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Screening of soybean [*Glycine max* (L.) Merrill] genotypes for seed longevity

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Abstract
Soybean seeds being inherently weak in structure is more susceptible to mechanical injury hence deteriorates faster and losses its seed quality so in the current research twenty one soybean genotypes were screened for seed longevity on the basis of standard germination test, methanol stress test and various morphological traits. Mean germination percentage of genotype after eight month of storage showed approximately the same germination after treating the freshly harvested soybean seeds with methanol. Germination percentage were found to be significantly negatively correlated with 100 seed weight, wrinkled seed coat, cracked seed coat percentage and positively with methanol stress test and smooth seed coat percentage. Bhatt. Kaliturr, TGX 1681-3F and PS 1225 were the best donors identified for longevity.

Keywords: screening, soybean, longevity, *Glycine max*

Introduction
Seeds are the main backbone of agriculture on which the entire agriculture is based, without good quality seed one cannot think of a successful, commercial, advantageous or progressive farming. Seed longevity refers to an ability of a genotype or germplasm to remain viable with high vigour even after prolonged storage, which is one of the most crucial factor for outstanding raising of a commercial crop. Major botanical structures of dicot seed consist of plumule, shoot meristem, epicotyl, hypocotyl, micropyle, hilum, cotyledon and seed coat, and if any one of these gets damaged the overall seed longevity gets reduced. Soybean seeds start losing its quality when harvested, processed or stored. The loss of seed longevity results in destitution of plant stand which is important for appropriate production and expansion of this crop in subtropical and tropical countries.

Seed deterioration is faster in soybean than other crops (Priestley *et al.*, 1985) [10]. Soybean seeds being inherently weak in structure is more susceptible to mechanical injury hence deteriorates faster and losses its seed quality (Tekrony *et al.*, 1987; Lori *et al.*, 2001) [4, 13] during post-harvest handling (Shelar, 2008) [12]. Non availability of good quality soybean seeds for sowing is one of the major constrain in soybean cultivation (Gupta and Aneja 2004) [2].

Percentage of seed which would remain viable after prolonged storage is one of the most important trait a breeder must know before exercising his breeding plan in case of soybean particularly in tarai region of India. There are different scientifically proven methods to know seed longevity in advance such as accelerated ageing test, methanol stress test, ethanol stress test, cold stress test and hot water stress test. Of these accelerated ageing test and methanol stress test are most economical, feasible and reliable test in soybean.

Morphological characters of seeds influence ability of a genotype to remain viable during prolonged storage. Thicker the seed coat more durable it will to withstand any damage to embryo and thereby it will increase longevity. Morphological characters such as cracked seed coat, wrinkled seed coat, smooth and shiny seed coat influence seed longevity indirectly by preventing necessary energy resources and bio-enzymes from leaching during imbibition. So detailed study of this trait is of paramount importance to get a clear crystal understanding of seed longevity and then futher improving this trait in elite line of soybean.

Breeding programme designed to achieve this important objective have already started in some parts of the country. However, in order to accelerate the pace and progress of this activity in tarai region of Uttarakhand, it is essential to have the knowledge of potential sources of seed longevity.

Materials and Methods

The experimental material in the current study consisted of 21 genotypes and was carried out during Kharif 2016 and 2017 at N. E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. The list of genotypes is given in Table 1.

Table 1: List of Genotypes

S. No.	Genotype	S. No.	Genotype
1	AGS 129	12	PS 1225
2	DT 21	13	PK 327
3	EC 38918	14	Kalitur
4	JS 335	15	Bragg
5	UPSM 534	16	PS 1024
6	EC 241778	17	PS 19
7	JS 20-69	18	Himso 1563
8	PS 1584	19	VLS 59
9	TGX 1681-3F	20	PS 564
10	EC 39491	21	PS 1042
11	Bhatt		

Methanol stress test as described by Musgrave *et al*. 1980 [8] and standard germination test (as per ISTA norms) was carried out after harvesting and at a gap of four months and eight months. The mean germination percentage after methanol stress test and standard germination test was used for analysis. Morphological observation that were recorded for studying longevity of soybean seed were seed with wrinkle seed coat percentage, seed with cracked seed coat percentage, 100-seed weight (g), and seed with smooth, shiny seed coat percentage.

Results and Discussion

The primary requirement for any crop improvement programme is substantial genetic variability. Thus, it is very important to confirm whether or not sufficient genetic variability is present, before starting any breeding programme for the various traits including seed longevity. Significant and high differences among genotypes indicated inherent genetic differences among treatments for all the characters *viz.* for standard germination test, methanol stress test and different morphological traits studied in this research. All the given genotypes had showed significant differences for seed longevity in different periods of seed storage at room temperature both for standard germination test and germination after methanol stress test.

