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CONTROLLING GENETIC FACTORS TO SOYBEAN SEED STORABILITY UNDER ROOM TEMPERATURE CONDITIONS

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SUMMARY

The objective of the research was to obtain information on genetic control of seed soybean storability. The research was conducted at seed testing laboratorium of Department of Agronomy and Horticulture (Bogor Agricultural University), Bogor, Indonesia. Genetic material used were 3 national varieties and 17 advanced breeding lines. The research was arranged in randomized completely block design with three replications. Black soybean seeds are stored in airtight plastic packaging at a temperature of 27–30°C and 57–60% RH for a 14 weeks. The results showed that all characters observed was significantly affected by genotypes. Traits related to seed storability are affected by genetic factors. All traits observed showed a high heritability. There is possiblity to improve seed soybean storabilty by breeding program. Based on growth rate of seedling and vigor index, SSD-10, SSD-17, SSD-18, SSD-39, SSD-82, SSD-91 dan SC-39- are the best seed storaability.

Keywords: Soybean, seed storability, heritability

INTRODUCTION

An important of seed is its storability in many various environment (Kueneman, 1981). Storability may vary according to the genetic factors. Seed strorability also depend on environment factors instorage conditions (Balesevic-Tubic *et al.,* 2010), such as temperature, moisture content, mechanical damage.Based on the Harrington Law, environmental factors such as room temperature storage of seed influence on the rate of deterioration. Low temperatures needed to slow down the aging seed.

Genetic factors will affect the hardness of the seed coat and the permeability of the seed coat. The harderthe seed coatwill be longer the seed storability. Seed cotton and soybean seed has a similar chemical composition, but the seed cotton could maintain viability for longer than soybean seed. Soybean seed has a morphological structure that can cause critical parts of seeds more easily damaged.

Improvement seed quality after storage periodthrough selection in a breeding program isan alternative to produce high seed quality. This research aims to investigate the effect of genetic factors on the storability of black soybean seed (*Glycine max* (L.) Merr.).

MATERIALS AND METHODS

Research was conducted at the Seeds Laboratory and Plant Breeding Laboratory of the Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Dramaga and Center for Development Seed Quality Testing of Food Crops and Horticulture. The research was conducted in March until July 2012.

The materials used are 17 promising lines of black soybean lines, namely SSD-10 SSD-13 SSD-17 StheSD-18 SSD-20 SSD-27 SSD-39 SSD-46 SSD-51 SSD-54, SSD-75 SSD-82 SSD-91 SSD-102, SC-39-1, SC-68-2, GC-74-7, and three national varieties as check, namely Cikuray, Malika and Wilis. The research used Randomized Complete Block Design. The treatment used is the single factor which is composed of 17 promising lines of black soybean seeds and three varieties with three replications. Seeds were stored on several storageperiodfor 0, 2, 4, 6, 8, 10, 12, 14 and 16 weeks.

Black soybean seeds stored in airtight plastic containers at temperature of 27-30°C and RH 57–60%. Once the seeds are conducted several tests to determine the storability of seeds at a certain time period. Parameters observed were percentage seed germination, growth rate of seedling, maximum potential growth,vigor index and seedling dry weight. Seed viability testing method used between paper methods. Seed moisture content determination used a temperature of 103 ± 2°C for 17 hours. Testing of electrical conductivity (EC) was conducted to look at the level of leakage of seeds stored for a certain period by using electric conductivity meter. Seeds soaked in distilled water for 24 hours in a sealed glass bottle. Variance analysis was performed for each parameter observed. Duncan's multiple range test was used to compare means.

RESULTS AND DISCUSSION

Storablity of Black Soybean Seed

One thousand seed weight was affected by genotype. SSD-54 SSD-75 SSD-102 and Cikurayshowed 100 seed weight highest compared to other lines. Seed volume was not affected by genotype factors. The result showed that there is a variation of 100 seed weight black soybean lines. There were posistif correlationbetween 100 seed weight and seed volume. It is estimated that seed size has a positive correlatiion with seed storability and viability. The larger seed size have a lower seed viability than the small one.

