International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

The Genetics Parameter Estimating of Quantitative's Character to F3 Soybean Generation as the Petek X Panderman Varieties' Crossbreding in the Shades-Environment

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Abstract: ***In beneath of crops plantation and industrial plant forest's stand, has the potential for developing of soybean plants. The Development efforts such as the crossbreeding of soybean variety that shades-tolerant. The crossbred between Patek varieties and Pandeman was expect to produce the high new variety, with criteria's such as high production levels, have a lot of pods, large seed size, short stem, and tolerance to shades, because the native was tolerant to shades, have many pods, high production rates, but high trunked and small seed size. While the characteristic of native Pandeman has types such as short trunked and large seed size, but has a little pods. This Hybridize varieties has already on the stage of F2 generation, so it need to held the advanced test and selection in the F3 generation to obtained the expect soybean, which high yielding and shades-tolerant. The purpose of this study, namely, 1) to obtain the information on the growth and yield of soybean in F3 generation, the result of crossbreeding the varieties of Petek x Panderman toward the 50% paranet shades and 2) to obtain the F3 generation soybean as the result of varieties from crossbred of Petek x Pandeman that are high yield, short trunked, large seed size and shade-tolerant. The results showed that crossbreeding varieties Petek×Panderman the shaded environment has added value to increase the value of the center on the number of pods, seed weight per plant and 100 seed weight increased, the value of the vast diversity, a high value of heritability estimates found in all the character and values expected progress are strong selection on plant height***

Keywords: soybean, shades, F3 generation

1. Introduction

Soybean is one of the *phyto-protein* sources and has a protein content as much as 30-50% and fat about 10-15%. This plant is a multipurpose plant, backwardly can be used as food, and raw materials in large or small-scale industries. In Indonesia, it is included to important commodity and occupied in third ranks after rice and maize. Along by the factors of increasing the human population, the public awareness of nutritional adequacy, and the development of animal feed, soybean was continuously increasing in every year. This is directly demand for an increasing in domestic soybean production to ensure the availability of the soybean itself.

The development of the national soybean in the last five years showed the greater decline, both in terms of production and also in the wide of planting area. According to the Central of national Statistics (2013), Indonesian's soybean production in the 2009-2013 period was decrease as an average of 3.43% per year from 974,512 tons in 2009 that became about 807 568 tones in 2013, the low productivity and limited agricultural land are two main causes of the decline in soybean production. Currently the planting area in 2009 amounted about 722 791 ha became about 554 132 ha in 2013 with a decline of 23.33%. Meanwhile, the soybean productivity was only 1.3 tons per ha-1, in which in the farmer level reached about 0.6 to 2.0 tonha^{-1} and in the level of research to reached about 1.7 to 3.2 tonha^{-1} (the Agency for Food Crops Research and Development, 2008).

The Increasing of national soybean production, through the expansion of planting area programs that have great potential. One effort that can be done is by the use of the land area in under of cultivation's standing, both plants and industrial forest plantations (HTI) through the agroforestry or intercropping with annual crops programs. According to the General Directorate of Plantations (2013), the extensive of rubber plantations' areas in Indonesia in 2012 reached about 3.48 million hectares, in which 3-4% of these areas were at the immature stage (TBM) that attaint of age about 2 -3 years old. Utilization of rubber plantation maximally at the phase of this stage, became the one of solutions to increase the national soybean production, so that the domestic needs are fulfill and can it directly reduce the soybean imports.

The main obstacle of this soybean plants as the secondary crops was due to the low of light intensity because of shades factor, so it is necessary the soybean variety that adaptive and have a high yield in such conditions. the Average of light intensity was reduce by 50% in under area of cultivation's stand of three-years old rubber trees and five-year old coconut plantation, while the corn was reduced 33% from the average of light intensity in the open environment of 800 cal/cm^2 /day (Muhuria*et al.*, 2006). The gripping of shades caused 50% yield of soybean per hectare be decreased about 10-40% (Pantilu*et al.*, 2012).

