapted in significant demarcation under diverse storage methods. The treatment P4 (plastic container) followed by P7 (plastic packet) indicated a positive achievement in comparison to other. The storing period showed a significant deterioration where M4 (8 months storage) in V1 and M5 (10 months storage) in V2 showed the utmost rate in deterioration. Considering the three factors interaction, the non-significant variation was observed though deterioration pattern was progressed with the storage duration.

The length containing 1.5 – 4.5 mm root diameter was helpful to develop root primordial and root strength in field. The differential treatments effect specified the strong significant relationship in mean values after maintaining the topmost effect in P6 (earthen pot) and P3 (seed drier, 34º±2ºC). The overall varietal mean showed dissimilarity in significant level with topmost performance in V2 (WBL58). The foremost declining rate was perceived in M3 (6 months storage) and M5 (10 months storage) in comparison to other periods.

Table 1: Effect of varied storage conditions on root parameters considering storage duration

Root Parameters	P1	P2	P3	P4	P5	P6	P7	SEM	LSD 0.01
Total root length (cm)	44.74	48.50	45.40	50.44	43.10	42.95	48.56	0.21	0.79
Surface area of root (cm^2)	44.21	48.22	44.92	51.58	44.40	44.33	48.75	0.21	0.77
Av. Dia. of Root (mm)	3.42	3.51	3.46	3.57	3.25	3.42	3.63	0.02	0.06
Root length (0-1.5 mm dia.)	20.13	22.44	21.04	23.54	20.93	20.26	23.11	0.10	0.36
Root length (1.5-4.5 mm dia.)	7.82	7.70	7.96	7.70	7.80	7.97	7.63	0.03	0.13
Root length (>4.5 mm dia.)	10.40	11.20	10.18	11.34	10.08	10.49	11.16	0.05	0.18

Table 2: Deterioration pattern of root parameters at varied storage duration considering different storage situation.

Root Parameters	M1	M2	M3	M4	M5	M6	SEM	LSD 0.01
Total root length (cm)	65.54	61.87	43.72	44.66	32.85	28.83	0.20	0.73
Surface area of root (cm^2)	57.35	53.94	48.63	44.95	40.08	34.84	0.19	0.72
Av. Dia. of Root (mm)	4.54	4.26	3.68	2.99	2.82	2.51	0.01	0.05
Root length (0-1.5 mm dia.)	26.45	25.29	22.64	20.05	17.90	17.52	0.09	0.33
Root length (1.5-4.5 mm dia.)	9.92	9.51	8.32	7.86	6.14	5.05	0.03	0.12
Root length (>4.5 mm dia.)	12.86	12.58	12.18	9.99	9.27	7.30	0.04	0.16

The progression of root length containing above 4.5 (> 4.5) mm diameter may be supportive to seedling/plant stand in soil or to grow lateral roots in rhizosphere. The different storing devices as treatments showed a significant variation in which P4 (plastic container) followed by P2 (1% CO_2 Incubator, 32º±2 ºC.) and P7 (plastic packet) were top. The varietal mean also indicated a significant hierarchy in V2. The different storage duration indicated maximum deterioration in M4 (8 months storage) and M6 (12 months storage). The declining value was noticed at M2 (4 months storage) for V2 but it was commenced at M3 (6 months storage) for V1.

Table 3: Varietal and interaction effect of variety (V), Treatment (T) and storage duration (M)

Root Parameters	V (variety)		VxM		VxT		TxM		VxTxM	
	SEM	LSD 0.01	SEM	LSD 0.01	SEM	LSD 0.01	SEM	LSD 0.01	SEM	LSD 0.01
Total root length (cm)	0.11	0.42	0.28	1.03	0.30	1.11	0.52	1.92	0.74	2.72
Surface area of root (cm^2)	0.11	0.41	0.27	1.01	0.30	1.09	0.51	1.89	0.73	2.68
Av. Dia. of Root (mm)	0.01	0.03	0.02	0.07	0.02	0.08	0.04	0.14	0.05	0.20
Root length (0-1.5 mm dia.)	0.05	0.19	0.13	0.47	0.14	0.50	0.24	0.87	0.34	1.23
Root length (1.5-4.5 mm dia.)	0.02	0.07	0.04	0.16	0.05	0.18	0.08	0.31	0.12	0.43
Root length (>4.5 mm dia.)	0.03	0.09	0.06	0.23	0.07	0.25	0.12	0.43	0.17	0.61

