

Screening of Soybean Germplasm for Better Storability

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ABSTRACT A total of 693 germplasm lines of soybean stored in bitumen paper bags for two years at IARI, New Delhi under ambient conditions were screened for storability. 104 genotypes showed more than 90 per cent germination even after two years of storage. In general, black seeded genotypes had higher germination (mean 77%) compared to yellow seeded (mean 35.9%) genotypes. Based on germination percentage 20 each better storer (more than 90% germination), medium storer (60-70% germination) and poor storer (30-40% germination) genotypes were selected and grown during *kharif* 2004. Observations were recorded on plant height, flower colour, days to flower and pod pubescence. The increased storability could be attributed to manually threshing method and bitumen paper waterproof seed envelopes. The study on morphological characters revealed that better storer had tawny pubescence (100%) and purple flower (95%); the poor storer genotypes had white flower (30%) and grey pubescence (20%). Storability had significant and positive correlation with days to flower ($r = 0.26$) and plant height ($r = 0.71$) and significant and negative correlation with 100 seed weight ($r = -0.39$). Fresh seeds of good storer, medium storer and poor storer genotypes were stored under ambient conditions for two years in cloth bags. Good storer still showed higher germination (mean 87.2%), compared to medium storer (mean 71.8%) and poor storer (mean 46.9%). Based on four years study sixteen good storer genotypes (> 90% germination even after two years of storage) were selected, of these four had yellow and twelve black testa and these can be used in the breeding programme.

Key words: Soybean germplasm, screening, storability

Soybean (*Glycine max* L. Merrill) is a major oil seed crop of India. Its area is increasing, it has increased during last three and half decade and especially during Technology Mission of Oil Seed from 0.03 m ha to 6.4 m ha [1]. Soybean contributes 28.6 per cent of the total oil seed production. The major problem being faced for soybean cultivation is its poor storability under ambient storage leading to poor plant stand [2]. The loss of germination potential in soybean is more acute in tropical countries as compared to temperate environment [5]. The environmental conditions of high temperature and humidity in tropical countries such as India make it difficult to produce quality soybean seed and maintain its viability during storage [6-10]. The soybean breeders are always in search of lines having good storability

for developing improved cultivars. Keeping this in view the present study was taken up to screen and select better storer lines in soybean amongst the germplasm maintained at IARI, New Delhi.

MATERIALS AND METHODS

693 germplasm lines stored in bitumen paper bags for two years at IARI, New Delhi under ambient conditions, were screened in March 2004 for storability by testing germination (%) in 50 seeds each in two replications in B.P. at 25°C and 95%RH in a germinator. The evaluation of germination was made as per ISTA Rules. The testa colour and 100 seed weight (3 replications of 100 seed each) of germplasm lines were also recorded.

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Out of the 693 germplasm lines 20 each, better storer (more than 90% germination), medium storer (60-70% germination) and poor storer (30-40% germination) were selected and sown during *kharif* 2004 at IARI Experimental Farm, New Delhi. Observations were recorded on plant height (at 60DAS), days to flower, flower colour and pod pubescence. Fresh seed of these selected lines produced during *kharif* 2004 were stored under ambient conditions in cloth bags to assess storability by testing per cent germination (3 replications of 50 seed each) after two years of storage in March 2006.

RESULTS AND DISCUSSION

The frequency distribution for per cent germination of soybean genotypes stored for two years under ambient condition in water proof seed envelopes has been given in Fig. 1. The germination in the soybean genotypes ranged from 0.0-100.0 per cent. Out of 693 genotypes screened 104 genotypes (15.0%) showed > 90 per cent germination, even after two years of storage. There were 36.2 per cent genotypes showing more than 70 per cent germination and 51.2 per cent genotypes had \leq 50 per cent germination. Either or less than 10 per cent germination was observed in 143 genotypes (20.6%).