The improving efforts of soybean adaptation towards of low light intensity, has been carried out through a study of physiological aspects, breeding and molecular genetics in

order the soybean plants are able to tolerance to this condition. Soverda*et al*., (2009) has conducted the research on the soybean tolerance to shade, as the solution of the problem of low light intensity. The Crossbreeding of soybean varieties that tolerant to shades has started with evaluating about 15 varieties that observed in the 50% shade paranet and in the dark room. The Results showed that it's obtained about 2 varieties of plants that were sensitive to this condition, that are Seulawah Varieties and Variety Jayawijaya. 5 varieties were moderate namely Kawi Variety, Variety Argopuro, Anjasmoro Variety, Variety and Variety CikurayTanggamus, whereas 2-tolerant varieties are Petek and Ringgit varieties. The next stage of this research was the characteristics test of physiological and morphological of Petek variety and can be inferred if this varieties that grown in shaded conditions (paranet 50%) may experienced an increasing leaf size, the carotene content, content of chlorophyll a and b, and also reducing the thickness of the leaves.

The research activities initiated by crossing the Petek varieties with Panderman varieties. Both native varieties were chosen because it possible to get the expected character of soybean. Patek Variety is the type of shade-tolerant variety, has a lot of pods and high production levels. However, but shortcomings are height stems and small seeds size. So it crossed with Paderman varieties that have short stems, and large seed size but have little pods, which is expected to obtain the new varieties, with high crops productivity, has a lot of pods, large seed size, short stems and shades- tolerance.

The Crossing between Petek variety and Panderman variety generated the F1 genotype and reciprocal F1 genotype (F1R). After that, all crosses seeds were planting with the bulk method, namely all seeds of F1 generation were harvest simultaneously and collected together without any selection. Then seeds of F1 generation were planting as the population of F2 generation, which can produce about 500 of F2 plants, and then selected by choosing the best individual plants by criteria's namely have short stems, large seed size, high production and resistant to shade, so it was getting about 10 selected F2 plants, then that all plants as the selection results were plant. Planting in this study aimed to examine of morphology and yield characters in locations of under the shades, to make sure if these plants were still in high yield, despite the light intensity was low, under 50% of shades paranent.

The purpose of this study to obtain the information about the plant growth and yield of F3 generation soybean, as the result of crossbreeding varieties between Petek x Pendeman toward the 50% shade paranet. In addition, to get the f3 generation of soybean plants derived from the crosses of these two native varieties, with characters are high production rate, short-trunked, large seed size and shade- tolerant.

2. Research Method

This study was carried out about 4 months, that is in January until April of 2014, in the experiment garden of Jambi university, Agriculture Faculty, which is located in the of Mendalodarat village, Jambi Luar Kota districts, Muaro Jambi regency, with height of place about ± 35 m asl, by Ultisol soil types. Materials used in this research were select from the F2 generation soybean seeds, as the result of crossing between Petek x Panderman varieties, and native varieties of Panderman and Petek varieties, 50% shade paranet, manure, Compound NPK about 16:16:16 (NPK Mutiara), fungicide active ingredient propined 70.5% (Antracol 70 WP) and insecticide active ingredient deltamethrin (Decis 2.5 EC).

In this experiment, the observed genotypes consisting by native genotypes (Petek and Panderman varieties) and F2 seeds derived from 10 selection F2 plants, which is as follows:

$F2_1$ = Ptx Pdm – 5 – 106;$F2_2$ = Pt x Pdm – 5 – 138;$F2_3$ = Pt x Pdm – 5 – 184;$F2_4$ = Pt x Pdm – 5 – 196;$F2_5$ = Pt x Pdm – 5 – 219;$F2_6$ = Pt x Pdm – 5 – 221;$F2_7$ = Pt x Pdm – 5 – 247;$F2_8$ = Pt x Pdm – 5 – 253;$F2_9$ = Pt x Pdm – 5 – 289;$F2_{10}$ = Pt x Pdm – 5 – 414.

