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THE SOYBEAN (*Glycine max* L) GENETIC PARAMETERS OBTAINED BY A SINGLE CROSSING THREE VARIETIES ON F2 GENERATION

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ABSTRACT

This study was conducted to determine the genetic parameters and selective traits of soybean that can be used in the single crossing of three different female parental varieties with the same male parent. Furthermore, this study was conducted between September and November 2020 on the Raya Usang agricultural land, which was located at the Dolog Masagal in Simalungun District with an altitude of 1,090 m above sea level. An augmented design was used in this study, which involved the crossing of three F2 lines, as well as the four parents. The plot size had a dimension of 10mx50m, with a spacing of 20cmx30cm. There were about 200 F2 seedlings and four elders containing 100 plants each, which were fertilized and maintained as needed. The data collected on each individual plant were analysed to determine the genetic diversity, coefficient of genetic, genetic progress, the predictive value of broad meaning heritability, and the correlation between the observed characters. The character selection was determined using about twenty genotypes from the F2 generation depending on the increase in heritability and KGH values, as well as the significant correlation between characters.. The results showed the value of heritability and expected genetic progress (EGP) F2 (Grobokan x Tanggamus, Anjasmoro x Tanggamus and Argomulyo x Tanggamus) was high while phenotypic correlation of quantitative characters of generation F2 (Grobokan x Tanggamus, Anjasmoro x Tanggamus and Argomulyo x Tanggamus) to all the characters observed has a real and high positive value.

Key words: cross, genetic, heritability, varieties

INTRODUCTION

Generally, the breeding technique for the soybean plant is based on the genetic diversity and selective traits in the plant population during the crossing of two or more parents. Natural and artificial crossing is one method for increasing the genetic diversity, particularly in self pollinating plants, such as soybeans (Hakim and Suyamto, 2015).

Plant breeding program aims to provide superior varieties. Superior varieties can be obtained by doing a cross artificial and repeated selection. A cross artificial is an activity aimed a cross was done with the parents desired. A cross artificial is expected to produce a population large enough viability with genetic selection can be conducted freely and may provide a genetic progress as expected (Wahyu and Susanto, 2021).

A cross artificial is one way to get the acid soil adaptive soybean varieties. Based on the absence of acid soil adaptive varieties and low temperatures so there needs to be conducted soybean crossing at a high land that might get acid soil adaptive varieties in the highland. The highlands of having traits acid soil and low temperatures so as to get maximum growth and the production of soybeans. There is very difficult because of the growing condition soybean plant is that around pH soil 5,5-6 and long duration only about 6-8 hours per days (Le and Pham, 2021)

Generations of the results of a cross artificial grown for selected, until obtained the furthermore generation next. The improvement of the nature of the strains would be effective if done selection so that effective selection so needed genetic parameters. Selection is done on a character will be beneficial if diversity of the character is a reflection of its diversity of genetically, so that selection will give you a big genetic progress (Buhaira *et al.*, 2014)

Krisnawati and Adie (2016), Said that genetic diversity available in the population is one of the requirements watercourse to determine the success improvement soybean varieties.Varieties with the trait of being superior can be obtained through breeding plant with selecting on germplasm which has been available or selected in the segregant population.

Genetic diversity were identified with supervise the genetic parameter. Parameter genetic as heritability, genetic diversity and coefficients genetic diversity is part of parameter genetic that is badly needed to determine character selection that obtained genotypes desired (Sulistyowati *et al.*, 2016). Besides genetic parameters, a correlation coefficient also used to determine character selection if the relationship between two variables.

Neelima et al., (2018), said that the genetic diversity value and heritability are useful parameters for estimating the expected value of the genetic progress in the selection. Therefore, there may be a high degree of genetic progress during the cross between the F2 population of three female parents, including Anjasmoro, Argomulyo, and Grobokan with a male Tanggamus parent when the traits involved also have a high genetic diversity and heritability. Subsequently, this is expected to produce high genetic progress for several agronomic characters observed in the study based on the previously established selections.

