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Screening and evaluation of seed characters and their relationship with seed quality in lentil (*Lens culinaris* Medikus)

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Abstract
Harvest yield relies on the quality of seed sown. To get the best returns, the quality of the seed should be of top priority. Seed physical, biochemical characters contribute to the success of seed. If the crop is taken in fallow conditions, the ultimate success of the crop depends on seed characters and quality. The present investigation was undertaken to characterize the relationship between the seed characters and quality of lentil WBL-58, at the department of plant physiology, B.C.K.V during the year 2017-18. Concerning physiological standpoint, seed screening is most important to mitigate the stress for late sown lentil in West Bengal field condition and to develop an effective protocol to grow a healthy crop with better yield.

Keywords: Lentil, Mobilization efficiency, seed, starch, sugars, SVI

Introduction
Lentil (*Lens culinaris* Medikus) is an important pulse crop grown during *rabi* season in the Indian subcontinent and spring season in the temperate regions of the world. Lentil is a highly nutritious legume with an ample quantity of carbohydrates and the right amount of proteins. In west Bengal, condition lentil is mainly grown as a fallow crop in the rice fields. For this reason, seed quality is the most important parameter as a seed with higher storage stuff can support the emerging seedling with greater assimilate and better seedling vigour. Presence of lower quality seeds in seed lots reduces the seedling emergence percentage in the field leading to non-uniform and lowered plant population and uneven maturity. Seed quality is an amalgamation of several seed components like physical, biochemical and physiological characters. Seed quality parameters are to be studied in detail concerning seed germination and vigour and establish their character association.

Seed germination is an essential process in plant development to obtain optimal seedling numbers that result in higher seed yield (Kaydan and Yagmur, 2008) [9]. Although seed size is an important parameter for plant growth and yield (Al-Karaki, 1998) [4]. Few studies explained that seed size highly influenced seed yield and seed yield components such as plant stand, plant height, seed weight, and the number of seeds per spike (Singh and Kailasanathan, 1976; Stougaard and Xue, 2004 and Royo *et al*., 2006) [21, 23, 19]. Similarly, Weimarck (1975) [24] reported that large seeds germinated better than medium and small seeds, and seedlings from large seeds had a higher survival rate than smaller seeds under field conditions. Moreover, seed size is positively correlated with seed vigour, and larger seeds tend to produce more vigorous seedlings (Ries and Everson, 1973) [17]. Larger seeds produced vigorous seedlings, taller plants with higher levels of dry matter (Manga and Yadav, 1995; Lopez *et al*., 1996 and Westoby *et al*., 1996) [13, 12, 25]. The present work was carried out to determine the effects of seed size on germination and seedling growth in laboratory condition.

Materials and Methods
The laboratory experiment was conducted at the Department of Plant Physiology, B.C.K.V, Mohanpur, for seed screening and evaluates the seed characters and their relationships with seed quality of lentil. For this purpose, WBL-58 lentil genotype is used for the experiment.

Experimental design
The pot culture experiment was undertaken in a completely randomised design (CRD). The seedlings were grown in petri-dish with cotton bedding and filter paper in five replications.

Germination (%)
The germination test was conducted in the laboratory by using petri-dish with cotton bedding and filter paper covering.

One hundred seeds in five replicates were placed on petri-dish were incubated in germination chamber maintained at 25±1ºC and 90% relative humidity. The germinated seedlings were evaluated fourth and eighth day as first and final count, respectively, and percentage germination was expressed based on normal seedlings.

Root length and shoot length (cm)
The healthy seedlings were selected randomly from each treatment. The root length was measured from the point of attachment of seed to the tip of the longest root, and shoot length was measured from the point of attachment of seed to the growing meristematic tip and expressed in centimetre (cm).

Root to shoot ratio
The mean shoot and root length (cm) was used to determine the root to shoot ratio by using the formula:

$$\text{Root to shoot ratio} = \frac{\text{root length}}{\text{shoot length}}$$

Mean seedling length (cm)
Ten seedlings taken randomly from each treatment and replications were separated carefully from the Petri dish of a laboratory germination test. The total length of seedlings after removing the cotyledons was measured. The mean length of ten seedlings in each treatment and replications were calculated and expressed in centimetre (cm).

Mobilization efficiency
Ten seeds in five replicates were selected randomly, weighed separately and kept for germination. On the eighth day (final count) of germination test, the seed coat, cotyledon and shoot to root axis were separated and dried in an oven at 80±2ºC for 17hours. Then the dry weight of individual components was recorded, and mobilization efficiency was calculated as described by Srivastava and Sareen (1974) [22].

$$\text{M.E}(\%) = \frac{\begin{array}{c}\text{Incerease in dry weight of embryonic axis}\\ \text{(Dry weight of seedlings)}\end{array}}{\begin{array}{c}\text{Decrease in dry weight of cotyledons}\\ \text{(Initial weight of seed dry weight of cotyledons and seed coat)}\end{array}} \times 100$$

Seedling dry weight (gm)
Ten seedlings from each treatment and their replications were used for measuring the seedling dry weight was kept in the hot air oven at 85±1ºC for 24 hours. The mean dry weight was measured and expressed in grams (gm/seedlings).