Variance analysis showed that genotype factor significantly affected to seed germination percentage, maximum potential , growth rate of seedling , seedling dry weight, vigor index and electrical conductivity in some storage periods (Table 1). Baktisari (2010) found that genotypes highly significant effect on all parameter observed ie. germination, the maximum growth potential, growth rate, moisture content, weight, volume, weight and electrical conductivity type. El Abady *et al*. 2013 reported that there are significant differences among soybean cultivars in seed quality traits.

Table 1. Variance analysis of parameters observed related to black soybean seed storability

Parameter	Genotype	Storage Periode	Interaction
seed germination	**	0-6, 12, 14**	**
		8, 16*	
		10ns	
Vigor Index	**	0-8,12-16**	*
		10*	
maximum potential growth	**	0,2,6,14**	tn
		4,8,10,12,16ns	
growth rate of seedling	**	2-8, 12-16**	**
		2,10*	
Seedling Dry Weigh	*	2, 6-16**	**
		0,4*	
Seed Moisture content	**	10-16**	**
		0-8ns	
Electrical conductivity	**	4,8,12,16**	*

*and **significant at 5% and 1% level, respectively

Seed germination at 0-week storage period ranged from 54–92%. Promising line that have the high seed germination at 0-week period are SSD-10 and SC-39-1 with the value of 85.33% and 91.33%. Seed germination in 2-week storage period showed remained high such as SSD-10 SSD-27 SSD-82, SC-39-1 and Willis varieties have more than 80%. Seed germination beginning to decline in the storage period of 6 weeks ranged between 41–87%. Promising line that have high viability at 6-week storage period are SSD-82, SC-39-1 and Wilis varieties with a value of 80.67%, 86.67% and 82.67%. Many promising line have low seed germination at 16-week storage period showed at ranged between 16–40%. Strain SC-39-1 has remained high seed germination,thatis 74.67% (Table 2).

The maximum growth potential is very high at 0-week storage period ranged between 78–94%. The maximum growth potential remains high until the storage period of 8 weeks. The maximum growth potential began to decline in the 10-week storage period reaches 49–76%. The promising line that have high maximum potential growth at the 14-week period is SC-39-1 with a value 90.67% (Table 3).

The growth rate of seedling in the 0-week storage period is high, ranged between 15–26%. The best promising line based on growth rate of seedling are SSD-10, SC-39-1 and Wilis. The growth rate of seedling began to reduce in the storage period of 6 weeks (11–23%) for all lines except SC-39-1 that have high the growth rate is 28.22% (Table 4).

Vigor index at 0-week storage period ranged between 34–72%. The promising line that have high vigor index was SSD-10 and SC-39-1 with a value of 66% and 72%. Vigor index began to reduce fastly in the storage period of 6 weeks, reaching 17–62%. The promising line SC-39-1 can still maintain vigor index remains high compared with other lines (Table 5).

Table 2. Seed germination percentage of many promising line in 16-weeks storage periode

