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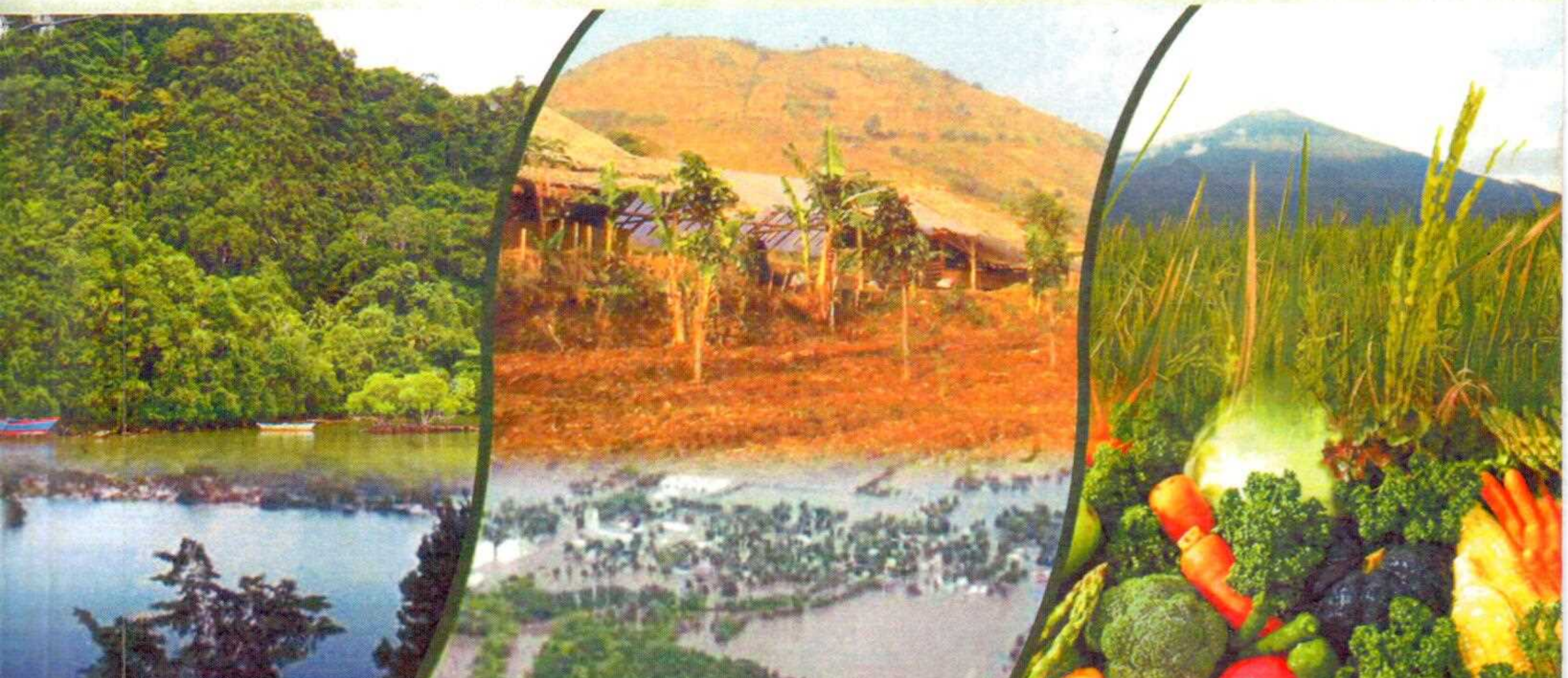

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HYBRID VIGOR OF CROSSING AMONG JAPANESE AND INDONESIAN SOYBEAN

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ABSTRACT

The magtitude of hybrid vigor is normally presented in term of heterosis (H, superiority of the F_1 hybrid over than its parental mean) and heterobeltiosis (Hb, superiority of the F_1 hybrid over its better parent). The data were collected on averaged seed yield/plant, number of pod/plant, number of seed/plant, 100 seed weight, number of fertile node in main stem/plant, and plant height. Several cross showed heterosis over than the mid parent and better parent. Crosses showing heterosis for seed yield/plant also showed heterosis for number of pod/plant, number of seed/plant (UNEJ-1xKaohsiung). However, only Kaohsing x Malabar, and Malabar x UNEJ-2 for seed yield/plant expressed heterobeltiosis.Superiority over the mid parent for seed yield/plant ranged from 3% to 31%, and that over the better parent ranged from 2% to 58%. The highest heterosis over the mid parent was Malabar x UNEJ-2 and better paret was shown in the cross Kaohsing x Malabar. The best three hybrid selected for next generation selection (breeding for high yielding and early maturity) were *Kaohsiung*-3 x Malabar, Malabar x UNEJ-2, Malabar x *East of Java*-2. In self pollinated crops, hybrid seed can be produced using a male sterile line as a female parent. The detected seed yield heterosis must be reasonably high to compensate for cost of seed production.