Out of 666 genotypes (in 27 genotypes seeds were not available for recording testa colour and 100 seed weight) studied yellow testa was found

in maximum number of genotypes i.e. 54.7 per cent genotypes (Table 1) followed by black testa 28.4 per cent genotypes. 10.7 per cent genotypes had either green or light green testa and 6.4 per cent genotypes had brown testa. Highest mean germination was observed in black seeded (77.4% germination) followed by brown seeded (40.7% germination) and green seeded (39.9% germination). Yellow seeded genotypes showed only 35.9 per cent mean germination. Among black seeded genotypes, only 38.1 per cent genotypes showed more than 90.0 per cent germination and 13.7 per cent had \leq 50 per cent germination. 86.3 per cent genotypes among black seeded had >50

Table 1. Mean values of germination (%) and 100 seed weight (g) in soybean genotypes in relation to testa colour

Testa colour	Number of genotypes	Germination (%)		100 seed weight (g)	
		Mean	Range	Mean	Range
Black	189(28.4)	77.39	0-100	7.52	3.20-15.80
Brown	42(6.4)	40.69	1-92	9.03	4.88-15.19
Green	71(10.7)	39.85	0-92	8.53	4.77-16.45
Yellow	364(54.7)	35.85	0-97	9.09	4.88-18.51
Total	666(100.0)	48.19	0-100	8.58	3.20-18.51

Value in percentage in parenthesis.

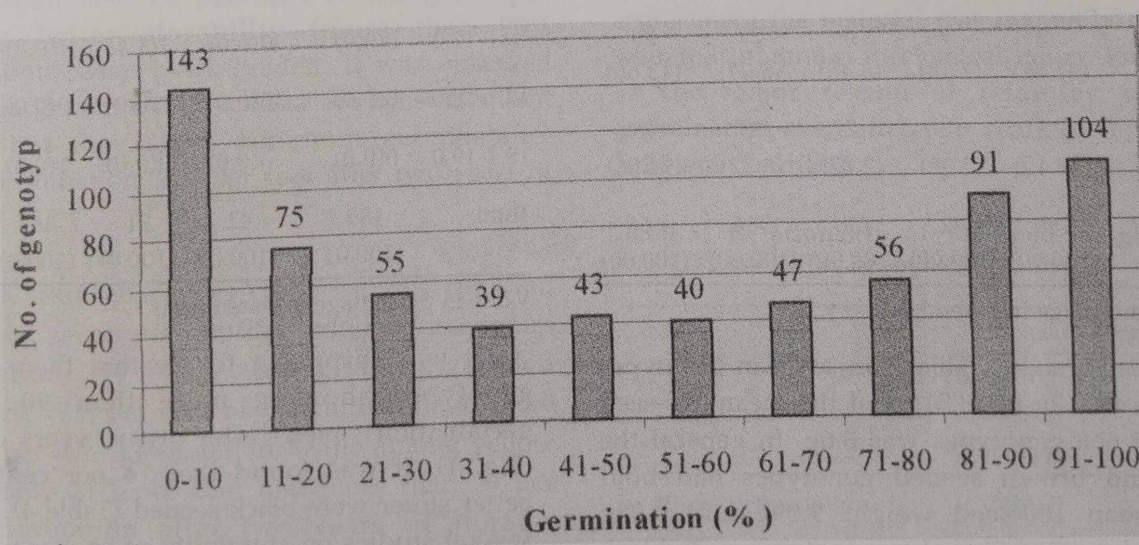


Fig. 1. Frequency distribution of soybean genotypes for germination (%) after two years of storage

per cent germination after 2 years of storage (Table 2). Among yellow seeded only 6.3 per cent genotypes showed more than 90 per cent germination and 30.5 per cent genotypes were in the group of 0-10 per cent germination.