Lines	Storage periode (weeks)								
	0	2	4	6	8	10	12	14	16
	Seed germination (%)								
SSD-10	85.33	80.67	88.67	76.67	73.33	50.67	56^{A}	40C	40
SSD-13	54.67^{abc}	60^{c}	60	41.33^{ac}	46.67	50.67	34.67	13.33^{b}	22.67
SSD-17	71.33	63.33^{c}	63.33	58	64	49.33	36	25.33	16
SSD-18	78.67	78.67	70.67	68.67	64	53.33	32	33.33	25.33
SSD-20	77.33	78.67	78	78	65.33	53.33	33.33	33.33	22.67
SSD-27	80	81.33	78.67	70.67	61.33	57.33	29.33	33.33	24
SSD-39	77.33	80	72.67	66.67	48	49.33	33.33	28	18.67
SSD-46	72	74.67	73.33	68	65.33	49.33	34.67	38.67	22.67
SSD-51	82.67	78.67	74.67	69.33^{c}	85.33^{AB}	60	41.33	32	25.33
SSD-54	64	54.67^{ac}	56^{c}	48.67^{c}	54.67	38.67	33.33	25.33^{b}	20
SSD-75	46^{abc}	60.67^{c}	62	47.33	49.33	44	28	13.33	16
SSD-82	71.33	80	86	80.67	68	57.33	44	32	28
SSD-91	84.67	78	72.67	62.67	61.33	53.33	42.67	28	26.67
SSD-102	70	70	75.33	64.67	58.67	52	29.33	30.67	25.33
SC-39-1	91.33	86.67^{B}	66.67	86.67	93.33^{B}	73.33	81.33^{ABC}	84^{ABC}	74.67^{ABC}
SC-68-2	63.33	56.67^{c}	70	52^{c}	50.67	52	41.33	29.33	16
GC-74-7	70	36^{abc}	46^{ac}	53.33^{c}	52	49.33	38.67	34.67	24
Cikuray	76	74.67	74	76	62.67	60	32	41.33	38.67
Malika	74.67	64.67	69.33	65.33	53.33	65.33	37.33	34.67^{C}	17.33
Wilis	79.333	83.33	82.667	82.67	70.67	58.67	45.33	17.33^{b}	17.33
F-value	6.87**	7.75**	2.98**	3.44**	3.20*	1.23^{tn}	4.73**	7.80**	3.09*
KK	9.56	11.07	14.37	17.86	18.69	21.77	24.31	27.62	49.93

Note : * = significant defferent at α = 5 %, ** = significant defferent at α = 1 %, tn= non significant, a = less significant different thanCikuray, b = less significant different than Malika, c = less significant different than Wilis, A = less significant different than Cikuray, B = less significant different than Malika, C = less significant different thanWilisbased onDunnett test at α = 5 %.

Table 3. The maximum potensial growth of many promising line in 16-weeks storage periode

Promising Line	Storage periode (weeks)								
	0	2	4	6	8	10	12	14	16
..... maximumpotensial growth (%).....									
SSD-10	90	85.33	92.67	70.67	86.67	54.67	68	66.67	69.33
SSD-13	80^{b}	74.67	73.33	44.67	70.67	57.33	50.67	41.33^{a}	48
SSD-17	82	73.33	73.33	59.33	80	53.33	50.67	50.67	37.33
SSD-18	89.33	84	80.67	72.67	76	61.33	48	58.67	41.33
SSD-20	87.33	84	85.33	74.67	73.33	60	48	61.33	49.33
SSD-27	78^{abc}	88.67	86	66	78.67	65.33	50.67	58.67	54.67
SSD-39	88.67	87.33	80	69.33	65.33	64	52	53.33	42.67
SSD-46	90	84.67	83.33	64.67	82.67	56	54.67	58.67	40

Table 3. The maximum potensial growth of many promising line in 16-weeks storage periode (Cont.)

Promising Line	Storage periode (weeks)								
	0	2	4	6	8	10	12	14	16
..... maximumpotensial growth (%).....									
SSD-51	89.33	84	80	64.67	89.33	65.33	58.67	58.67	46.67
SSD-54	80.67^{b}	70c	68.67	50.67	76	49.33	49.33	53.33	40
SSD-75	86.67	69.33	74	50	66.67	53.33	41.33	32^{ab}	44
SSD-82	86	86	92.67	78.67	76	69.33	56	49.33	46.67
SSD-91	80.67^{b}	91.33	83.33	65.33	88	61.33	57.33	56	52
SSD-102	82.67	79.33	85.33	61.33	70.67	58.67	44	58.67	42.67
SC-39-1	92.67	90	71.33	75.33	94.67	76	84	90.67^{ABC}	78.67
SC-68-2	78.67	64^{c}	78.67	50	73.33	60	49.33	58.67	45.33
GC-74-7	81.33^{b}	42^{c}	61.33	72.33	70.67	52	50.67	61.33	42.67
Cikuray	90	81.33	82.67	71.33	84	64	53.33	65.33	53.33
Malika	93.33	71.33^{c}	81.33	65.33	70.67	68	49.33	58.67	44
Wilis	90	90.67	90.67	74.67	78.67	69.33	58.67	49.33	38.67
F-value	3.24**	7.62**	1.76^{tn}	3.45**	1.40^{tn}	1.40^{tn}	0.6^{tn}	4.34**	1.42^{tn}
KK	5.47	9.38	13.12	14.27	15.01	16.46	24.69	16.39	31.01