Key word: Heterosis, Heterobeltiosis, soybean, hybrid vigor

INTRODUCTION

Soybean, *Glycine max*, L. Merrill was a crucial source of protein in Indonesia. Soybean is a crop with a harvest ripe age between 70 to 85 days. The increase results mainly from an increase in harvest area. Increases in productivity result not easily achieved through an increase in acreage planted. The use of hybrid cultivars can increase the power limitations of the results of pure line cultivars. Hybrid varieties have contributed greatly to the increased production of various crops, including major food crops such as rice and corn. Commercial exploitation of heterosis is one of the strengths and extensive development on seed production. Heterosis breeding for results has been conducted on various crops, including cross-pollinated plants, and plant species at self-pollinated plants.

Exploitation of heterosis to increase productivity in legume seeds, as well as in other plants, relies on three main factors: (1) the amount of heterosis, (2) the feasibility to produce hybrid seeds for large-scale production, and (3) type action of existing genes. Heterosis could improve yield, size, and number of plant parts, component-chemical components, and nature's resistance to disease. The hybrid is a type of crop produced from the merger of gametes is not the same as or derived from pairs of genes heterozygote for certain characters.

Heterosis and heterobeltiosis expressed in percentage without going through the tests of significance. If the standard error associated with each value was high, the high heterosis may be statistically not significant different, thus the data obtained did not meet the requirements of seed companies that produce commercial hybrid seed. The main obstacle to the utilization of heterosis in soybean is a crop that kleistogami properties, making it difficult in a crossover. If there is male sterility in plants (male sterile), then the utilization of heterosis will be easier. Potential heterosis in crosses between male and female parent would be better if the kinship between the two elders is increasingly distant. This is associated with the mechanism of heterosis due to the heterozygote alleles in hybrid offspring (F1). In this regard, the researcher tried to cross between Indonesian soy with soy Japan.

Based on the results of the study was first (Poerwoko *et al.*, 1998) have been obtained soybean genotypes Unej Unej-1 and-2 are high yielding and properties of soybean leaf rust resistance are moderate.

MATERIALS AND METHOD

The material used is the five soybean: (1) Unej-1, (2) Unej-2, (3) Variety Malabar, (4) Japanese Soybean cultivar Ryokkoh, R-75), (5) cultivar Kaohsiung-3, and (6) cultivar East of Java-2.

Genotype Unej-1 and Unej-2 is soybean germplasm of high yielding, rust resistant obtained from previous studies (Poerwoko, *et al.*, 1998). Malabar varie-ties are a source germplasm early age, while the Ryokkoh, R-75, Kaohsiong-3 and the East of Java-2 are edamame cultivars with large seed size (weight of 100 seeds on top of 20g). To assemble the hybrid method is used Griffing (1956) through dialel crossing 6x6.

The formula used to determine the value of heterosis and heterobeltiosis as used by Soehendi and Srinives (2005) as follows.

Significance testing of heterosis

For each F_1 cross, percent heterosis (%H) and heterobeltiosis (%Hb) for a particular trait were calculated as follows:

$$\%H = \left(\overline{F}_1 - \overline{MP}\right) \times 100 / \overline{MP} \text{ , and}$$

$$\%Hb = \left(\overline{F}_1 - \overline{P}_i\right) \times 100 / \overline{P}_i,$$

Where:

$\overline{F}_1$ = mean observation of the F_1 progenies from the total of n_1 plants,

$\overline{MP}$ = mean observation of both parents from $n_2 + n_3$ plants, and

$\overline{P}_i$ = mean observation of the i^{th} parent from n_2 plants for P_1, and n_3 plants for P_2.

Significance of H and Hb were determined by a t-test as follows:

$$\text{t-test for H} = \frac{\overline{F}_1 - \overline{MP}}{S_H}, \text{ and}$$

$$\text{t-test for Hb} = \frac{\overline{F}_1 - \overline{P}_i}{S_{Hb}},$$

where S_H and S_{Hb} are the standard error of estimates of H and Hb which can be derived as shown in the attached note.

The degree of freedom (*df*) for each test was obtained by summing up the *df* of each generation involved in the estimate. Thus, the *df* for testing H is $(n_1-1)+(n_2-1)+(n_3-1)$, and the *df* for testing Hb is $(n_1-1)+(n_i-1)$, $i = 2$ or 3, depending on whether the high parent is P_1 or P_2.