The Experiments conducted with planting soybean in a head torow. All observing plants were growing on a plot of land that has been homogenized. In order the drainage be spread evenly, it made the 5 lanes with a width about ± 50 cm. The Soybean planted with a plat spacing about 30 cm x 30 cm. In each planting hole, will planted 1 seed from F2 seeds derived from selection F2 plants results. While 3 seed of native varieties for a planting hole and types, and only 1 plant was being to maintained. Overall of F3 plants were observing, whereas the native varieties plants as the sample were only take about 10 plants randomly. The method of selection was carry out by the pedigree method, where the selection held by way take the best individual, accordance with the variables observed.

The Variables observed such as height of plants (cm), a number of pods per pithy plant (pods), a number of pods per plant (pods), weight of seeds per plant (g), weight of 100 seeds (g).The advancement value of this selection was determine by the value of variance, mean and heritability (Falconer and Mackay, 1996). The values above are calculate with the following formula:

a. The median value was calculate based on the populations of F3 generation, then first variety and second variety with the formula:

$$\mu = \frac{\sum Xi}{N}$$

μ = median

Xi = phenotype value of first individual
N= amount of individual observed

b. The phenotype diversity is the overall diversities that calculated from populations of F3 generation and native varieties 1 and 2 with the formula:

$$\sigma_F^2 = \frac{\sum_{i=1}^{N}(Xi - \mu)^2}{N}$$

σ_F^2= phenotype diversity
Xi = first phenotype individual value
μ = median
N= amount of individual observed

c. The environment diversity from phenotype diversity of native 1 and 2 phenotype, by the assumption if the population of native 1 and 2 are the population in one kind, so the genetic diversity is considered to be zero and the range of phenotypes considered as a result of the influence of environmental variability.

$$\sigma_E^2 = \frac{n_1\sigma_{P1}^2 + n_2\sigma_{P2}^2}{n_1 + n_2}$$

$\sigma_{P1}^2$and σ_{P2}^2 = NativeP etek and Panderman Diversity
n_1 dan n_2= amount of Native Petek and Panderman

d. The genetic diversity is Calculated from the phenotypes and environments diversity with the formula:

$\sigma^2_G = \sigma^2_F - \sigma^2_E$
σ_G^2= genotypes diversity
σ_F^2= phenotypes diversity
σ_E^2= environment diversity

According to Anderson and Bancroft (1952) in Barmawi *et al*. (2013) that the phenotypic diversity said extensive if $\sigma_F^2 > 2\sigma_F$ and said narrow if $\sigma_F^2 < 2\sigma_F$. The genotypes diversity said extensive if $\sigma_G^2 > 2\sigma_G$ and said narrow if $\sigma_G^2 < 2\sigma_G$.

e. Predictive value of heritability (h2) was calculate by using the heritability formula in the extensive meaning with the formula:

$$h_{bs}^2 = \frac{\sigma_G^2}{\sigma_F^2}$$

h^2_{bs} = heritability in diversity meaning
σ^2_F = Phenotype diversity
σ^2_G = Genetic diversity

According to Standfield (1991) if the value of heritability were classified as follows: low (h2bs <0.2); medium (0, 2≤h2bs≤0, 5); and high (h2bs> 0.5).

f. The advancement of selection is calculate by the formula

$$R = i.\ h^2.\ \sigma_F \quad \%R = \frac{R}{\mu} \times 100\%$$

R = advancement of selection
%R= percentage of advancement selection
I = Intensity of selection
h^2= Heritability
σ_F= Phenotype of deviation standard
μ = the median of selection population

According to Karmana *et al*. (1990) in Susiana (2006) if the percentage of genetic advancement may classified as follows: low (R <3.3%); quite low (3.31% ≤R≤6,6%); quite high (6.61% ≤R≤10%); and high (R> 10%).