Note : * = significant defferent at α = 5 %, ** = significant defferent at α = 1 %, ^{tn}= non significant, a = less significant different than Cikuray, b = less significant different than Malika, c = less significant different than Wilis, A = less significant different than Cikuray, B = less significant different than Malika, C = less significant different than Wilis based on Dunnett test at α = 5 %,

Table 4. The growth rate of seedling of many promising line in 16-weeks storage periode

Promising Line	Storage periode (weeks)								
	0	2	4	6	8	10	12	14	16
..... the growth rate of seedling(%).....									
SSD-10	23.77	23.93	24.86	22.11	23.22	19.67	16.22	12.11^{C}	11.11
SSD-13	15.82^{c}	16.46^{bc}	18.71	13.11^{a}	13.67c	10.56^{a}	9.67	4.22	6.89
SSD-17	19.84	18.93	18.57	14.61	14.78c	14.67	10.11	7.78	4.78
SSD-18	19.8	21.84	19.38	11.78^{abc}	16.56c	15.89	9	10.33	7.44
SSD-20	20.62	23.99	22.8	17.67	21.78	14.11	9.44	9.56	7
SSD-27	21.81	23.01	21.82	18.94	17.33c	18	8	9.89	6.78
SSD-39	21.61	20.86	21	16.5	20.33	16.67	9.33	8.56^{C}	6
SSD-46	21.62	18.96	20.94	16.5	19.11	17.89	9.67	11.56	6.89
SSD-51	22.14	22.36	21.41	15.83	18.56^{c}	16.89	11.56	9.33	7.89
SSD-54	17.64	19.14	18	13.56^{a}	12.56^{c}	12.44^{a}	9.67	7.22	7
SSD-75	16.73	16.72^{c}	14.51	13.83^{a}	15.11^{c}	14.78	8.22	4	5.56
SSD-82	19.56	25.04	27.17^{B}	20.56	18.33^{c}	21.44	13.11	9.89	8.78
SSD-91	21.99	21.6	21.5	20.28	18.11^{c}	16	12.56	8.56	7.67
SSD-102	20.9	20.16	19.61	14.83	19.44	16.44	8.67	9	7.78
SC-39-1	25.42	22.76	27.94^{B}	28.22	29.11	26.56^{B}	26.89^{ABC}	27.89^{ABC}	23.89^{ABC}
SC-68-2	18.34	20.6	19.62	15.28	14.33^{c}	14.56	12.44	8.56	7.11
GC-74-7	17.48	6.07^{abc}	17.56	11.11^{abc}	10.22^{abc}	14.67	11.44	9.89	7.33

Table 4. The growth rate of seedling of many promising line in 16-weeks storage periode (Cont)

Promising Line	Storage periode (weeks)								
	0	2	4	6	8	10	12	14	16
..... the growth rate of seedling(%).....									
Cikuray	21.12	22.32	21.53	22.83	20.33	22.22	9.33	12C	12.11
Malika	20.39	24.47	19.33	21.78	21.78	15.78	10.67	10.11	5.56
Wilis	23.8	24.79	21.27	21.22	28.56	18.44	12.78	5.11	6.22
F-value	1.96*	5.47**	3.28**	4.12**	21.05**	3.04*	6.6**	11.37**	3.72**
KK	14.89	15.25	14.48	20.77	4.52	21.74	24.53	25.19	44.43

Note : * = significant defferent at α = 5 %, ** = significant defferent at α = 1 %, ^{tn}= non significant, a = less significant different than Cikuray, b = less significant different than Malika, c = less significant different than Wilis, A = less significant different than Cikuray, B = less significant different than Malika, C = less significant different than Wilis based on Dunnett test at α = 5 %,