Derivation (offspring) from the use of formulas and Heterobeltiosis Heterosis in accordance with the criteria according to Soehendi and Srinives, 2005, as follows

Note on derivation method for S_H and S_{Hb}.

$$H = \overline{F}_1 - \frac{(\overline{P}_1 + \overline{P}_2)}{2},$$

$$= \overline{F}_1 - \frac{\overline{P}_1}{2} - \frac{\overline{P}_2}{2}.$$

Using the property of expectation (Steel and Torrie, 1980; Chapter 5, topic 5.10) then,

$$\text{Variance of H} = \text{Var}\left(\overline{F}_1 - \frac{\overline{P}_1}{2} - \frac{\overline{P}_2}{2}\right),$$

$$= V\overline{F}_1 + \frac{V\overline{P}_1}{4} + \frac{V\overline{P}_2}{4},$$

(assuming no covariation between generations),

$$= \frac{VF_1}{n_1} + \frac{VP_1}{4n_2} + \frac{VP_2}{4n_3},$$

$$= \frac{SSF_1}{n_1(n_1-1)} + \frac{SSP_1}{4n_2(n_2-1)} + \frac{SSP_2}{4n_3(n_3-1)},$$

Where $V\overline{F}_1$, $V\overline{P}_1$, and $V\overline{P}_2$ are the variances of the mean of each generation; and VF_1, VP_1, VP_2, SSF_1, SSP_1 and SSP_2 are variances and sums of squares of the specified generations, respectively.

Then, the standard error of estimate of H (or S_H) = $\sqrt{\text{variance of H}}$.

In the same manner, variance of Hb can be obtained from

$$\text{Variance of Hb} = \text{Var}(\overline{F}_1 - \overline{P}_i),$$

$$= \frac{VF_1}{n_1} + \frac{VP_i}{n_i} = \frac{SSF_1}{n_1(n_1-1)} + \frac{SSP_i}{n_i(n_i-1)},$$

and $S_{Hb} = \sqrt{\text{variance of Hb}}$.

RESULTS AND DISCUSSION

Observations for six agronomic properties elders, F_1 and F_1 reciprocal presented in Table 1 below.

Table 1. Yield and Yield Component of Agronomic Characters F_1 and Six Parents

No.	Genotype	Seed Yield Per Plant (g)	∑ pod Per Plant	∑ Seed Per Plant	100 Seed Weight	∑ Fertile Nodes	Plant height (cm)
1	UNEJ-1 (1)	4.95±1.14	60.31±18.53	54.00±21.25	8.55±0.00	8.00±3.08	49.50±8.93
2	UNEJ-2 (2)	3.18±0.87	35.04±10.85	43.20±19.57	8.16±0.00	9.60±2.73	53.76±6.97
3	Malabar (3)	8.27±2.50	72.75±13.50	105.50±54.43	9.25±0.00	11.50±1.66	51.38±7.44
4	Ryokkoh (4)	10.08±1.37	28.25±9.52	38.75±14.15	24.98±0.00	7.75±2.49	27.6±9.15
5	Kaohsiung 3 (5)	8.57±2.31	31.94±6.32	36.00±13.66	19.57±0.00	6.75±0.83	32.23±4.15
6	East of Java 2 (6)	10.04±2.96	24.44±1.55	32.22±6.28	25.30±0.01	5.33±1.70	28.80±17.13
7	1 x 2	3.93±0.48	60.12±19.88	31.79±9.22	5.09±0.00	13.45±4.55	80.5±6.5
8	1 x 4	10.24±0.00	74.00±0.00	144.00±0.00	8.28±0.00	13.00±0.00	69.00±0.00
9	1 x 5	7.57±2.12	42.95±2.95	75.81±7.67	11.89±0.00	8.75±0.43	56.08±10.57
10	2 x 6	2.65±0.00	100.00±0.00	70.00±0.00	3.79±0.00	15.00±0.00	85.00±0.00
11	3 x 1	5.72±1.45	121.56±30.94	81.2±24.5	10.30±0.00	12.80±1.17	74.61±6.91
12	3 x 2	**12.74±1.65**	86.75±6.94	112.25±22.57	12.17±0.00	9.75±0.43	63.00±13.97
13	3 x 6	**13.93±1.11**	95.44±7.67	178.33±31.26	11.05±0.00	15.33±1.25	59.24±4.08
14	4 x 2	6.57±1.93	43.56±15.35	32.89±7.34	21.21±0.00	6.40± 0.49	38.60±6.31
15	4 x 5	1.45±0.40	29.50±5.50	31.25±3.75	5.26±0.00	6.50±0.00	44.00±4.00
16	4 x 6	11.40±1.83	41.00±6.00	61.13±3.88	19.34±0.01	9.50±0.50	29.70±1.80
17	5 x 1	4.39±1.13	22.00±4.32	21.81±5.31	18.68±0.01	5.00±0.82	28.89±4.32
18	5 x 3	**13.55±0.00**	35.00±0.00	65.00±0.00	27.00±0.00	9.00±0.00	31.50±0.00
19	5 x 4	4.22±0.67	33.92±3.60	28.28±3.36	16.19±0.00	6.80±0.75	41.28±1.57
20	5 x 6	7.33±1.32	36.68±15.29	27.95±4.21	26.57±0.00	6.80±0.40	38.67±2.14
21	6 x 3	9.72±1.25	35.88±1.87	40.84±11.26	26.47±0.05	7.20±0.40	35.61±5.10
22	6 x 4	7.67±1.65	31.72± 6.02	33.81±10.01	24.10±1.43	7.25±1.09	32.33±5.29

