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Quality assessment of yard long bean (*Vigna unguiculata*) seeds through the controlled deterioration technique

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Abstract

A three-factor experiment was conducted at the Horticulture Laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur during April- May 2014 to study the effects of the controlled deterioration (CD) on the yard long bean seed quality at the constant temperature of 35°C to assess the physiological seed quality of both the two cvs. The 3 factors considered were: seeds of 2 varieties (Lalbeni/LB of Lal Teer Seed Ltd., and Kegarnatki/KN of United Seed Ltd.); 4 ageing periods (0, 4, 8 and 16 days); and 3 seed moisture contents (12, 16 and 20%). Thus, the 24 treatment combinations compared in the Completely Randomized Design (CRD) with the 3 repetitions for the 8 parameters were: % germination, % abnormal seedlings, % dead seeds, % soil emergence; and seedling evaluation test for the root and shoot lengths as well as their dry matter contents. Identical prototypes of notable (5-1% level) degradations were recorded everywhere. But the disparities were lucid under the extreme stresses. Moreover, highly noteworthy (1% level) relations were observed from all the traits ranging from -0.958 (normal seedling × abnormal seedling) to 0.953 (soil emergence × normal seedling). So, the controlled deterioration technique was very effectual in judging the physiological statuses of the seeds of the two varieties of yard long bean studied. Thus, the seed quality certification program, the suitable limits of vigor for the chosen traits could also be got by that technique. In addition, varietal differences were also found as Lalbeni of Lal Ter Seed Limited was better over Kegarnatki of United Seed Limited.

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Introduction

Yard long bean *(Vigna unguiculata* sub. sp. *sesquipedalis)* is a fast growing summer annual climbing vine of Fabaceae (or Leguminosae) family. Its synonyms are bora, long-podded cowpea, asparagus bean, pea bean, snake bean, garter bean and Chinese long bean. Those are a good source of protein; vitamins A, thiamin, riboflavin, C, folate; iron, phosphorus, potassium, magnesium and manganese (Anonymous, 2002). As a legume crop, it is also grown for forage and silage. Besides, it improves soil productivity by fixing considerable atmospheric nitrogen with *Rhizobium* bacterium in the symbiosis process. Considerable quantities of yard long beans are exported every year from Bangladesh to the high-price upstream markets of the United Kingdom, Belgium, the Netherlands, France, the UAE, Singapore and Hong Kong (Anonymous, 2002).

Seed quality affects the performance of any crop under the field conditions in several ways (Roberts, 1986; Keefe and Draper, 1986, Roberts and Osei-Bonsu, 1988;). In addition, the initial seed quality also affects the storage life of seeds. So, an in-depth study of the seed quality is vital if crop productivity as well as the storage life of any seed is to be enhanced or even maintained.

A single definition of the seed quality fit for all crops under varied agro-ecological conditions is neither possible nor usable. So, the elements of the seed quality should be taken into the account are: (1) percent seeds that germinate and therefore, initial seedling density. (2) Germination rates and growth of seedlings, which would determine the sizes of plants being produced. (3) Health conditions of seedlings. (4) Uniformity of the seedlings and finally (5) Yield and grade of the produce.

Seed germination, vigour and size are the three crucial aspects of seed quality, which influence crop yield and grade through both the indirect and the direct effects (Ellis, 2004). A major component of the seed quality is the % germination determined as per the International Seed Testing Association (ISTA, 1999) and performed by each and every seed certification program all over the world on the routine basis. The germination rate under the laboratory conditions is usually a good estimator of the field emergence (Pourhadian and Khajehpour, 2010). Many seeds though germinate profusely under the ideal laboratory situations fail to emerge abundantly in the crop field (Wang *et al.*, 2004). So, the aim of the laboratory germination test is to facilitate the global trade in seeds by proving a standard measure of the field planting value under the idyllic conditions.

Differences in the field emergences of the seed lots with the similar and acceptable levels of the laboratory germination percentage are noticed in several legumes (Borba, 1987). As such variations are usually observed, the standard laboratory germination test fails to be the effective indicator of the field establishment. Failure of the germination percentage to relate with the field emergence leads to the very term 'Vigour' at the 1950's ISTA Congress in Washington D. C. (Perry, 1978). Seed lots are considered to possess the low vigour when the field emergence is low compared to other seed lots having the similar germination percentages.