Table 5. The vigor index of many promising line in 16-weeks storage periode

Promising Line	Storage periode (weeks)								
	0	2	4	6	8	10	12	14	16
..... vigor index (%).....									
SSD-10	66	54	66.67^{A}	43.33	54.67	37.33	26.67	25.33^{C}	20
SSD-13	38	45.33	30^{ABc}	22	22.67	33.33	12	10.67	10.67
SSD-17	53.33	43.33^{c}	37.33^{A}	29.33	36	25.33	13.33	17.33	5.33
SSD-18	56	60	40.67^{A}	37.33	32	45.33	12	24^{C}	9.33
SSD-20	45.33	56	52^{A}	45.33	45.33	44	13.33	14.67	12
SSD-27	54.67	54.67	50.67^{A}	35.33	40	45.33	8	18.67	5.33
SSD-39	54	55.33	45.33^{A}	33.33	32	38.67	12	18.67	12
SSD-46	44.67	52	47.33^{A}	36	46.67	34.67	12	22.67	10.67
SSD-51	58	63.33	56.67^{A}	37.33	58.67	46.67	14.67	16	14.67
SSD-54	42	38.67^{c}	31.33^{ABc}	24	28	21.33	16	10.67	16
SSD-75	34	38^{c}	40^{A}	24	32	22.67	14.67	8	9.33
SSD-82	44.67	58.67	68.67^{B}	53.33	46.67	41.33	25.33	22.67	17.33
SSD-91	52	54.67	52^{A}	30.67	44	41.33	22.67	18.67	8
SSD-102	43.33	55.33	50^{A}	30	36	34.67	16	16	8
SC-39-1	72	54.67	52^{A}	62^{BC}	86.67^{ABC}	66.67^{C}	78.67^{ABC}	82.67^{ABC}	53.33^{ABC}
SC-68-2	50	36^{c}	41.33^{A}	24.67	29.33	26.67	25.33	14.67	9.33
GC-74-7	45.33	26^{c}	16^{ABc}	17.33^{ac}	38.67	25.33	21.33	14.67	12
Cikuray	54.67	54	52^{A}	41.33	36	42.67	16	20	20
Malika	57.33	46.67	41.33^{A}	34.67	34.67	40	16	17.33	6.67
Wilis	54.67	64.67	51.33^{A}	40	38.67	30.67	17.33	9.33	10.67
F-value	3.01**	4.24**	7.29**	4.82**	4.0^{1**}	2.78*	15.45**	21.15**	4.57**
KK	18.14	16.54	16.95	24,35	29.53	29.61	33.18	24.96	61.66

Note : * = significant defferent at α = 5 %, ** = significant defferent at α = 1 %, ^{tn}= non significant, a = less significant different than Cikuray, b = less significant different than Malika, c = less significant different than Wilis, A = less significant different than Cikuray, B = less significant different than Malika, C = less significant different than Wilis based on Dunnett test at α = 5 %

Electrical conductivity in the storage period of 4 weeks is 13–35 µS cm-1 g-1. Electrical conductivity of the lowest in the storage period of 4 weeks is owned by SSD-10 strains and varieties Cikuray with a value of less than 16 µS cm-1 g-1. Electrical conductivity continues to increase along with the increase in seed storage period. Electrical conductivity in the storage period of 12 weeks reached 26–60 µS cm-1 g-1 The higher the value of electrical conductivity shows the membranes damagemore severe damage. Rated electrical conductivity is inversely related to seed vigor. The higher the value of the electrical conductivity of the lower seed vigor. The electrical conductivity have a negative correlation to germination, growth rate of seedling and vigor index (Figure 1) This shows that the higher the electrical conductivity of the germination, growth rate and vigor index become lower. The electrical conductivity can be used as a character selection on seed vigor.