Weight of seeds per plant for Unej-1, Unej-2, Malabar, Ryokkoh (R-75), Kaohsiung-3, and East of Java-2, respectively, 4.95, 3.18, 8.27, 8.10; 8:57, and 10:04 g / plants. Kaohsiung-3 x Malabar (15%), and Malabar x East of Java-2 (13%). Hybrids Malabar x Unej-2, besides having a mean value of heterosis based on both parent is high (31%), supported also by the value of heterosis pods per plant number (15%), number of seeds per plant (13%), weight of 100 seeds (10%) and plant height 5%). As for the nature of the number of fertile book, it turns out heterosis value (-2%), but this trait proved to have different degrees of closeness unreal Table 4, r = 0.093ns. F1 and reciprocal F1's best in a row is Malabar x East of Java-2 (13.93 g / plant), Kaohsiung x Malabar (13:55 g / plant), and Malabar x Unej-2 (12.74 g / plant). Furthermore, Table 2 presents the value of heterosis based on the average of the two mid-parents.

Table 2. *Heterosis* (%) Above Mid-Parent Several Crossing for Six Agronomic Character

No	Recombinants	Seed Yield Per Plant (g)	∑ pod Per Plant	∑ Seed Per Plant	100 Seed Weight	∑ Fertile Nodes	Plant height (cm)
1	1 x 2	-0.01	0.07	-0.09	-0.10	0.13	0.14
2	1 x 4	0.09	0.17	0.53	-0.13	0.16	0.20
3	1 x 5	0.07	-0.02	0.17	-0.04	0.05	0.09
4	2 x 6	-0.15	0.59	0.21	-0.19	0.25	0.26
5	3 x 1	-0.03	0.21	0.00	0.04	0.08	0.12
6	3 x 2	0.31	0.15	0.13	0.10	-0.02	0.05
7	3 x 6	0.13	0.24	0.40	-0.09	0.21	0.12
8	4 x 2	0.00	0.09	-0.05	0.07	-0.07	-0.01
9	4 x 5	-0.21	0.00	-0.04	-0.19	-0.03	0.12
10	4 x 6	0.03	0.14	0.18	-0.06	0.11	0.01
11	5 x 1	-0.09	-0.13	-0.13	0.08	-0.08	-0.07
12	5 x 3	0.15	-0.08	-0.02	0.22	0.00	-0.06
13	5 x 4	-0.14	0.03	-0.05	-0.07	-0.02	0.09
14	5 x 6	-0.05	0.08	-0.05	0.05	0.03	0.07
15	6 x 3	0.04	-0.07	-0.10	0.13	-0.04	-0.03
16	6 x 4	-0.06	0.05	-0.01	-0.03	0.00	0.04
	Average	0.00	0.09	0.07	-0.01	0.05	0.07
	Stand Dev.	0.12	0.16	0.18	0.11	0.10	0.09

1 = UNEJ-1; 2 = UNEJ-2; 3 = Malabar; 4 = *Ryokkoh* (R-75); 5 = Kaohsiong-3 (KS-3); 6 = *East of Java*-2 (EO-2)

Table 3. Yield and Yield Component of Agronomic Characters F_1 and Six Parents Presents (Table 1), the heterosis (Table 2) and the value heterobeltiosis in Table 3), and the value of the correlation between the six agronomic trait Table 4), then it can be determined at least one crossing who will be able to proceed to the assembly of new soybean varieties. Three hybrid combinations for each agronomic trait values in Table 3 indicated in bold (bold). Three hybrids with the highest value on heterobeltiosis best trait grain yield per plant, respectively, Kaohsiong-3 x Malabar (58%), Malabar Unej-2 (54%), and Malabar x East of Java-2 (39%).