3. Result and Discussion

1.1. Median Value

The Seven relatives that derivited form F2 selecting plants, forming the F3 plants population. From Table 1 shows, that the median maximum and minimum values of F3 Family plant population, the median of F3 plant population, the median value of native Petek and Panderman for all observed variables. The median maximum value was higher than the median F3 population and both natives. Meanwhile, the median minimum value is smaller than the median value of F3 populations and both natives, except on the variable of seed weight per plant and 100 seed was higher than the natives' varieties. The Middle value of F3 population was higher than the two natives on the variable of number pithy pods only. The Middle value of seeds weight per plant from seven relatives ranged from 9,5g to 17,3 g. The median values of all variables were observe in each relative can be seen in Table9.

Table 1: The median values of some relatives' variable, F3 population and the natives

Weight of 100 seds (g)	*Weight of seed per plant* (g)	*Sum of pithy pods* (polong)	*Sum of pods(polong)*	*Height of plant(cm)*	*Population*
12,4	9,5	42,6	44,9	62,2	relative (minm)
15,2	17,3	70,2	74,8	112,9	relative (makm)
14,2	13,6	58,2	63,5	89,6	F3 population
9,7	9,2	54,9	58,1	107,5	Petek's native
22,7	22,4	55,9	59,6	145,6	Panderman's native

From the Table 1 showed, that the median value of all the characters observed from the Petek's native and Panderman's and F3 populations plants.

The Panderman's native has a middle value that greater than the natives of Petek. Median value of F3 populations generally was higher than the native Petek, except the

variable of plant height, whereas when it compared with native Panderman was lower, except the variables of number of pods per plant and number of pithy pods. In general, the selection for crossing of Petek with Panderman was running well and characterized by the decreasing of height plant of both natives and the increasing of number of pods per plant and number of pithy pods which was exceed of natives Petek and Panderman and also the weight of seeds per plant and weight of 100 seed was exceed of native.

Table 2: The spreading of some native characters and F3 population

		F3 Population			*Panderman*			*Petek*	*Observing Population*
maks	min	μ	maks	min	μ	Maks	min	μ	
189,7	29,3	89,6	191,8	112,4	145,6	129,3	92,5	107,5	Height of plant
142,0	21,0	63,5	88,0	35,0	59,6	67,0	45,0	58,1	Sum of pods per plants
137,0	20,0	58,2	82,0	32,0	55,9	63,0	40,0	54,9	Sum of pithy pods
35,4	4,2	13,6	32,1	16,3	22,4	11,8	6,7	9,2	weight of seeds per plant
18,8	9,0	14,2	24,2	20,6	22,7	10,4	8,2	9,7	Weight per 100 seeds

1.2. The Genotype Diversity Value, Phenotype and Environments

The phenotype Maximum and minimum diversity value of these relatives on the F3 population can be seen in Table 3, which can be compared with a phenotypes diversity of F3 populations, the natives Petek and Panderman. Phenotype diversity value of seeds' weight per plant from seven relatives were observed from F3 populations that ranged from 12.7 to 35.2 g. Phenotypic diversity value for each family can be seen in Table 10.

Table 3: The diversity values of relative's character, F3 population and natives

Weight of 100 seds(g)	*Weight of seed per plant(g)*	*Sum of pithy pods(polong)*	*Sum of pods(polong)*	*Height of plant(cm)*	*population*
1,2	12,7	155,6	165,5	309,9	relative (minim)
6,7	35,2	626,3	724,7	1426,3	relative (maks)
3,6	39,5	576,6	684,1	1090,8	F3 population
0,6	3,1	44,3	40,7	142,3	Petek's native
1,4	16,9	183,1	208,8	607,9	Panderman's native

All variables observed have a relatives phenotypic diversity that were lower minimally than the F3 populations and the maximum phenotype diversity that was higher than F3 populations, except in variable of seeds weight per plant. When compared with the two natives, the value of maximum relatives phenotypic diversity was higher for all the variables observed, so it can be said that each member of relatives were still very diverse, for the next selection was still carry out the selection or individual selection. The phenotype diversity on this stage were look very diverts for all variables observed, either in the original population and F3 plants. Population of F3 plant has a greater diversity value than the value of diversity in the population of both natives' varieties.