Accelerated aging is a very responsive test in ranking the quality of seeds (Khan *et al.*, 2007). And the controlled deterioration test is usually illustrated by the nonlinear courses of germination loss during the aging period (Kruse, 1999). Several factors are liable for the vigour of any seed. But little work is carried out to study the effects of the ageing on the physiological statuses of yard long bean seeds.

Keeping that view in mind, the study was set with these three objectives:

1. To investigate some of the significant effects of ageing using the controlled deterioration technique on the physiological status of the two cvs. (Lalbeni and Kegarnatki) of yard long bean seeds during their germination and subsequent establishment of the seedlings.

2. To relate the findings with the standard germination test; at present this is considered as the legal basis for the judgment of every seed quality certification program all over the globe and

3. To assess the physiological qualities of seeds of both the two cvs. for breeding purposes to develop high quality yard long bean varieties.

Materials and methods

The materials utilized and the methods exploited in doing this work are presented here under various heads including their descriptions. The experiment was set-up at the Laboratory, Department of Horticulture, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The experimentation was carried out from April - May, 2014.

The varieties

The seeds of two varieties of yard long bean, namely Lalbeni (from Lal Teer Seed Limited) and Kegarnatki (from United Seed Limited) were obtained from the local market of Dinajpur town. The re-names of those two varieties are LB and KN, respectively.

At the beginning of the experimentation, the following twelve selective traits of the two yard long bean varieties were measured to have their comparative worktable mark information. Initial moisture content (% fresh wt. basis) 11.40 and 11.95; Thousands seed weights(g) 121.00 and 119.70; Percent germination (paper towel)- Normal seedlings (%) 93.00 and 87.00, Abnormal seedlings (%) 5 and 7.67, Dead Seeds(%) 2 and 5.33, Shoot length (cm) 18.67and 17.90, Root length(cm) 9.60 and 9.50, Shoot dry matter (g/100 seedlings) 5.65 and 5.31, Root dry matter (g/100 seedlings) 1.88 and 1.63 respectively for LB and KN.

Experimental design

The Completely Randomized Design (CRD) with three replications was used. The three factors and their levels judged in the study were as varieties: LB and KN; Seed moisture contents (MC):12, 16 and 20%; and ageing periods (AP): 0, 4, 8 and 16 days.

Factors exploited

The three factors and their levels to be judged in the study were as Varieties (2) LB and KN, Seed moisture contents (%) 12, 16 and 20; Ageing periods (days) 0, 4, 8 and 16.

Treatment combinations

There were 24 treatment combinations. LB had 12 treatment combinations i.e. TC1 to TC12 and KN were 12 i.e. TC13 to TC24. TC1 had one moisture content i.e. 12% and four ageing period i.e. 0, 4, 8 and 16 similar to TC2 as well as TC24.

Number of seeds used per replication

For both the standard germination and the soil emergence tests, randomly selected 100 seeds per replication were used.

Tests utilized to evaluate the seed quality following the deterioration, parameters noted and the methods of data collection

The following tests were exploited for that purpose A) Standard germination (4-ply rolled paper towel method) for-Normal seedlings (percent germination) and Abnormal seedlings (percent) and Dead seeds (percent decayed) B) Soil emergence (in seed-flat containing sterilized coarse sand) and C) Seedling evaluation test (with 7 days old normal seedlings taking from the standard germination test accompanied) for: Length of the root (per seedling), Length of the shoot (per seedling), Dry matter of the root (per 100 seedlings basis) and Dry matter of the shoot (per 100 seedlings basis) and D) All the above eight parameters were also correlated with one another.

Standard germination test

The rolled paper towel method was used for it. In each towel 25 seeds were set centrally lengthwise 2cm apart from one another and then rolled loosely as required. The towels were then also tied loosely with a piece of thread. Those were set on a plastic tray in the upright direction. The tray was kept on the table at the room temperature. Light watering was done as required with a plastic jet bottle. After 7days, the seedlings were evaluated according to ISTA (1999). For that, data were collected for normal seedlings, abnormal seedlings and dead seeds. The results were then converted to the percentage and the converted values were exploited for the statistical analyses.