Considering differential rooting system, the occurrence of young root initials may be considered as upgraded seedling for good plant. Root morphology and root branching patterns are important determinants of water and nutrient uptake by plants (Fageria, 2004) [8]. The larger diameter of primary and secondary roots may rise the usual root diameter though extent of young root initials (lateral roots) may not leading in expression of root diameter. The precise root strictures may have a leading role in progression of quality seedling due to efficient consumption of soil nutrients (Frageria and Stone, 2006; Hatzig *et al.*, 2015) [9, 11]. The variable treatment motivated the deterioration action on sprouting seeds through modification of specific physiological action that may alter the seedling root nature (Kaushik and Chakraborti, 2017) [13]. The rapid sequence of cell division in advancement of morphological characters, particularly root was very much linked to diverse biochemical markers (Tinus *et al.*, 2000) [20] like DNA, RNA and protein synthesis etc. (Mandal *et al.*, 2013) [15] that may be influenced in existence of appropriate storing facility. Observation on various rooting system was helpful to standardize the retention of seed storability in different storage structure, particularly for short duration crop.

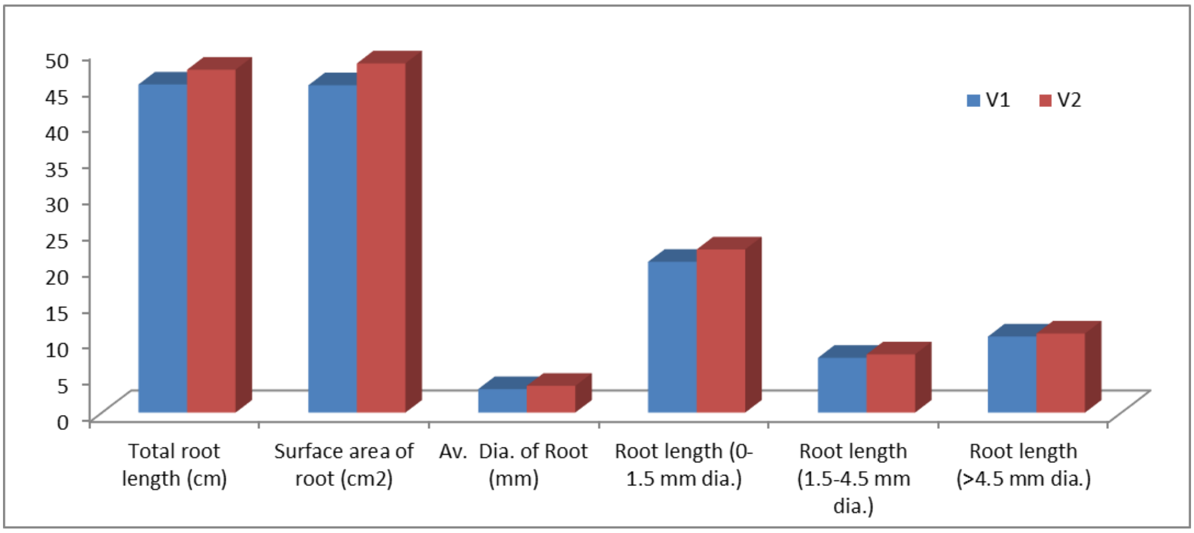

Fig 1: Cumulative effect on root parameters considering Varieties

The young root initials were proficient to reach and exploit local patches of nutrients in soil (Lynch, 1995) compare to older ones through utilization of the sensitive thin epidermal layers of root. Better accumulation of nutrient may enhance the amount of dry matter helpful for rapid creation of vigorous seedlings (Chakraborti, 2017) [13].

To confirm the comprehensive seed production practice, the connecting situation of post-harvest handling at seed storage was vital to maintain storability that was evaluated in present observations. The seven storage conditions P1 to P7 showed encouraging results with respect to quality analysis pattern on root characterization which showed noticeable activity in later stages with varietal distinctive sensitivity in most cases. In contrast to control (P1), the effect of P4 provides the highest peak with P7 where treatment P6 retained equivalence mostly with the control (P1) and sometimes with P5 (cloth bag). Smit *et al.* (1994) [19] also found no evident influence on average root diameter measurements; however a certain effect on distribution evaluation of diameter classes when increasing the sample density was reported (Bauhus and Messier, 1999; Bouma *et al.*, 2000, Hatzig *et al.*, 2015) [3, 5, 11].

A critical study on root system indicated the seedling efficacy in application of seed treatments at different phases. The precise storing environment (P_4) on Lentil seed enhanced the establishment seedling through adaptation of ideal root system. Hence, the Plastic container can be considered as best storing system for retaining the quality of Lentil seed.

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