The Value of genetic diversity, phenotypic and environmental diversity on a F3 population plants can be seen in Table 4. The extensive genetic and phenotype Variety, which is found on height of plant, number of pods per plant, number of pithy pods and weight of seeds per plant, while the weights of 100 seeds which has a narrow diversity.

Table 4: The genotype diversity, phenotype and environment diversity on the F3 population plants

σ^2 E	σ^2 P	σ^2 G	Variable Observed
375,1	1090,8	715,7	Height
124,8	684,1	559,3	Sum of pods per plant
113,7	576,6	462,9	Sum of pithy pods
10,0	39,5	29,5	Weight of seed per plants
1,0	3,6	2,6	Weight of 100 seeds

1.3. Heritability Value

From the Table 5 appear that the value of heritability for height of plant, number of pods per plant, number of pithy pods, weight of seed per plant and weight of 100 seed in F3 populations that have a high value

Table 5: The herability value on the F3 population plants

Chriteria	h^2_{bs}	*Variable Observed*
High	0,7	Height
High	0,8	Sum of pods per plant
High	0,8	Sum of pithy pods
High	0,7	Weight of seed per plants
High	0,7	Weight of 100 seeds

1.4. The Advancement Of Selection and Percentage of Selection Advancement

Table 6 shows that the advancement of the predictive selection value and the percentage selection of advancement on the F3 population plant for all variables observed by the 10% selection intensity in general were high. The percentage advancement of selection for height of plant, number of pods per plant and number of pods were high, while the selection advancement percentage of the seeds per plant and weight of 100 seeds was quite low and low.

Table 6: The advancement selection value and selection of advancement value on a F3 population plant

Criteria	*%R*	*R*	*Variable Observed*
high	14,1	1259,6	Height
high	15,5	984,4	Sum of pods per plant
high	14,0	814,8	Sum of pithy pods
Quite low	3,8	52,0	Weight of seed per plants
low	0,3	4,6	Weight of 100 seeds

4. Discussion

The results of this study indicate, if the range value of the F3 population plant's greatest median value was in height of plant, number of pods per plant and number of pithy pods. The range of median value a characters will determine that diversity of these characters was whether extensive or not. As Wider the range of middle values of a character, so the diversity will be widened. On a character of height's plant, a number of pods per plant and number of pithy pods, which has the greatest range of values, so that the diversity of these characters were vast. This is consistent with the results of the research Barmawi *et al*. (2013), if the heights of plant, number of pods per plant and weight of seed per plant in F2 generation as the crossbreeding result between yellow bean and Taichung have a wide range of middle values.

The diversity of phenotypes and genotypes that vast, which were contain in height of plant, number of pods per plant, number of pithy pods and weight of seeds per plant, while weight of 100 seeds showed the narrow diversity value. According to Pinaria et al. (1995) in Dasumiati (2003), if the genetic variability that has a wide range, such as index of harvest, leaf weight ratio (LWR), seed weight partitioning index (SWPI), number of pods per plant, weight of seeds per plant and total of dry weight. The results of the Barmawi's study et al. (2013) was also pointed out, if the character of flowering age, harvesting, plant's height, number of pods per plant and seed weight per plant has a of extensive genotype and phenotype have a vast value range, whereas on a number of branches productive character and weight of 100 seeds showed a narrow value diversity.

On height of plant, numbers of pods per plant, number of pithy pods and weight of seeds per plant showed that, these characters have a vast genetic variability, so the selection that held on these characters would be effective. The vast diversity in a range of genotype and phenotype, which is caused by the using seed was the seed of F3 in high level segregation. The vast diversity can also occur because the both of seed have a different genetic characteristic of native varieties. The native type of this population selection was the Petek varieties that derived from the purification of local varieties, whereas the variety of Panderman was the soybean varieties that introduced from Taiwan. Fehr (1987) in Dasumiati (2003) said if there are differences in background genetic of native variety that can directly influence to amount of genetic diversity in the population. As wide the difference of the native genetic background, so then the genetic diversity will be greater, when compared to closely related natives.