Soil emergence test

The soil emergence test was conducted using the heat sterilized coarse sand as the substratum. The particulars of that were as follows:

Sufficient coarse sand was sieved to avoid all the organic substances, and soil particles > 0.8 and < 0.05mm in diameter. The sieved sand was sterilized in the electric oven running at 100°C for 24 hours. Later on, the sand was cooled down. A rectangular wooden seed flat (0.5 × 0.5 × 0.15M) was filled in with the sterilized sand. Then the seeds were inserted in the sand 5 × 5cm apart in all the directions and also at the depth of 5cm. In that way 100 seeds were placed in each seed flat for each replication. Light watering was done as needed with a plastic jet bottle (250ml). After 7 days of setting, the emergence was recorded. The result was expressed as the percentage and the transformed values were used for the statistical analyses.

For that, the normal seedlings obtained from the standard germination test were used. Then the root and shoot lengths, and their dry matters were measured. Firstly, the normal seedlings were selected. The seed residues were separated from the seedlings with a sharp knife. Roots and shoots were also separated, spread on a table and waited to wither for two hours to facilitate the measurement of the roots and shoots with a 30cm plastic scale. The roots and the shoots were then taken separately in 50ml beakers and lastly dried in the electric oven at the constant temperature of 85°C for 48 hours (ISTA, 1999). Finally, those were weighed and expressed on the 100-seedling basis for the statistical analyses.

Statistical analyses

The results were calculated using the analysis of variance (ANOVA) while the paired means were compared using the 'T' test. Correlation was studied. The MSTAT-C package was exploited for that.

Results and discussion

The results of the present study being stated are accessible in this chapter under the nine different captions and in the 2 tables. Moreover, the findings are also discussed and supported by the experiences of a range of scientists investigated the quality of different seeds all over the planet, specially the legumes using the controlled deterioration method.

Normal seedlings

Due to the controlled deterioration, the % normal seedlings vis-à-vis the % germination decreased remarkably at the 5% level of probability from 90.67 (TC_1) to 28.00% in (TC_{24}), i.e., up to 62.67% due to the treatment combinations (Table 1). As the conditions of the ageing, i.e. seed moisture content from 12 - 20% and the ageing periods as of 0 - 16 days were progressively intensified, the fall in the % normal seedlings was also in the same direction.

The integrity of the cellular membranes, enzymatic roles, metabolic functions and also translocation activities hampered increasingly due to the degradation. So, the seeds lost their credibility to produce adequate number of normal seedlings as found in the germination test (Khan *et al.*, 2004). Iqbal and Smith (1996) noted such reduced germination in pea seeds following the controlled declining. Bahadur *et al.* (2005) obtained parallel types of results in groundnut seeds weakened through the controlled degradation. Kabir *et al.* (2005) recorded the similar type of happenings too with such an ageing study of chick pea seeds.

Table 1. Various characteristics achieved from the standard germination and the soil emergence tests for the seeds of the two varieties of yard long bean as influenced by the controlled deterioration technique.