This cross study aimed to obtain genetic parameters and selective traits that could be used in three single crossing of Grobokan x Tanggamus, Argomulyo x Tanggamus, and Anjasmoro x Tanggamus in the highlands. We used Grobokan, Argomulyo and Anjasmoro as female parent because the third varieties have been big seeds but not resistant in acid soil, while Tanggamus as male parent because resistant in acid soil but has been small seeds .

MATERIALS AND METHODS

The study was conducted between September and November 2020 on the Raya Usang forest located at Dolog Masagal Sub-district in Simalungun District at an altitude of 1090 m above sea level. Furthermore, an augmented design was employed in this study, which involved the triple replication of the parent, including Argomulyo, Grobokan, Anjasmoro, and Tanggamus, in place of the F2 generations.

The plots had a dimension of 20cm x 30cm and included three F2 crosses of Grobokan x Tanggamus, Anjasmoro x Tanggamus, and Argomulyo x Tanggamus from four parents, which were Grobogan, Anjasmoro, Argomulyo, and Tanggamus with a spacing of 10 m x 50 m. In August 2018, three crosses were performed, which involvd Anjasmoro with Tanggamus, Grobokan with Tanggamus, and Argomulyo with Tanggamus. According to the soybean variety descriptions, the Argomulyo variety can grow optimally up to 400 m above sea level, while Tanggamus as the parent (check) can grow optimally up to 1000 m above sea level (Arsyad, Adie and Kuswantoro, 2007)

The plant materials used were 200 F2 seeds obtained from the crosses between Anjasmoro x Tanggamus, Grobokan x Tanggamus, and Argomulyo x Tanggamus. Four parent plant varieties were also involved, which include Argomulyo, Grobokan, Anjasmoro, and Tanggamus, each with 100 plants. Fertilization

was done at the time of planting using Urea, SP36, and KCl/ha dose at 50 kg, 100 kg, 75 kg, respectively. Plant maintenance entails performing irrigation, weeding, pest, and disease control as needed. The data observed for each individual plant was analysed to determine the genetic diversity, genetic progress, the estimated value of broad sense heritability (h^2), and the correlations between observed characters. The values of genetic variance, CGD, and broad-sense heritability were calculated using Singh and Chaudary's formula (Singh and Chaudhary, 1979)

The formula for caluclating heritability values:

$$\mathbf{h^2_{bs} = (\sigma^2\ g)/\ (\sigma^2\ p)}$$

Description:

h^2_{bs} : heritability broad sense
σ^2 g : genetic variety
σ^2 p : phenotypic variety

The criteria for heritability values in a broad sense were consistent with the conditions proposed by Singh and Chaudry as follows: $h^2 <$ 0.20 = low heritability $0.20 < h^2 > 0.50$ = moderate heritability $h^2 > 0.50$ = high heritability.

The formula for calculating the CGD value:

$$= \frac{\sqrt{\sigma^2\ G}}{\overline{X}} \text{ x } 100\%$$

Description:

CGD : Coefficient of Genetic Diversity
σ^2G : square root of the genotypic variance
$\overline{X}$: average value

According to Knight (1979), the CGD criteria between 0-10% is narrow, while between 10-20% is medium and > 20% is broad.

According to Falconer (1964), the value of the genetic progress value can be calculated using the formula:

$$\mathbf{EGP = i.\ h^2_{bs}.\ \sigma_p \text{ or } \%\ EGP = \frac{EGP}{\mu} \text{ x } 100\%}$$

Description:

EGP : expected genetic progress
i : selection intensity (20%= 1.40)
h^2_{bs} : heritability broad sense
σ_p : standard deviation
μ : average value (Fehr 1988)

The selection criteria can be divided into four categories, which include low, moderately low, moderately high and high under the following conditions 0 < EGP <3.3% is low, 3.3% < EGP < 6.6% is slightly low, 6.6% < EGP < 10% is high enough and EGP > 10% is high.

The plant population with the highest total number of pods and the heaviest seed weight for planting can be used as the most significant selection character. Additionally, 20 genotypes can be selected from each F2 generation, depending on the degree of the heritability and EGP values, as well as the significant correlation value. Agronomic characteristics were observed by measuring plant height, flowering age, total number of productive branches, harvest age, total number of pods planted, weight of seeds planted, and weight of 100 seeds.