The Predictive value of heritability in the vast meaning on the height of plant, number of pods per plant, number of pithy pods, weight of seed per plant and weight of 100 seeds were high, as the categories accordance to Stansfield (1969) in Mangoendidjojo (2003), if the high heritability (> 0.5), moderate (0.2 to 0.5) and low (<0.2). Welsh (1991) stated, if the heritability values theoretically ranged from zero to one. A zero value is, if all diversities caused by environmental factors, whereas the value one is if the all of diversities is caused by genetic factors. This means that the height of plant, number of pods per plant, number of pithy pods, weight of seed per plant and weight of 100 seeds that more influential on the phenotype were genetic factor rather than the environmental factors.

In addition, the heritability was also determining the success of the selection, because it can provide the clues that a character was more influence by genetic factors or environmental factors. Kojima and Kelleher (1963) in Dasumiati (2003) stated that the high heritability values for all characters indicate that the character improvement through a mass selection will be more efficient. The Selection of the high heritability characters can also do in the initial generation. Sharma (1994) in Barmawi *et al*. (2013) said if a character that has a high heritability values can be selected in early generations (F2 and F3). Conversely, if a heritability value is low, then the character must be selected in the next generation. However, the high heritability value for character of plant's height, number of pods per plant, number of pithy pods, weight of seed per plant and weight of 100 seed needed to be noticed, because that heritability value was in the vast meaning. The Heritability value in the vast meaning included the effect of additive gene action, dominance, and epistacy, so that

selection cannot be done at the beginning of the generation, and it must be selected in the next generation.

The high of genetic advancement rate within a character indicated, if the appearance of that character were support by a genetic factors, so it can complement the advancement of the selection (Barmawi *et al*., 2013). Height of Plant, number of pods per plant and number of pithy pods have a selection advancement value that were high, while the seed's weight per plant and weight of 100 seeds have a selection of advancement value that was quite low and also low on the 10% intensity of selection. This was presumably because of genetic factors is more dominant for the character on plant's height, number of pods per plant and number of pithy pods, whereas an environmental factors have a relatively large influence of the weight of seed's character per plant and weight of 100 seeds.

From this study results indicates, if the characters such as height of plants, number of pods per plant and number of pithy pods have a vast diversity values, the high of heritability estimates value, and a high value of genetic advancement. Thus the selection to obtaining of superior genotypes can be applied to these characters.

5. Conclusion

Based on the results of this study concluded that:

a. Median high value on a height of F3 population plant has decreased compared to both native varieties, but have an increase in the median on the number of pods and number pithy pods than the both natives. While the weight of seeds per plant and weights of 100 seed have increased of the median toward the native Petek and decrease the native Panderman.
b. The diversity phenotypic values of F3 population in a plant's height, number of pods per plant, number of pithy pods, weight of seed per plant and weight of 100 seeds were increase toward the native varieties.
c. F3 populations have a great median range value that is in the characters of the plant's height, number of pods per plant and number of pithy pods, while the character of seed's weight per plant and weight of 100 seeds have a small median range value.
d. The values of vast diversity, either on a phenotypes, genotypes, or environments were consisted on a height of plant, number of pods per plant, number of pithy pods and weight of seeds per plant, while the weight of 100 seeds have a narrow diversity.
e. The High heritability estimates value, which were consist in characters such as height of plant, number of pods per plant, number of pithy pods, weight of seed per plant and weight of 100 seeds.
f. The Predictive of high advancement value the selection, which is found on a height of plant, number of pods per plant and number of pithy pods, while the seed weight character per plant and weight of 100 seeds had a predictive value of advancement selection value that were quite lower and lower.

6. Suggestion

The selection is still need to be continue and for the next generation, is expect to constant in using of the individual method selection and have not been used the methods of relative's selection.

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