Treatment combinations	Nature of the combinations	Normal seedlings (%)		Abnormal seedlings (%)		Dead seeds (%)		Soil emergence (%)	
TC_1	$LBM_{12}A_0$	90.67	a*	6.67	M	2.67	n	78.67	a
TC_2	$LBM_{12}A_4$	86.67	ab	9.33	Lm	4.00	mn	77.33	ab
TC_3	$LBM_{12}A_8$	84.00	bc	10.67	k-m	5.33	l-n	73.33	a-c
TC_4	$LBM_{12}A_{16}$	77.33	de	14.67	h-l	8.00	j-m	62.67	e-g
TC_5	$LBM_{16}A_0$	80.00	cd	12.00	j-m	8.00	j-m	69.33	c-e
TC_6	$LBM_{16}A_4$	73.33	ef	17.33	g-k	9.33	i-l	64.00	d-g
TC_7	$LBM_{16}A_8$	70.67	fg	18.67	g-j	10.67	h-k	58.67	f-h
TC_8	$LBM_{16}A_{16}$	64.00	hi	22.67	e-g	13.33	f-i	53.33	hi
TC_9	$LBM_{20}A_0$	73.33	ef	16.00	g-l	10.67	h-k	61.33	fg
TC_{10}	$LBM_{20}A_4$	57.33	jk	26.67	d-f	16.00	e-g	52.00	hi
TC_{11}	$LBM_{20}A_8$	41.33	lm	36.00	a-c	22.67	cd	33.33	lm
TC_{12}	$LBM_{20}A_{16}$	32.67	n	38.67	ab	28.67	b	25.33	n
TC_{13}	$KNM_{12}A_0$	84.00	bc	9.33	lm	6.67	k-n	73.33	a-c
TC_{14}	$KNM_{12}A_4$	80.00	cd	12.00	j-m	8.00	j-m	70.67	b-d
TC_{15}	$KNM_{12}A_8$	73.33	ef	14.67	h-l	12.00	g-j	62.67	e-g
TC_{16}	$KNM_{12}A_{16}$	66.67	gh	20.00	f-i	13.33	f-i	57.33	g-i
TC_{17}	$KNM_{16}A_0$	77.33	de	13.33	i-m	9.33	i-l	65.33	d-f
TC_{18}	$KNM_{16}A_4$	70.67	fg	16.00	g-l	13.33	f-i	58.67	f-h
TC_{19}	$KNM_{16}A_8$	64.00	hi	21.33	f-h	14.67	f-h	52.00	hi
TC_{20}	$KNM_{16}A_{16}$	53.33	k	26.67	d-f	20.00	de	44.00	jk
TC_{21}	$KNM_{20}A_0$	60.00	ij	22.67	e-g	17.33	ef	50.67	ij
TC_{22}	$KNM_{20}A_4$	46.67	l	29.33	c-e	24.00	cd	37.33	kl
TC_{23}	$KNM_{20}A_8$	37.33	m	33.33	b-d	29.33	ab	28.00	mn
TC_{24}	$KNM_{20}A_{16}$	28.00	n	40.67	ab	31.33	a	22.67	n
CV (%)		5.90		9.41		8.6		8.74	

LB= Lalbeni KN= Kegarnatki M = Moisture A = Ageing

*In a column means bearing the same letter(s) do not differ significantly as per the LSD at the 5% level of probability.

The decline was also noticeable in the varieties though their magnitudes were overall less in LB (TC_1 - TC_{12}) while it was least in KN (TC_{13} - TC_{24}). These results showed that LB was the best seed between the two varieties explored. That might be due to the fact that LB had the slightly bigger seeds, i.e. 121 g while KN was 119.70 g for thousand seeds. The differences in producing % normal seedlings might also be linked-up with the heredity of the varieties. While working with the ageing of five chick pea varieties, Kapoor *et al.* (2010) found that the % germination declined notably having differential responses among varieties. Low seed moisture content is another vital issue for the less seed quality. LB had the least initial moisture content (11.40%) than the rest one (KN), i.e. 11.95%. So, it might play another imperative role in varying the % normal seedlings between the seeds of the two varieties of yard long bean. The treatment combinations TC_1, TC_5 and TC_9 were different but statistically identical. Similarly, the treatments TC_{13}, TC_{17} and TC_{21} were also different but statistically identical with one another. So, it proved that just rise in the seed moisture content at the zero incubation had no impact on that trait.

Finally, the two varieties were quite alike for the % normal seedlings under the least stress conditions (12% moisture content and 0 day incubation in TC_1 and TC_{13}). But as the adverse situations were most severe (20% moisture content and 16 days ageing in TC_{12} and TC_{24}), their physiological divergences were clear from the germination percentages (Table 1). So, the results paved the way to opine further that to watch such disparities in the seeds of very close physiological statuses, the ageing should be done under the extreme conditions.

Finally, the two varieties were quite alike for the % normal seedlings under the least stress conditions (12% moisture content and 0 day incubation in TC_1

and TC_{13}). But as the adverse situations were most severe (20% moisture content and 16 days ageing in TC_{12} and TC_{24}), their physiological divergences were clear from the germination percentages (Table 1). So, the results paved the way to opine further that to watch such disparities in the seeds of very close physiological statuses, the ageing should be done under the extreme conditions.