Table 2. Frequency distribution of soybean genotypes for germination percentage

Germination (%) class	Number of genotypes				
	Black testa	Brown testa	Green testa	Yellow testa	Total
0-10	8 (4.23)	5 (11.90)	18 (25.35)	111 (30.49)	142 (21.32)
11-20	8 (4.23)	7 (16.67)	8 (11.27)	52 (14.29)	75 (11.26)
21-30	6 (3.17)	6 (14.29)	7 (9.86)	34 (9.34)	53 (7.96)
31-40	0 (0.00)	5 (11.90)	4 (5.63)	24 (6.59)	33 (4.95)
41-50	4 (2.12)	3 (7.14)	4 (5.63)	31 (8.52)	42 (6.31)
51-60	5 (2.65)	4 (9.52)	8 (11.27)	21 (0.55)	38 (5.71)
61-70	11 (5.82)	3 (7.14)	7 (9.86)	18 (32.42)	39 (5.86)
71-80	16 (8.47)	5 (11.90)	7 (9.86)	28 (7.69)	56 (8.41)
81-90	59 (31.22)	3 (7.14)	6 (8.45)	22 (6.04)	90 (13.66)
91-100	72 (38.10)	1 (2.38)	2 (2.82)	23 (6.32)	98 (14.56)
Total	189 (100.00)	42 (100.00)	71 (100.00)	364 (100.00)	666 (100.00)

Value in percentage in parenthesis.

100-seed weight (Table 1) in soybean genotypes ranged from 3.2g to 18.51g and the mean 100-seed weight of 666 genotypes was 8.6g. In general the yellow and brown seeded genotypes had bold seeds (mean 100-seed weight 9.09g and 9.03g respectively) as compared to genotypes with black testa (mean 100-seed weight 7.5g). Frequency

distribution of 100-seed weight in the soybean genotypes are shown in the Table 3. Majority (71.5%) of the genotypes had 100-seed weight in the range of 6g to 10g. There were only 11 genotypes, which were very small seeded having 100-seed weight of ≤ 5.0 g. Similarly, there were only five genotypes with very bold seed > 15 g.

Table 3. Frequency distribution of soybean genotypes for 100-seed weight (g)

100 seed wt.(g)	Black testa	Brown testa	Green testa	Yellow testa	Total
3.1-4.0	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.2)
4.1-5.0	5(0.5)	1(2.4)	3(4.2)	1(0.3)	10(1.5)
5.1-6.0	18(2.7)	2(4.8)	13(18.3)	16(4.4)	49(7.4)
6.1-7.0	77(40.7)	2(4.8)	6(8.5)	38(10.4)	123(18.5)
7.1-8.0	49(25.9)	11(29.4)	12(19.9)	70(19.2)	142(21.3)
8.1-9.0	27(14.3)	9(21.4)	9(12.7)	69(19.0)	114(17.1)
9.1-10.0	7(3.7)	6(14.3)	8(11.3)	9(2.9)	97(14.6)
10.1-11.0	2(1.1)	4(9.5)	7(9.9)	39(10.7)	52(7.9)
11.1-12.0	1(0.5)	2(4.8)	4(5.6)	31(8.5)	38(5.7)
12.1-13.0	1(0.50)	2(4.8)	2(2.8)	15(4.1)	20(3.0)
13.1-14.0	0(0.0)	1(2.4)	3(4.2)	7(1.9)	11(1.7)
14.1-15.0	0(0.0)	1(2.4)	2(2.8)	1(0.3)	4(0.6)
15.1-16.0	1(0.5)	1(2.4)	0(0.0)	0(0.0)	2(0.3)
16.1-17.0	0(0.0)	0(0.0)	1(1.4)	1(0.3)	2(0.3)
17.1-18.0	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
18.1-19.0	0(0.0)	0(0.0)	0(0.0)	1(0.3)	1(0.2)
Total	189 (100.0)	42 (100.0)	71 (100.0)	364 (100.0)	666 (100.0)

Value in percentage in parenthesis.

It was surprising to see that there were 104 genotypes showing more than 90 per cent germination even after two years of storage (Fig. 1). It was found that 74 per cent of these better storer were black seeded (Table 4). There are several studies on storability of soybean and some of the studies indicate that waterproof seed

envelope (polythene bags, metal tins etc.) increase storability in case of soybean [11, 12]. In the present case, bitumen paper waterproof seed envelopes were

Table 4. Relationship of testa colour with storability in soybean genotypes

Class	Number of genotypes			
	Black testa	Yellow testa	Other testa	Total
> 90% germination	72 (73.46)	23 (23.47)	3 (3.06)	98 (100)
≤ 10% germination	8 (5.63)	111 (78.17)	23 (16.20)	142 (100)

Values in percentage in parenthesis

used which are routinely used in the breeding programmes for storage of small quantity of seed. Thus, it appears that these seed envelopes, which were used, have helped to increase the storage life of soybean genotypes.