In case of standard germination test, for freshly harvested seeds Bhatt showed highest germination percentage (90.33%) and least by Himso 1563 (39.67%) and that for methanol stress test was Kaliturr (75.33%) and least again by Himso 1563 (21.67%). After four months of storage best genotype in case of standard germination was Bhatt (88.33%) and that for methanol stress test was TGX 1681-3F with 68.33 % of germination as given in Table 2 and 3. While, least germination performance was recorded in Himso 1563 in both the cases. Whereas after eight months of storage Bhatt emerged as best storer in both the cases and EC 241778 showed least germination percentage of 23.33% in case of normal germination test while PS 1024 showed 15.33 % of germination after treating with methanol for two hours.

It was observed that mean germination percentage of genotype after eight month of storage showed approximately the same germination after treating the freshly harvested soybean seeds with methanol. Therefore methanol stress test emerged as a valuable tool in detecting the longevity capability of genotype in advance.

The average performance of 100-seed weight was maximum for genotype Himso 1563 and it was lowest of Bhatt as given in Table 4. The wrinkled seed coat was highest of genotype VLS 59 and it was least of genotype TGX 1681-3F, while that of cracked seed coat and smooth seed coat percentage highest was recorded in Himso 1563 and TGX 1681-3F respectively and lowest in Kaltiurr and Himso 1563 respectively.

The best genotypes which revealed good germination percentage both at normal germination and after methanol stress are Bhatt. Kaliturr, TGX 1681-3F, PS 1225. So, these genotypes could be used as an efficient seed longevity donor in soybean breeding improvement programme. While, genotypes which emerged as poorer storers are Himso 1563, Bragg, PK 327 and DT 21. Therefore, these good storer and poorer ones can be crossed among themselves to enhance the recovery of better recombinants *i.e* transgressive segregants in the segregating generations. Muhammad *et al.,* 2017 [7] concluded that land races have the potential to emerge in various environmental conditions and hence have better germination contrasted with improved varieties of soybean. So was in the case of Bhatt which is in general cultivation in hills of uttarakhand adapted to this region and showed better germination among all the genotypes. Similar results were also reported by Kueneman, 1982 [3]; Mugnisjah and Nakamura, 1986 [5]; Nkang and Umoh, 1997 [9]; Bassi *et al.*, 1999 [1]; Rao *et al*., 2001 [11]; Muhammad, 2008 [6]; Wang *et al.*, 2015 [14].

The seed longevity is highly variable character and a result of joint effect of various seed morphological, biochemical and molecular features. Moreover exact capability of a genotype to germinate with high percentage after a long period of storage might not be quantified just after harvest of crop. Therefore, direct selection for seed longevity may not be very efficient. The seed longevity is not always be independent and is due inter-connection of many other traits. The selection accomplished for one character may concurrently bring modification in the other related trait. Hence, the information on the magnitudes and direction of association between the component traits are necessary for the improvement in the desirable direction. Information on correlation between germination percentage and other traits may be useful in the prediction of correlated response to directional selection in the construction of selection indices and in the detection of some characters having no values in themselves but being indication of the more important ones under consideration.

In general, phenotypic correlations were smaller than genotypic correlations. This can occur when the genes that govern two characters are similar and the environmental conditions related to the expression of these characters have low and similar effects. The genotypic correlations between the character pairs for all traits are presented in Tables 5. Genotypic correlations, in general, were higher than phenotypic correlations. The directions of phenotypic and genotypic correlations were nearly the same for all combinations of characters. Environmental correlations, in general, were of a magnitude lower than phenotypic and genotypic correlations.

Germination percentage showed significant positive correlation with methanol stress test both at phenotypic and genotypic levels, respectively. This deciphered that either standard germination test or methanol stress test can be applied to check the seed longevity of soybean. Moreover the results of methanol stress test of freshly harvested seeds and that of germination percentage after eight month of storage were similar so, it can be concluded that methanol stress test can be efficiently applied to fresh harvested seed to know its seed longevity in advance without waiting for eight long months.

Germination percentage were found to be significantly negatively correlated with 100 seed weight, wrinkled seed coat, cracked seed coat percentage both at genotypic and phenotypic levels. Therefore selection can be practiced in between and among the soybean lines and in segregating generations for high seed longevity on the basis of line showing reduced 100 seed weight, wrinkled seed coat and cracked seed coat percentage without performing cumbersome exercise of germination and methanol stress test. Zanakis *et al.* 1993 [15] also reported that seed longevity is negatively correlated with these morphological traits.

Hence for selection of high seed longevity in advance without actual waiting for eight long month, the lines should be selected on the basis of morphological traits *viz.* low wrinkled seed coat and cracked seed coat percent and high smooth seed coat percentage.

Table 2: Mean performance and range of variation for seed longevity after different storage duration (standard germination test) in soybean.