Abnormal seedlings

The percent abnormal seedlings ranged notably at the 1% level of probability from 40.67 in TC_{24} to 6.67 in TC_1, i.e. up to 34.00% on account of the treatments incorporated (Table 1). As the conditions of the deterioration, viz. the seed moisture content from 12-20% and the ageing periods from 0-16 days were strengthened, the rise in abnormalities in the two varieties were also in the same trend. Nonetheless, the magnitude was less in LB i.e. TC_1 - TC_{12} (6.67 - 38.67) gone after by KN i.e. TC_{13}-TC_{24} (9.33 - 40.67). The results again exposed that LB was the best one between the two varieties and might happen once more due to the bold seeds and the low initial seed moisture content as noted before. Again, Roberts (1986) mentioned that the effects of low vigor would likely be a great problem in those species where the manifestation of deteriorative changes occurred in the seeds well in advance of the death, e.g. in soybean. Because its seeds became defective about 1.7 normal deviates before the death (Ellis and Roberts, 1981).

Lastly, the treatments TC_1, TC_5 and TC_9 were statistically identical among themselves. Again, the combinations TC_{13}, TC_{17} and TC_{21} were alike with one another. All these six treatment combinations had 12-20% seed moisture content but no pessimistic effects. So, it again proved that just increase in the seed moisture content at the zero incubation periods had no effect on that trait. Finally, the two varieties were alike for the % abnormal seedlings under the least stress (12% moisture content and 0 day in TC_1 and TC_{13}). But as the stress conditions were extreme (20% moisture content and 16days of incubation for TC_{12} and TC_{24}), their physiological divergences became clear from the rise in the % abnormalities (Table 1). So, to study such disparities in the varieties with very close physiological statuses, the ageing must be done under the extreme settings.

Dead seeds

Due to the controlled deterioration, the % dead seeds rose up markedly from 2.67 (TC_1) to 31.33 (TC_{24}) i.e. up to 28.67% in consequence of the treatments compared (Table 1). Nonetheless, TC_{24} (31.33), C_{12} (28.67%) were statistically analogous with one another. The magnification in the % dead seeds was significantly countable in the two varieties although the extents were less in LB i.e. TC_1 - TC_{12} (2.67 - 28.67) while that was at the top in the entire sub groups of KN i.e. TC_{13} - TC_{24} (6.67- 31.33%). These results revealed that in that trait LB was superior between the two varieties explored. The ability of the cellular membranes, enzymatic roles, synthesis activities and also translocation processes were impaired increasingly due to the ageing (Khan *et al.*, 2004). Thus, the seeds lost their credibility to produce any seedlings leading to the rise in the death toll. Moreover, it is widely accepted that the loss of germination is all most the last stage of the deterioration: the final catastrophe i.e. the death as proceed by the more subtle stages (Heydecker, 1972). So, the abnormalities in the legumes are quite common and it might be the main cause of the less % of dead seeds than the % abnormal seedlings in cases of the two varieties used. Finally, the differences in the % dead seeds between the two varieties might also be linked-up with the genotypes as stated earlier for germination.

Percent soil emergence

The percent emergence vis-à-vis field establishment declined notably at the 1% level of possibility from as high as 78.67 (TC_1) to as low as 22.67 (TC_{24}) i.e. up to 56.00% as a result of the treatment combinations used (Table 3). Moreover, TC_{12} (25.33%) was statistically at per with TC_{24} (22.67%). As the weakening conditions of the seeds in terms of the seed moisture contents and the ageing days were exaggerated, the drop in the soil emergence was also in the same track. The decline was also notable in the two varieties too. But the highest enormity in deprivation was less in LB i.e. 25.33 in TC_{12} while in

KN it was the least i.e. 22.67% in TC_{24}. Those results revealed that LB was statistically paramount than the rest one variety exploited. That might also happen due to the bold seeds in LB over KN as well (Table 1) as bold seeds are always treated as the high vigorous ones by the universal seed scientists as pointed out before. Furthermore, there could be differential responses between the genotypes used. Low seed moisture content is another factor for quality seeds. And LB had also the least initial seed moisture content than the rest one. That issue might also have a dynamic role for disparities in the % soil emergence capacities as cited earlier for the 4 traits.