RESULTS AND DISCUSSION

Single crosses on three different varieties with the same male parents produced different genetic variance, coefficient of genetic diversity (CGD), and heritability values between the F2 generations of the three crosses. Table 1 showed that the F2 generation CGD values from the Grobokan x Tanggamus cross had high criterion values for all observed characters except harvest age, while the F2 generation from the Argomulyo x Tanggamus and the Anjasmoro x Tanggamus had low CGD values on the flowering age and harvest age characters.

There may be an increase in the CGD value during the crossing between the F2 generation of Grobokan x Tanggamus because genetic factors can greatly affect the appearance of the characters. Meanwhile, there may be a

decrease in the age-flowering character due to the greater influence of environmental factors over genetic factors. According to Hakim & Suyamto (2015), there was a high coefficient of genetic diversity because the expression of genetic factors was more dominant due to the low influence of environmental factors on the appearance of the observed characters.

The high heritability value is caused by a relatively uniform environment and greater genetic variability than environmental variability (Puspita Anwar, Sofia Hanafiah and Sartini Bayu, 2019). There was a difference in the heritability values of all the observed characters for the three crosses. The most observed character with the highest heritability criteria value was discovered in the F2 line from the Grobokan and Tanggamus crosses, while only the harvest age characters had moderate heritability criteria. The observed character heritability values, including high criteria, could be attributed to the F2 population's maximum segregation level. High heritability values for the observed characters indicate that selection for these characters can be carried out efficiently (Barmawi, Yushardi and Sa, 2013). The same with the opinions Amien et al (2021) said that characters have broad value genetic variance, high value heritability, and the value of genetic gains can be used as the selection character.

The F2 line from Anjasmoro and Tanggamus crosses had a low criterion heritability value for the total number of branches, total number of pods, and harvest age. The total number of branches, total number of pods, and harvest age of the F2 line of Anjasmoro and Tanggamus crosses were more dominantly controlled by environmental factors than genetic factors, implying that character improvement could be accomplished through selection.

Table 3 shows the expected value of genetic progress in the F2 generation of Anjasmoro and Tanggamus crosses, with only the total number of branches and pods included in the high criteria and the other characters included in the low criteria. This demonstrates that there is no increase in character observed in the F2 generation, implying that selection should be carried out in the subsequent generation (Widyawati, Yulianah and Respatijarti, 2014)

The expected genetic progress value in the F2 generation of Anjasmoro and Tanggamus crosses and the F2 generation of Grobokan and Tanggamus crosses was high for the total number of pods, seed weight, total number of branches, flowering and harvesting ages. This demonstrates that there is a chance to improve these character traits through selection (Wulandari and Yulianah, 2016)

The correlation between the characters observed in the three crosses revealed a significant relationship between the total number of pods planted and the weight of seeds planted in the cross's three F2 generations. Selection can be made using the total number of pods planted and seed weight as selection characters, based on the significant relationship between the total number of pods planted and seed weight. Tables 4, 5, and 6 show the correlation values for all characters observed in three generations of F2 crosses.

Table 4 shows the results of the phenotypic correlation analysis of quantitative characters observed in the F2 generation of Anjasmoro and Tanggamus crosses. The correlation between the character of seed weight per plant and the total number of branches (r= 0.757*) and pods planted (r= 0.939*) was significant. This demonstrates that there is a unidirectional relationship, which means that the more branches there are, the more pods are formed per plant. If the correlation between characters is positive, it is not significant, as in the case of plant height with flowering age (r= 0.259^{tn}) and total number of branches (r=.0.246^{tn}). This demonstrates that an increase in plant height does not result in an increase in

flowering age or the total number of branches. (Krisnawati & Muchlish, 2016).