Table 3. *Heterobeltiosis* (%) Six Agronomic Character Based on High Parent Several Crossing

No	Recombinants	Seed Yield Per Plant (g)	Σ pod Per Plant	Σ Seed Per Plant	100 Seed Weight	Σ Fertile Nodes	Plant height (cm)
1	1 x 2	-0.21	0.00	-0.41	-0.40	0.40	0.50
2	1 x 4	0.02	0.23	0.85	-0.03	0.63	0.39
3	1 x 5	-0.12	-0.01	0.40	-0.39	0.09	0.47
4	2 x 6	-0.74	1.85	0.62	-0.85	0.56	0.58
5	3 x 1	-0.31	0.67	-0.23	0.11	0.11	0.45
6	3 x 2	0.54	0.19	0.06	0.32	-0.15	0.17
7	3 x 6	0.39	0.31	0.69	-0.56	0.33	0.15
8	4 x 2	-0.35	0.24	-0.24	-0.15	-0.33	-0.28
9	4 x 5	-0.86	-0.08	-0.19	-0.79	-0.16	0.36
10	4 x 6	0.13	0.45	0.58	-0.24	0.23	0.03
11	5 x 1	-0.49	-0.64	-0.60	-0.05	-0.38	-0.42
12	5 x 3	0.58	-0.52	-0.38	0.38	-0.22	-0.39
13	5 x 4	-0.58	0.06	-0.27	-0.35	-0.12	0.28
14	5 x 6	-0.27	0.15	-0.22	0.05	0.01	0.20
15	6 x 3	0.13	-0.51	-0.61	0.05	-0.37	-0.31
16	6 x 4	-0.24	0.12	-0.13	-0.18	-0.06	0.12
Average		-0.15	0.16	-0.01	-0.19	0.04	0.15
Stand Dev.		0.41	0.55	0.46	0.34	0.31	0.32

1 = UNEJ-1; 2 = UNEJ-2; 3 = Malabar; 4 = *Ryokkoh* (R-75); 5 = Kaohsiong-3 (KS-3); 6 = *East of Java-2* (EO-2)

Table 4. Correlation Matrix among Six Agronomic Characters

Agronomic Characters	Seed Yield/ Plant (g)	Pod/ Plant	Seed/ plant	100 Seed Weight (g)	Fertile Nodes	Plant Height (cm)
	1	2	3	4	5	6
1	1.000	-0.223 ^{ns}	0.510 *	0.478^{ns}	0.093^{ns}	-0.223^{ns}
2		1.000	0.698**	-0.606 *	0.836**	0.813**
3			1.000	-0.402^{ns}	0.693**	0.533 *
4				1.000	-0.637**	-0.803**
5					1.000	0.800**
6						1.000

Table r (5%, db. n-2 = 0.497), r (1%, db. n-2 = 0.623) ns: *non significance difference* *: *significance difference* **: *highly significance difference*

Resume based on the results and discussion of Tables 1, 2, 3, and 4 are presented Table 5 as follows. On the basis of Table 5, the three best hybrids can proceed to further study, which is assembling a new high yielding soybean cultivars are Kaohsiung-3 x Malabar, Malabar x Unej-2, the Malabar X-2 East of Java.

Table 5. Crossing Combination, Rating of Three Best Hybrids Performance Based on Agronomic Properties, Heterosis Value, Value Heterobeltiosis, Total Score, and Hybrids Selected

Crossing Combi-nation	Agronomic Performance	The Best Crossing		Total Score	Rank of Selected Hybrids
		Heterosis	Heterobeltiosis		
3 x 6	1	3	3	7	3
5 x 3	2	2	1	5	1
3 x 2	3	1	2	6	2

CONCLUSION

Based on research results and discussion, it can be deduced conclusions as follows.

1. Vigor of three best hybrids on the basis of mid parent is Malabar x Unej-2, Kaohsiung-3 x Malabar, and the Malabar x East of Java-2. While the basis of the best parent are Kaoh-siong-3 x Malabar, Malabar x Unej-2, and Malabar x East of Java-2.
2. Ranked of three hybrids are selected for use as material for the assembly of new high yielding soybean varieties are the Kaohsiung-3 x Malabar, Malabar x Unej-2, the Malabar x East of Java.

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