In general, soybean is an extremely poor storer and its viability can be maintained up to next growing season with great difficulty in gunny bag/cloth bags. In the certification programme hardly any (almost nil) seed lot is revalidated because the germination (%) is extremely low. There are two types of earlier information available on longevity of soybean, one is related to testa colour and another is related to seed size. In the present investigation also 74 per cent of the genotypes showing better storability (more than 90% germination) were black seeded. It was observed that varieties with yellow testa are most frequent (54.7%) but they show minimum germinability (mean germination 35.9 per cent after two years of storage).

Black testa genotypes comprise 28.4 per cent of the total genotypes but they exhibited maximum germination (77.4%). Among black seeded genotypes, 77.8 per cent of the cultivars had more than 70 per cent germination. while among yellow seeded only 21.1 per cent had more than 70 per cent germination after two years of storage. Kueneman and Wein [13] and Singh and Ram [9] in separate studies reported that black seeded land

race varieties of tropical and subtropical regions such as T-49 and Kalitur have better storability than yellow seeded temperate varieties.

Similarly, the better storer genotypes were small seeded. A wide range of 100 seed weight (3.2g to 18.51g) was observed in the soybean genotypes. Most of the genotypes (71.5%) lied between 6g to 10g. The number of genotypes with more than 15g hundred seed weight were only five and those with less than 5g hundred seed weight were 11 in number. In general, yellow (9.09g) and brown (9.03g) seeded genotypes had bold seed as compared to genotypes with black testa (7.5 g).

Verma and Gupta [14] reported that many dark seeded lines were good storer, while there are others with poor storability. Studies carried out on genotypic differences on soybean storability and reasons for such differences indicated that seed size and testa thickness were reasons of these differences [3, 15, 16]. Among the better storer ones (more than 90% germination) there were 23 genotypes with yellow testa. Similarly, among the better storer, there were only two genotypes with more than 10g hundred seed weight (Table 4 and 5). In the poor storer (<10% germination) there were 8 genotypes with black testa also (Table 4). Among poor storer, there were 31 genotypes with >10g hundred seed weight and only 11 genotypes showed less than 6g hundred seed weight (Table 5). Mechanical damage is another important aspect which takes place during harvesting, threshing, processing and transport. Since in the present experiment the material was manually threshed, it suffered minimum mechanical injury. Probably this is the major reason of retaining quite high germination even after two years of storage under ambient condition.

Table 5. Relationship of 100-seed weight (g) with storability in soybean genotypes

Class	100-Seed weight (g)	
	> 10g No. of genotypes	< 6g No. of genotypes
> 90 % germination	2(1.92)	9(8.65)
< 10% germination	49(34.5)	11(7.74)

Value in percentage in parenthesis.

Relationship of storability with morphological characters of plants

In the present study 20 genotypes each of better storer (< 90% germination), medium storer (60-70% germination) and poor storer (30-40% germination) were grown during *kharif* 2004 and observations were recorded on days to flower, plant height, flower colour and pod pubescence. The study revealed that better storer in general had tawny pubescence (100%) and purple flower (95%). While, among the poor storer there were genotypes with white flower (30%) and grey pubescence (20%) also (Table 6). There is no previous study indicating the relationship of flower colour and pod pubescence with storability.

The relationship of plant height and storability was positively associated as revealed by very high positive correlation ($r = 0.71$) between plant height and storability. The high correlation revealed that genotypes with higher plant height are better storer and genotypes with small plant height were poor storer. There is no earlier report on the relationship of plant height with storability in soybean. The present study also indicated that most of the genotypes with black testa were tall (mean height 73.35 cm) and genotypes with yellow testa were dwarf (mean height 45.97 cm). Thus positive correlation between storability and plant height may be a reflection of the association of black testa-storability-tall plant type.