Table 5 shows the results of the phenotypic correlation analysis of the quantitative characters observed in the F2 generation of the Grobokan and Tanggamus crosses. The correlation between all observed characters is unidirectional and significant, with a high positive value. This indicates that all observed characters have a unidirectional relationship, which means that when one character increases, the other characters also increase, such as the correlation value of the total number of pods planted with positive and high seed weight per plant, indicating that the two characters have a close and unidirectional relationship, i.e. increasing the total number of pods planted will cause an increase in seed weight (Wardana, Karyawati and Makmur, 2015)

Table 6 shows the results of the phenotypic correlation analysis of quantitative characters observed in the F2 generation of Argomulyo and Tanggamus crosses. The relationship between the character of seed weight per plant and the total number of branches (r= 0.665*) and pods planted (r= 0.885*) has a real and high positive value. This demonstrates that there is a one-way relationship, which means that the more branches there are, the more pods form per plant, and also the higher the total weight of plant seeds (Sundari, 2016). If the correlation between characters is positive, it is not significant, as in the case of plant height with total number of branches (r= 0.260tn) and seed weight (r=.0.265tn). This demonstrates that an increase in plant height does not lead to an increase in the total number of branches or seed weight (Maretta *et al.*, 2021)

Based on the value of heritability and the expected genetic progress, selection can only be carried out on the F2 generation resulting from crossing Argomulyo with Tanggamus and the F2 generation crossing Grobokan with Tanggamus for the character of the total number of pods planted using the genealogical selection method, while the F2 generation resulting from crossing Anjasmoro and Tanggamus has a low heritability value for the character of the total number of pods planted (Hidayat *et al.*, 2019). If the heritability value for the selected character is high, selection can be performed; if the heritability value is low, the selection method used is a single seed progeny selection method.

The pedigree selection method was used to select 20 genotypes based on the character of the total number of pods planted with high heritability and genetic progress values from the F2 generation resulting from a cross of Grobokan and Tanggamus. This is consistent with a previous study by Meriaty et al., (2021) and Suroso & Sodik, (2016), which revealed that there is a signficant and positive correlation between the the total number of pods per plant and the crop seed weight. Therefore, the productivity of soybean seed can be improved by increasing the total number of pods per plant.

CONCLUSION

Based on the value of heritability and expected genetic progress (EGP) F2 (Grobokan x Tanggamus, Anjasmoro x Tanggamus and Argomulyo x Tanggamus) was high while phenotypic correlation of quantitative characters of generation F2 (Grobokan x Tanggamus, Anjasmoro x Tanggamus and Argomulyo x Tanggamus) to all the characters observed has a real and high positive value. There was a significant correlation between the characteristics, indicating that the total number of pods planted was dependent on the F2 generation of Grobokan x Tanggamus as selected character for next generations.

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Tables

Table 1. Genetic Varieties (σ^2G) and Coefficient of Genetic Diversity (KKG) in Generation F2 Three Crosses

Character	F2 (A x T)			F2 (AJXT)			F2 (GxT)		
	(σ^2g)	KKG (%)	Criteria	(σ^2g)	KKG (%)	Criteria	(σ^2g)	KKG (%)	Criteria
Plant height	75,99	15,02	High	316,9	25,9	High	311,93	257,05	High
Total of branch	0,36	31,42	High	0,41	23,27	High	1,26	407,19	High
Total of pods	334	65,24	High	265,05	24,44	High	1550,78	591,20	High
Flower age	0,25	1,47	Low	1,27	3,2	Low	0,78	25,09	High
Harvest age	1,33	1,37	Low	1,35	0,07	Low	0,37	0,71	Low
Weight of seeds	9,35	25,19	High	64,72	36,03	High	156,95	561,05	High
Weight of 100 seeds	19,44	37,4	High	4,4	16,22	High	15,78	307,22	High

Table 2. The value of heritability in the F2 Generation of Three Crosses

Character	F2 (A x T)		F2 (AJXT)		F2 (GxT)	
	h^2	Criteria	h^2	Criteria	h^2	Criteria
Plant height	0,39	Medium	0,85	High	0,84	High
Total of branch	0,47	Medium	0,2	Low	0,64	High
Total of pods	2,4	High	0,12	Low	0,74	High
Flower age	0,26	Medium	0,92	High	0,56	High
Harvest age	3,15	High	0,07	Low	0,27	Medium
Weight of seeds	0,35	Medium	0,29	Medium	0,71	High
Weight of 100 seeds	0,92	High	0,22	Medium	0,80	High