Storage duration / Genotypes	Freshly harvested	4 months	8 months
AGS 129	78.69	72.52	68.33
DT 21	43.33	38.67	31.00
EC 38918	69.33	65.00	62.33
JS 335	72.67	68.64	64.67
UPSM 534	58.67	57.00	53.00
EC 241778	44.00	47.33	23.33
JS 20-69	51.56	45.00	43.33
EC 39491	79.33	72.00	64.33
TGX 1681-3F	83.67	75.00	75.00
PS 1347	77.00	66.33	60.67
Bhatt	90.33	88.33	80.33
PS 1225	80.00	75.67	71.67
PK 327	46.33	37.67	42.00
Kalitur	86.00	80.00	74.33
Bragg	54.67	51.00	43.00
PS 1024	63.33	61.00	54.67
PS 19	75.33	66.00	61.00
Himso 1563	39.67	30.38	24.67
VLS 59	71.60	64.33	57.33
PS 564	66.00	56.33	49.00
PS 1042	70.33	63.33	61.67
Range	39.67 to 90.33	30.38 to 88.33	23.33 to 80.33
General mean	66.73	61.02	55.42
Sem (±)	3.15	2.79	1.85
CD at 1 %	12.06	10.67	7.08
CD at 5 %	9.01	7.97	5.29
CV (%)	8.18	6.49	7.78

Table 3: Mean performance and range of variation for seed longevity after different storage duration (methanol stress test) in soybean.

Storage duration / Genotypes	Freshly harvested	4 months	8 months
AGS 129	63.33	55.00	51.00
DT 21	41.00	32.00	27.00
EC 38918	56.33	49.00	43.00
JS 335	61.00	57.00	54.00
UPSM 534	43.00	41.00	32.00
EC 241778	39.33	37.00	29.00
JS 20-69	46.00	44.00	34.00
EC 39491	48.67	59.00	49.67
TGX 1681-3F	69.67	68.33	59.33
PS 1347	59.67	53.33	47.00
Bhatt	71.65	65.67	63.33
PS 1225	69.00	62.00	60.00
PK 327	36.67	35.00	33.33
Kalitur	75.33	63.33	58.67
Bragg	44.00	39.67	39.00
PS 1024	55.00	45.33	15.33
PS 19	47.00	38.33	23.67
Himso 1563	21.67	23.89	19.67
VLS 59	51.33	44.00	44.67
PS 564	40.33	38.67	34.33
PS 1042	65.00	60.67	55.33
Range	21.67 to 75.33	23.89 to 68.33	15.33 to 63.33
General mean	52.76	48.17	41.58

Sem (±)	2.82	2.34	2.10
CD at 1 %	10.79	8.98	8.05
CD at 5 %	8.06	6.71	6.01
CV (%)	9.26	8.44	8.77

Table 4: Mean performance and range of variation of morphological traits in soybean.

Morphological traits / Genotypes	100-seed weight (g)	Wrinkle seed coat %	Cracked Seed coat %	Smooth, shiny seed coat (%)
AGS 129	8.65	7.56	2.6	89.84
DT 21	11.29	8.93	5.2	85.88
EC 38918	10.48	7.04	3.3	89.67
JS 335	15.62	10.50	4.33	85.17
UPSM 534	9.91	5.88	4.17	89.95
EC 241778	10.88	8.51	6.1	85.40
JS 20-69	11.57	4.52	4.9	90.59
EC 39491	11.50	9.66	2.3	88.04
TGX 1681-3F	6.63	1.40	1.33	97.27
PS 1347	10.18	5.95	2.8	91.25
Bhatt	4.56	3.40	1.5	95.10
PS 1225	10.88	6.62	1.7	91.69
PK 327	9.58	12.92	5.1	81.99
Kalitur	7.87	2.80	0.33	96.87
Bragg	10.90	12.08	4.33	83.60
PS 1024	9.88	13.76	3.6	82.65
PS 19	10.12	5.15	2.6	92.26
Himso 1563	20.18	12.71	6.3	81.00
VLS 59	9.54	14.70	2.1	83.20
PS 564	10.74	7.70	3.4	88.90
PS 1042	9.78	10.15	3.1	86.75
Range	4.56 to 20.18	1.40 to 14.70	0.33 to 6.30	81.00 to 97.27
General mean	10.51	8.18	3.38	88.43
Sem (±)	0.49	0.20	0.12	2.10
CD at 1 %	1.42	0.78	0.46	8.05
CD at 5 %	1.90	0.56	0.34	6.01

Table 5: Inter-character correlation coefficient between different character at genotypic level.

Character	Germination (%)	Methanol stress test	100-seed weight (g)	Wrinkle seed coat (%)	Cracked Seed coat (%)	Smooth, shiny seed coat (%)
Germination (%)	1.000	0.917**	-0.591**	-0.521**	-0.968**	0.867**
Methanol stress test		1.000	-0.658**	-0.525**	-0.840**	0.802**
100-seed weight (g)			1.000	0.501**	0.667**	-0.690**
Wrinkle seed coat (%)				1.000	0.494**	0.084
Cracked Seed coat (%)					1.000	-0.837**
Smooth, shiny seed coat (%)						1.000
Ascorbate Peroxidase						
Superoxide dismutase						
Catalase						
Peroxidase						

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