In the present study the better storer were having more than 90 per cent germination, the medium storer between 60-70 per cent germination

and poor storer with 30-40 per cent germination and by adjusting the seed rate the plant population was maintained. But the three classes differ significantly in plant vigour. In a number of crops including mustard there are reports that seed lots with higher seed vigour show more plant height at the time of flowering as compared to seed lot of low vigour [18]. Thus, in the present study the association of plant height with storability could be due to difference in the vigour of these storability classes.

There was a positive and significant correlation between days to flower and storability ($r = 0.26$). In Delhi, in the early flowering genotypes seed development takes place at comparatively higher temperature as compare to late flowering genotypes where seed development and maturation takes place in the month of November and December with comparatively cooler temperature. Thus, it appears that the seed development and maturation at cooler temperature helps in improving the seed quality (storability) in soybean. Spears *et al.* [18] reported that high temperature during soybean seed development reduces seed vigour in the absence of associated mechanical injury and seed borne mycoflora.

Storability had a negative and significant correlation ($r = -0.39$) with 100 seed weight. It may be because in general black seeded genotypes are better storer and small sized.

Fresh seeds of good storer, medium storer and poor storer genotypes were stored under ambient

Table 6. Flower colour and pod pubescence in better, medium and poor storer soybean genotypes

Characters		Better storer		Medium storer		Poor storer		Total	
		No. of genotypes	(%)	No. of genotypes	(%)	No. of genotypes	(%)	No. of genotypes	(%)
Flower colour	Purple	19	95	17	85	14	70	50	73
	White	1	5	3	15	6	30	10	17
Pod pubescence	Tawny	20	100	19	95	16	80	55	92
	Grey	0	0	1	5	4	20	5	8

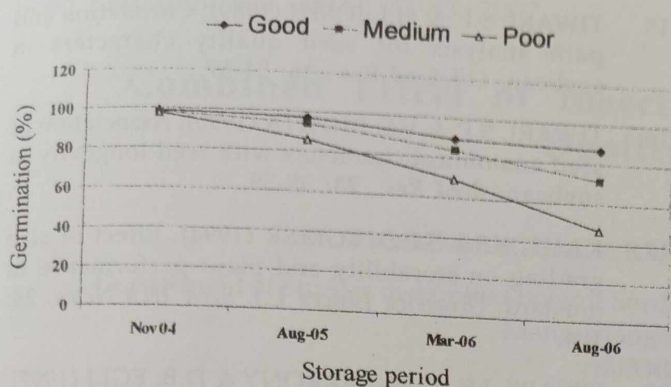


Fig. 2. Mean values of germination percentage of good, medium and poor storer genotypes of soybean during storage

conditions for two years in cloth bags. Good storer still showed (Fig. 2) higher germination (mean 87.2%), compared to medium storer (mean 71.8%) and poor storer (mean 46.9%).

Based on four years study sixteen good storer genotypes (> 90% germination even after two years of storage) were selected (Table 7), of these four had yellow and twelve black testa. Most of these were small seeded (6.3 to 7.1 g 100 seed weight). However, these were bold seeded also (yellow seeded genotype EC-1023 had 100 seed weight of 10.12g). These genotypes can be used in the breeding programme.

Table 7. Confirmed better storer soybean genotypes (Based on 4 years study)

Genotype	100 seed weight (g)	Germination (%) after 2 years of storage	
		2004	2006
YELLOW SEEDED			
EC-93751	8.25	90.0	95.0
EC-34141	9.75	97.0	93.0
EC-1023	10.12	96.0	91.0
MACS-681	6.85	90.0	91.0
BLACK SEEDED			
DSMM-64	6.45	92.0	90.0
G 2253	6.31	94.0	93.0
G 2263	6.35	93.0	96.0
G 2601	6.83	93.0	93.0

G 2603	7.15	93.0	95.0
G 2614	6.35	95.0	93.0
G 2651	6.70	95.0	94.0
M 253	6.35	95.0	95.0
M 1030	6.91	91.0	94.0
M 1090	9.56	96.0	95.0
M 11913	6.97	92.0	94.0
TGX 444-422	6.50	93.0	91.0

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