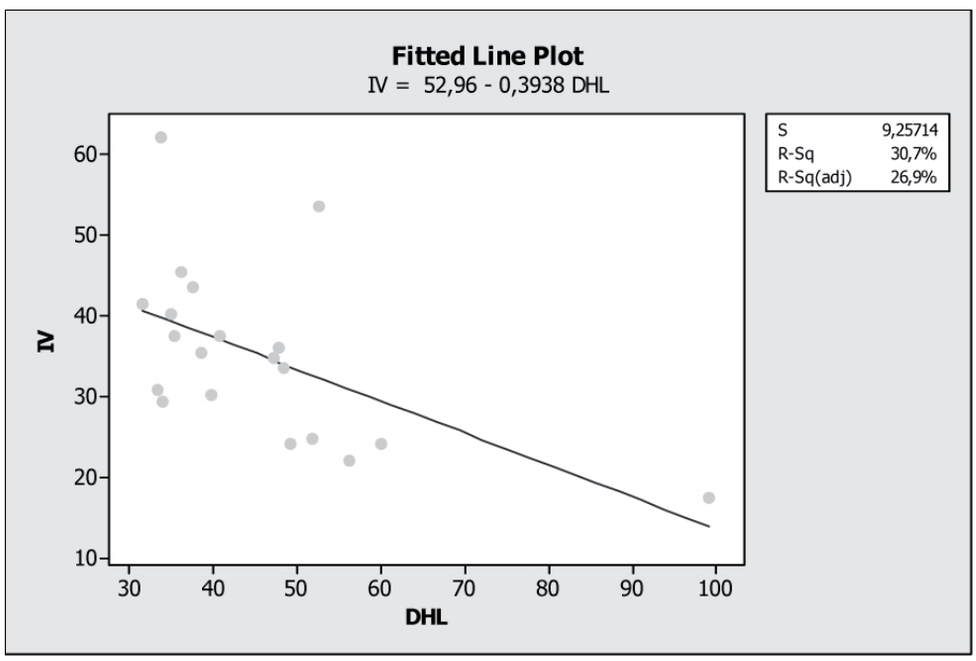

Figure 1. The correlation between electrical conductivity with vigor index

Variation and Heritability of storabillity parameter of some black soybean lines

Based on percentage of mean square, seed germination percentage, maximum potential growth and electrical conductivity has the highest mean square percentage in the storage period of 16 weeks among the parameters observed. It means that mean difference of the parameters among lines evaluated mostly caused genotype factors. All the parameters observed showed a high heritability (Table 6). Seed storability parameters are not only affected by environment, but also affected by genetic factor so that the parameter will be heritable from parents to progeny.

Tabel 6. Heritability of storability parameters of black soybean lines after 16 weeks storage periode under room temperature conditions

Parameter	σ^2e	σ^2p	σ^2g	h^2_{bs} (%)	Criteria
Seed germination	138.31	158.58	112.81	71.14	High
Potensial growth	86.83	99.84	70.89	71.004	High
Growth rate	12.99	19.09	14.76	77.32	High
Vigor Index	72.89	117.21	92.92	79.27	High
conductivity	216.36	242.26	170.14	70.23	High

Keterangan :High Heritabiliy (h^2_{bs}>50), medium (20 ≤ h^2_{bs} ≤50), low (h^2_{bs}≤20)

Seed storability an important trait for agronomic aspects because it has a correlation with high seed germination and seedling vigor. Kazmi *et al.* (2012) reported that seed traits are quantitative and genetically complex. One traits Germination percentage (GP) was used to determine the degrees of seed storability.

It is very possible to make an effort for breeding program of high storability soybean seed. Selection process is important step in breeding program. To obtain satisfied genetic progress after the selection, it is necessary to determine the method and criteria for proper selection. Seed germination percentage, maximum potential growth and electrical conductivity could be used as a single trait selection or multiple traits selection.

CONCLUSION

Parameters of quality seeds of black soybean lines are influenced by genetic factors, namely seed germination percentage, maximum potential growth, growth rate of seedling, vigor index and electrical conductivity. All parameters of quality seeds have a high heritability ie germination, maximum potential growth, growth rate, vigor index and electrical conductivity with heritability of more than 70% . Seed germination percentage, maximum potential growth and electrical conductivity could be used as a single trait selection or multiple traits selection. SSD-20 SSD-82 and SC-39-1 had are two the best black soybean lines for storability parameters.

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