Shoot length

From the table 4, it is clear that the shoot became dwarf at the 5% level of possibility as high as 17.90 in TC_1 to as low as 13.83 cm in TC_{24} i.e. up to 22.73% because of the treatment combinations judged. As the weakening conditions of the seeds, i.e. the seed moisture contents and the ageing days were magnified, the depletion in the shoot length also happened in the same manner. Again, the reliability of the cellular membranes, enzymatic activities, metabolic paths and also translocation routes were ever more damaged due to the worsening (Khan *et al.*, 2004). So, the seedlings from such weak seeds could lose their competence to have the long shoots. Again, the differences might also be associated with the seed sizes and the inherent qualities of the varieties utilized as narrated previously in connection with the other parameters. The declining tendency was also remarkable in the seeds of the two yard long bean varieties. But the reduction was least in L i.e. TC_1 - TC_{12} from 17.90 - 14.50 compared to K i.e. TC_{13} - TC_{24} from 17.80 - 13.83 cm; the results further confirmed that the variety LB was superior to the rest KN. Finally, the seeds of the two varieties were rather identical for their shoot lengths under the least stress conditions (12% moisture content and 0 day incubation in TC_1, and TC_{13}).

Table 2. Evaluation of seedlings' parameters of the seeds of the two varieties of yard long bean as influenced by the controlled deterioration technique.

Treatment combinations	Nature of the combinations	Shoot length (cm)		Root length (cm)		Shoot dry matter (g)*		Root dry matter (g)*	
TC_1	$LBM_{12}A_0$	17.90	a*	9.21	a	5.53	a	1.76	a
TC_2	$LBM_{12}A_4$	17.30	a-d	9.16	a	5.44	ab	1.68	a-c
TC_3	$LBM_{12}A_8$	17.10	a-e	9.12	a	5.37	a-d	1.57	a-e
TC_4	$LBM_{12}A_{16}$	16.10	c-h	9.00	a	5.18	a-f	1.38	d-g
TC_5	$LBM_{16}A_0$	17.90	a	9.19	a	5.52	a	1.75	a
TC_6	$LBM_{16}A_4$	17.00	a-f	8.98	a	5.41	a-c	1.60	a-d
TC_7	$LBM_{16}A_8$	16.33	a-g	8.80	a-c	5.28	a-e	1.45	d-f
TC_8	$LBM_{16}A_{16}$	15.23	g-j	7.65	b-d	5.04	b-g	1.35	e-h
TC_9	$LBM_{20}A_0$	17.87	ab	9.14	a	5.16	a-f	1.73	ab
TC_{10}	$LBM_{20}A_4$	16.63	a-g	8.43	a-c	5.09	a-f	1.55	a-e
TC_{11}	$LBM_{20}A_8$	16.20	b-g	7.63	cd	4.86	e-h	1.35	e-h
TC_{12}	$LBM_{20}A_{16}$	14.50	h-j	6.59	d	4.57	hi	1.11	i-l
TC_{13}	$KNM_{12}A_0$	17.80	ab	9.15	a	5.25	a-e	1.51	b-f
TC_{14}	$KNM_{12}A_4$	17.23	a-d	9.10	a	5.18	a-f	1.44	d-f
TC_{15}	$KNM_{12}A_8$	16.47	a-g	9.06	a	5.13	a-f	1.33	f-i
TC_{16}	$KNM_{12}A_{16}$	15.33	f-j	8.94	a	4.94	d-h	1.15	h-k
TC_{17}	$KNM_{16}A_0$	17.73	a-c	9.12	a	5.22	a-f	1.51	b-f
TC_{18}	$KNM_{16}A_4$	16.70	a-g	8.91	ab	5.12	a-f	1.36	e-h
TC_{19}	$KNM_{16}A_8$	15.93	d-i	8.73	a-c	4.97	c-h	1.21	g-k
TC_{20}	$KNM_{16}A_{16}$	14.00	j	7.58	cd	4.75	f-i	1.09	j-l
TC_{21}	$KNM_{20}A_0$	17.30	a-d	9.06	a	4.88	e-h	1.49	c-f
TC_{22}	$KNM_{20}A_4$	15.50	e-j	8.38	a-c	4.74	f-i	1.30	f-j
TC_{23}	$KNM_{20}A_8$	14.30	ij	7.56	cd	4.60	g-i	1.06	kl
TC_{24}	$KNM_{20}A_{16}$	13.83	j	6.51	d	4.35	i	0.91l	l
CV (%)		6.31%		8.99%		5.55%		9.58%	

* 100 shoot/roots basis

LB= Lalbeni KN= Kegarnatki M = Moisture A = Ageing

*In a column means bearing the same letter(s) do not differ significantly as per LSD at the 5% level of probability.