Seedling vigour index [SVI-I and SVI-II]
The seedling vigour index was calculated as per the formula provided by Abdul Baki and Anderson (1973) [1].

SVI-I = Germination (%) X Mean seedling length (cm)
SVI-II = Germination (%) X Seedling dry weight (gm)

100 seed weight (gm)
100 seeds in five replications were weighed, and the mean weight is expressed in grams (ISTA, 2007) [8].

Seed length (mm)
Length of ten randomly selected seeds was measured using grain micrometer as the distance from the base to the tip of seed. The mean length of seed is expressed in millimetre (mm).

Seed breadth (mm)
The thickness of ten seeds was calculated as the height of seed when placed horizontally and expressed in millimetre (mm). The thickness was used for computing the profile value of the seed.

Seed width (mm)
Width of ten seeds was calculated when placed vertically and expressed in millimetre (mm).

Seed size (mm^3)
Based on length (L), Width (W), breadth (B) of the ten seeds, the seed size was calculated in cubic millimetre by using the formula below.

Seed size (mm^3) = L x W x B

Seed density (gm/cc)
Seed density was measured following the toluene displacement method, as mentioned by (Konak *et al*., 2002) [10]. It is calculated as

$$Seed\ density = \frac{Mass\ of\ 100\ seeds}{Volume\ displaced\ by\ 100\ seeds\ (g/cc)}$$

Total soluble sugar
Extraction and estimation of total soluble sugar were done following the method of Yoshida *et al*. (2011) [26].
Amount of sugar was estimated from the standard curve of glucose. The amount of sugar and starch were expressed as mg g^{-1} dry weight.

Results and Discussion
Seed Physical Parameters
Seed size and seed vigour are important because they indicate the amount of reserve food supply for seedlings to meet out the requirements of food materials during the time of germination, field emergence and stress condition.
In the case of germination percentage, there were no significant results among the treatments. The germination percentage varies from 89.33 to 92.13 and seed with higher density showed the highest germination percentage. Germination and seedling establishment and critical stages in the plant life cycle. In crop production, stand establishment determines plant density, uniformity and management options (Cheng and Braford, 1999) [6]. Rapid seed germination, along with fast germination and seedling emergence substantially contribute to high lentil yield under drought conditions.
Seed development is the period between fertilization and maximum fresh weight accumulation, and seed maturation begins at the end of seed development and continues till harvesting (Mehta *et al*., 1993) [14] when seed reaches its maximum dry weight at physiological maturity. The early harvested seed will be immature and poorly developed and as such are less effective storage units compared to seeds harvested at physiological maturity (Singh and Lachanna, 1995; Deshpande *et al*., 1991) [20]. Populations from

developing countries are likely to be the most severely affected as nearly 50% entirely on agriculture. In many crop species, the effects of high-temperature stress are more prominent on reproductive development than on vegetative growth and the sudden decline in yield with temperature is mainly associated with pollen infertility (Young *et al*., 2004; Zinn *et al*., 2010) [27, 28].

Root length varies from 1.44 cm to 2.09 cm, and shoot length varies from 1.94 cm to 3.27cm. The highest value of root length and shoot length were present in seeds with higher single seed weight and density (T_3) with a value of 2.09 cm and 3.27 cm, respectively. The lowest value of root length and shoot length were present in unscreened seeds (T_0). Root to shoot ratio showed the highest value in unscreened seeds (T_0) with the value of 0.74, followed by T_1 (0.66), T_2 (0.66) and T_3 (0.64).

The most important physical indicator of seed quality is that affects vegetative growth and is frequently related to yield, market grade factors and harvest efficiency. Depends on seed size, seeds are categorised as small, medium and large size, which indicates the flow of nutrients into the seed at the mother plant (Ambika *et al*., 2014) [5]. A wide array of different effects of seed size has been reported for seed germination and emergence. In an experiment, Roshanak *et al.* (2013) showed that in soybean cultivars seeds are basically in three sizes (small, medium and large). Results showed that medium seeds had higher germination percentage than that for large and small-size seeds. Germination percentage, root length, shoot length, seedling length and seedling dry weight were significantly affected by seed size. Mean seedling length varies from 3.46 cm to 5.32 cm. The highest value was present in seeds with higher single seed weight and density (T_3) with a value of 5.32 cm and lowest in unscreened seeds (T_0) with a value of 3.46 cm. Seedling dry weight showed the highest result in T_1 (0.5280 gm) followed by T_2 (0.5190 gm), T_3 (0.5050 gm) and T_0 (0.4310 gm). At physiological maturity, the pods of small and medium seeded cultivars accounted for 28-36% of total dry matter, whereas for the large-seeded cultivar, the pods constituted only 12% of total dry matter (Kurdali *et al*., 1997) [11].