Table 3. The value of the Expected Genetic Progress (EGP) in the three crosses of the F2 Generation

Character	F2 (A x T)		F2 (AJXT)		F2 (GxT)	
	% KGH	Criteria	%KGH	Criteria	%KGH	Criteria
Plant height	0.13	Low	2.99	Low	1.57	Low
Total of branch	10.28	High	17.02	High	11.57	High
Total of pods	14.10	High	18.69	High	13.09	High
Flower age	0.01	Low	23.38	High	32.81	High
Harvest age	0.03	Low	75.70	High	16.86	High
Weight of seeds	0.21	Low	3.71	Slightly low	11.02	High
Weight of 100 seeds	0.50	Low	9.48	High enough	1.20	Low

Table 4. Phenotypic Correlation of Quantitative Characters of Generation F2 Results of Crossing Anjasmoro and Tanggamus

Character	TT	UB	JC	UP	JPTN	BBTN	B100
TT	1	0.259^{tn}	0.246^{tn}	0.359*	0.276^{tn}	0.265^{tn}	0.011^{tn}
UB		1	0.781*	0.544*	0.853*	0.838*	0.462*
JC			1	0.522*	0.876*	0.757*	0.476*
UP				1	0.639*	0.667*	0.378*
JPTN					1	0.939*	0.589*
BBTN						1	0.634*
B100							1

Description: TT=Plant Height, UB= Flowering Age, JC= Total of Branches, UP= Harvest Age, JPTN= Total of Pods/Plant, BBTN= Weight of Seed/Plant, B100= Weight of 100 seeds

Table 5. Phenotypic Correlation of Quantitative Characters of Generation F2 Results of Crossing Grobokan and Tanggamus

Character	TT	UB	JC	UP	JPTN	BBTN	B100
TT	1	0.413*	0.511*	0.588*	0.585*	0.553*	0.415*
UB		1	0.847*	0.644*	0.819*	0.823*	0.595*
JC			1	0.682*	0.869*	0.887*	0.585*
UP				1	0.816*	0.790*	0.580*
JPTN					1	0.976*	0.685*
BBTN						1	0.729*
B100							1

Description: T=Plant Height, UBI= Flowering Age, JC= Total of Branches, UP= Harvest Age, JPTN= Total of Pods/Plant, BBTN= Seed Weight/Plant, B100= Weight 100 grains.

Table 6. Phenotypic Correlation of Quantitative Characters of Generation F2 Results of Argomulyo and Tanggamus Crosses

Character	TT	UB	JC	UP	JPTN	BBTN	B100
TT	1	0.354 *	0.260^{tn}	0.308*	0.481*	0.265^{tn}	0.185^{tn}
UB		1	0.624*	0.238^{tn}	0.814*	0.757*	0.703*
JC			1	0.243^{tn}	0.739*	0.665*	0.647*
UP				1	0.302*	0.215^{tn}	0.163^{tn}
JPTN					1	0.885*	0.814*
BBTN						1	0.972*
B100							1

Description: TT=Plant Height, UB= Flowering Age, JC= Total of Branches, UP= Harvest Age, JPTN= Total of Pods/Plant, BBTN= Weight of Seed/Plant, B100= Weight of 100 grains

Table 7. Selected Genotypes Based on the Total number of Planted Pods

No Genotype	Total Pods/Plants
Grb/Tgm-F2-17	253
Grb/Tgm-F2-75	219
Grb/Tgm-F2-60	160
Grb/Tgm-F2-13	158
Grb/Tgm-F2-80	143
Grb/Tgm-F2-95	143
Grb/Tgm-F2-57	141
Grb/Tgm-F2-51	131
Grb/Tgm-F2-15	128
Grb/Tgm-F2-100	124
Grb/Tgm-F2-20	121
Grb/Tgm-F2-101	118
Grb/Tgm-F2-96	117
Grb/Tgm-F2-16	115
Grb/Tgm-F2-6	113
Grb/Tgm-F2-54	112
Grb/Tgm-F2-78	112
Grb/Tgm-F2-28	111
Grb/Tgm-F2-63	110
Grb/Tgm-F2-24	109