Root length

The roots became stunted distinctly from 9.21 (100.0) in TC_1 to 6.51cm (70.68%) in TC_{24} i.e. up to 29.32% on account of the treatments compared (Table 2). As the weakening conditions of the seeds, i.e. the seed moisture contents and the ageing days were embellished, the reduction in the root length also happened in the same mode.

Furthermore, the differences in the root length might also be linked with the heritable nature of the seeds of the two varieties of yard long bean. Bahadur *et al.* (2005), Kabir *et al.* (2005) and Kapoor *et al.* (2010) working with the ageing of different legume seeds also found notable decrease in the root length in different varieties. The declining trend was also amazing in the two varieties. But it was least in LB i.e. TC_1 - TC_{12} from 9.21 - 6.59 cm than the rest one. The results further established that LB was superior to the KN.

Finally, the two varieties were fairly similar for their root lengths under the least stress conditions (12% moisture content and 0 day incubation in TC_1 and TC_{13}). But as the enforced adverse conditions were most severe (20% moisture content and 16 days ageing for TC_{12} and TC_{24}), their physiological divergences were clear from their root lengths (Table 2). But the roots became stunted notably even at 8 days of ageing irrespective of the moisture content. So, the results set the base to opine further that to watch such inequalities in the roots of the varieties of very alike physiological behaviors, the ageing should be done under the medium to the extreme situations.

Shoot dry matter

The shoot dry matter became markedly less at the 1% level of possibility (Appendix II) from as much as 5.53 in TC_1 (100) to as poor as 4.35 g (78.67%) in TC_{24} i.e. up to 21.33.% due to the treatments studied (Table 2).

As the ageing conditions of the seeds, i.e. the seed moisture contents and the incubation days were inflated, the lessening in the gathering of shoot dry matter also occurred in the same route. As the integrity of the cellular membranes, enzymatic reactions, metabolic functions and also translocation activities gradually slowed down owing to the deprivation (Khan *et al.*, 2004), the seeds could lose their competence to have long shoots and consequently bound to produce less amount of dry matter in it. Again, the differences in its dry matter might also be governed by the genotypes of the varieties explored. The declining trend was also amazing in the two varieties. But the rates were the slightest in LB i.e. TC_1 - TC_{12} from 5.53 - 4.57g compared to the next one. The results proved that the variety LB was undoubtedly superior between the two varieties exploited in the present experimentation.

Again, the two varieties were quite parallel for the shoot dry matter buildups under the least adverse situations (12% moisture content and 0 day ageing in TC_1 and TC_{13}) but varied at the intensified conditions (20% moisture content and 16 days ageing for TC_{12} and TC_{24}) (Table 2). So, the results opened the avenue to remark again that to evaluate such disparities in the seeds of the varieties of very identical physiological ranks, the weakening should be done under the extreme settings.

Root dry matter

The root dry matter also went down distinctly at the 1% level of possibility from as high as 1.76 in TC_1 to as downhill as 0.91g in TC_{24} i.e. up to 48.29% owing to the treatment amalgamations (Table 2). As the weakening conditions of the seeds, i.e. the seed moisture contents and the ageing days were exaggerated, the depletion in the root dry matter synthesis also occurred in the same style. Again, the divergences in the root dry matter might also be profoundly allied with the genotypes of the two varieties explored. Iqbal (1989), Bahadur *et al.* (2005), Kabir *et al.* (2005) and Kapoor *et al.* (2010) working with the ageing of various legume seeds also found notable decrease in it. The declining movement was also outstanding in the two varieties. But the fall was least in LB i.e. TC_1 - TC_{12} from 1.76-1.11g compared to the next variety i.e. KN. These results notably confirmed that LB was statistically finest than the rest one i.e. KN.