Seed size is positively correlated with seed vigour, larger seeds tend to produce more vigorous seedlings establishment in rice (Roy *et al*., 1996) [18]. Nagarju (2001) [15] noticed higher germination percentage, seedling length, seedling vigour index, dry weight and field emergence in large size seeds compared to small size seeds in a sunflower. There was significant result in seedling vigour index (SVI-I and SVI-II) and 100 seed weight. The highest value of seedling vigour index- I was present in T_3 (485.55), and the case of seedling vigour index-II highest value was present in T_1 (70.82). Another component that is 100 seed weight showed the highest value in T_3 (1.49 gm) followed by T_2 (1.45 gm), T_1 (1.40 gm) and T_0 (1.31 gm) respectively.

Seed size is one of the major components of seed quality, which affects the performance of the crop (Ojo, 2000; Abebisi, 2004; Adebisi *et al*., 2011) [16, 2, 3]. The length of different screened and unscreened seeds grown in laboratory condition varied from 1.93 mm to 2.50 mm with an average of 2.24 mm. Similarly, seed Breath and seed width were varied from 1.70 mm to 3.23 mm and 0.08 mm to 1.12 mm, respectively. The seed size of lentil varied from 2.63 to 9.05. Seed density is highest in T_2 (1.40 gm/cc) followed by T_3 (1.34 gm/cc), T_0 (1.23 gm/cc) and T_1 (1.11 gm/cc) respectively.

Table 1: Seed Physical Parameters

Treatments	**Germination Percentage (%)**	**Root length (cm)**	**Shoot length (cm)**	**Root to shoot ratio**	**Mean seedling length (cm)**	**Seedling dry wt. (gm)**	**SVI – I (cm)**	**SVI -II (gm)**	**100 seed wt. (gm)**	**Seed length (mm)**	**Seed breath (mm)**	**Seed width (mm)**	**Seed size (mm^3)**	**Seed density (gm/cc)**
T0	89.33	1.44	1.94	0.74	3.46	0.4310	308.92	60.01	1.31	1.93	1.70	0.80	2.63	1.23
T1	92.13	2.04	3.11	0.66	4.77	0.5280	439.72	70.82	1.40	2.17	1.97	0.93	3.96	1.11
T2	91.87	2.07	3.12	0.66	5.21	0.5190	478.81	69.82	1.45	2.34	3.00	0.84	5.88	1.40
T3	91.20	2.09	3.27	0.64	5.32	0.5050	485.55	68.04	1.49	2.50	3.23	1.12	9.05	1.34
SE (m)±	2.26	0.042	0.062	0.018	0.105	0.012	9.49	1.592	0.034	0.053	0.056	0.021	0.118	0.032
C.D. (P=0.05)	N/A	0.128	0.187	0.054	0.316	0.035	28.688	4.815	0.102	0.160	0.170	0.064	0.355	0.095

Treatments:
T0: Unscreened seeds
T1: seeds with higher density (that settle down at the bottom)
T2: Seeds with higher single seed weight
T3: Seeds with higher single seed weight and density (larger 50% of the seed lot)

Table 2: Seed bio-chemical parameters

Treatments	**Mobilization efficiency (%)**	**Soluble Sugar (mg g^{-1} dry wt.)**	**Starch (mg g^{-1} dry wt.)**	**Single seed sugar content (mg)**	**Single seed starch content (mg)**	**Single seed total carbohydrate content (mg)**
T0	53.39	103.20	307.55	1.352	4.029	5.381
T1	55.09	105.45	317.90	1.472	4.450	5.922
T2	48.46	105.00	312.90	1.522	4.537	6.059
T3	43.16	110.25	314.95	1.643	4.692	6.335
SE (m)±	1.286	2.62	7.77	0.036	0.106	0.142
C.D. (P=0.05)	3.888	N/A	N/A	0.108	0.321	0.429

Treatments:
T0: Unscreened seeds
T1: seeds with higher density (that settle down at the bottom)
T2: Seeds with higher single seed weight
T3: Seeds with higher single seed weight and density (larger 50% of the seed lot)

Seed bio-chemical parameters

Seed reserve mobilization efficiency means the amount of shoot and root dry matter produced from one unit of seed dry weight that was lost as respiration. Mobilization efficiency is highest in T_1 (55.09) followed by T_0 (53.39) T_2 (48.46) and T_3 (43.16) respectively. Higher the value of seed reserve mobilization efficiency, higher the efficiency of seed as more seed reserves would be used for producing roots and shoots (Hasan *et al*., 2004) [7].

In case of both soluble sugar and starch, based on mg per gram of dry weight show a non-significant effect on four treatments. Single seed sugar content, single seed starch content, single seed carbohydrate content in mg basis shows the highest result in T_3 treatment followed by T_2, T_1 and $T_{0,}$ respectively.

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