Finally, the two varieties were rather analogous for the root dry matters under the least stresses (12% moisture content and 0 day ageing in TC_1 and TC_{13}) but were diverse at severe stresses (20% moisture content and 16 days ageing for TC_{12} and TC_{24}) (Table 1). So, the results provided the footage to opine additionally that to judge such inconsistencies in the seed lots of very close physiological natures, the degradation should be done under severe settings.

Table 3. Correlation matrix for the eight quantitative aspects of the seeds and seedlings of the two yard long bean varieties studied following the controlled deterioration skill.

	RL	SDM	RDM	NS	ABS	DS	SE
SL*	0.779**	0.621**	0.759**	0.658**	-0.655**	-0.650**	0.651**
RL		0.573**	0.656**	0.713**	-0.728**	-0.646**	0.697**
SDM			0.641**	0.760**	-0.693**	-0.722**	0.729**
RDM				0.699**	-0.655**	-0.683**	0.701**
NS					-0.958**	-0.937**	0.953**
ABS						0.840**	-0.907**
DS							-0.931**

** Significant at 1% level of probability.

*SL = Shoot length
NS = Normal seedling
RL = Root length
ABS = Abnormal seedling
SDM = Shoot dry matter
DS = Dead seed
RDM = Root dry matter
SE = Soil emergence

Correlation studies

Highly significant (P>0.01) associations were found between all the eight parameters compared and the figs. ranged from -0.958 to 0.953 (Table 3). Of those relationships, 12 were negative while 16 were positive. Out of those, the uppermost positive value was 0.953 between the normal seedlings × soil emergence while the least positive fig. was 0.573 for the root length × shoot dry matter. On the other hand, the paramount negative value was -0.958 for the normal seedlings × abnormal seedlings but the poorest negative integer was -0.646 in case of the root length x dead seeds. Another vital finding was that among all the values pertaining to the normal seedlings (i.e. germination percentage); its affiliation with the soil emergence was at the climax, i.e. 0.953. So, it vividly pinpointed that the standard germination test is really an effective indication of the field emergence. While dealing with the controlled deterioration of pea seeds, Iqbal and Smith (1996) also found such positive and negative affinities among the different studied parameters. And the common findings for Iqbal (1989) and the present study were of similar natures. Bahadur *et al.* (2005) dealing with the ageing of groundnut seeds had also found identical associations among the common traits. Roberts and Osei-Bonsu (1988) argued that when care was taken to assess the liaison in various biologically meaningful terms, it was clear that most of the vital attributes of seed vigour were closely associated to one another.

Conclusion

From the results it was fairly clear that the seeds of the variety LB were the most vigorous one while the seeds of KN were the last one in the queue in terms of the quality. Such significant positions could possibly be due to disparities in the thousand seed-weights: 121 g and 119.70 g in those varieties, respectively. Note that the bold sized seeds in any crop variety are always considered the high vigorous ones by the seed technologist all over the globe and so, sieving of seeds with screens of slots of variable dimensions is done during their processing to have only the bigger ones.
Highly significant (at 1% level) correlation were found between all the eight parameters studied and those ranged from -0.958 to 0.953 (Table 5). Among the relationships, 16 were positive while 12 were negative. Again, among the 7 values for the normal seedlings, the topmost fig. was 0.953 with the soil emergence indicating that the standard germination test is an effective mirror of the field emergence.

The results further pointed out that all the tests performed during the course of the study gave comparable as well as consistent consequences. As such, the uses of all other tests might be limited to specific situations where,, those either substitute the standard germination test, or complement it. For example, in the developing countries where the labour is cheap as well as abundant but funding, equipment and technical hands are limited, the same seeds could be tested using the standard germination test and the normal seedlings attained from that test could then be evaluated for their root and shoot characteristics. So, the controlled deterioration technique is a unique skill to study the physiological statuses of the seeds even having initially very close natures. In addition, as the variety Lalbeni of Lal Teer Seed Ltd., was superior, it could be used as a parent in hybridization to develop yard long variety having quality seeds.

Nonetheless, further research works should be done for the consistency of the acceptable limits of each of the parameter for the seeds of all the cultivated varieties of yard long bean as those traits might differ among themselves. In addition, the seeds of other varieties should also be investigated for their genetic potentialities. Finally, to save time, the ageing period could also be squeezed by increasing the seed moisture contents.

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