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The Yield Potential Of F_6 Generation Of Yellow Common Bean (*Phaseolus vulgaris* L.)

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ABSTRACT

The yield potential test is an important step in breeding activity in creating new varieties through evaluation the desired genes on some lines (Basuki, 1995). The value of heritability could indicate that every character observed was genetically influenced which inherited from the parental lines and its interaction with environmental factors. On this basis, this research was conducted at the Sawaulan, Tawang Agro Village, District Karangploso, Malang, East Java. The used materials in this research were three lines of yellow pod common beans of F_6 generation (CS x GK 50-0-24; CS x GI 63-0-24; and CS x GI 63-33-31), three parental varieties and Lebat-3 variety as check varieties. The completely randomized block design was used by observed 10 samples of plants per plot. This research showed that the three lines of common bean tested had uniformity in all characters evaluated by using quantitative and qualitative analysis. The value of GCV (Genotypic Coefficient of Variance) in every characters evaluated of the tested lines were low criteria and these values were lower than in the check varieties. The low variation indicated the small variation, i.e that the lines were already uniform. The heritability value of some characters observed in the lines were lower, while some other characters still had high heritability value. The heritability in the three lines tested were influenced by environment and genes as well. The character that had high heritability could inherit uniformly the character in concern on the next generation. The high heritability shows that the plant breeding program especially the selection program has been succesful.

Keywords: Common Bean, Yield Potential, GCV, Heritability.

INTRODUCTION

Common beans (*Phaseolus vulgaris* L.) is a vegetable belongs to the family of Leguminoceae. Common bean is suitable to be cultivated and produce well in lowland either to highland. It is sources of protein, vitamins and minerals that are important for the human's health and containing other substances that able to become medicine for various diseases. Target production of common bean in Indonesia in 2010 - 2014 was tend to increase, starting from 336.5 tons (2010), 342.1 tons (2011), 347.7 tons (2012), 353.6 tons (2013) and 359.7 tons (2014) (Anonymous, 2016).

Bahar and Zen (1993) stated that to increase the production of the common bean could be achieved by improvement and increase the genetic quality in order to achieve optimum productivity through plant breeding programs. Plant breeding is expected to improve and enhance the genetic potential of plants to obtain superior results with a corresponding character according to consumer tastes and ability to adapt into the specific agro ecosystem.

Potential yield trial test is a step to find new varieties through the evaluation of presence the desired genes in a line (Basuki, 1995). In yield trial occurs indirectly selection activity to get potential lines, and choose one or more the best lines that will be released as a new variety. According Kasno (1999), the assessment criteria in the selection of this stage is based on the characters that have economic significance, such as yield, quality and the others.

Genetic diversity plays an important role in the breeding program. According to Alexy *et a*l., (2009), genetic diversity has great affect of the success of a process of selection in the breeding program. Prajitno *et al*., (2002) described the diversity

observed in plants is a phenotypic diversity result from the genetic differences. In this research, the estimating value of genotypic and phenotypic diversity was low on some characters on the yellow podded common bean of F_6 generation.

MATERIAL AND METHODS

The research was conducted in Sawaulan, village of Tawang Agro, District Karangploso, Malang, East Java. Planting materials used were consisted of three lines of common beans which had yellow pods of F_6 generation (CS x GK 50-0-24; CS x GI 63-0-24; and CS x GI 63-33-31), three parental varieties and Lebat 3 as the check varieties. The research was conducted in February until May 2016. Fertilizers used were consisted of manure, urea and NPK 16:16:16. Pesticides used were consisted of Anthracol 70 WP, Primadan 3 GR, Ripcord and Curacron 500 EC.

The experimental design used in this research was the completely randomized block design with 7 treatments and 4 replications. Therefore, there were 28 experimental units. The number of plant in each plot were 30, then the total plant number in this study were 840 plants. Observation was done on 10 plants sample which were chosen randomly. The methods of this research were including: the preparation of planting materials, land preparation, planting, installation of stakes, maintenance, fertilizing, and harvesting. Observations were done on quantitative characters such as: early flowering time; number of cluster per plant; number of pod per plant; pod length; pod diameter; weight of pod and pod weight per plant; harvesting time; length of plants at 14 dap, 35 dap, and 60 dap; number of leaves at 14 dap, 35 dap, 60 dap; and the character of qualitative such as type of growth, flower color, base color of pods, intensity of base color pods. The qualitative characters observation was using manual Testing Individual Novelty, Uniqueness, Uniformity and Bean Stability in 2007 and Technical Guidelines for Preparation Description of Horticultural Varieties 2013. The qualitative data presented in the form of descriptive statistics and graph.

Data quantitative was presented in the table. GCV value is calculated using a formula according to Moedjiono and Mejaya (1994):

$$GCV = \frac{\sqrt{\sigma^2 g}}{\dot{X}} x100\%$$

Variability criteria of GCV and PCV according Moedjiono and Mejaya (1994) were: low ($0\% \leq x \leq 25\%$), moderate ($25\% \leq x \leq 50\%$), medium ($50\% \leq x \leq 75\%$) and high ($75\% \leq x \leq 100\%$). The heritability was estimated according to Aha (2015) by using the formula:

$$h^2 = \frac{\sigma^2 g}{\sigma^2 g + \sigma^2 e}$$

Notes:
h^2 = broad-sense heritability
$\sigma^2 g$ = genotypic variance
$\sigma^2 e$ = environmental variance

Heritability criteria according to Mangoendijojo (2003) are as follow: high if $h^2 > 50\%$, moderate if $20\% > h^2 > 50\%$, and low if $h^2 < 20\%$.

RESULTS AND DISCUSSION

The analysis data showed that the variables observations on the promising lines were significant differences. Flowering age, number of pods, pods length, number of seeds per pod, weight of pods, pod weight per plant and pod yield per hectare showed significantly different in the tested promising lines. Such differences could indicate that there is a phenotypic difference between the lines tested. Flowering age of CS x GK 50-0-24, CS x GI 63-0-24, CS x GI 63-33-31, and the three parental lines were varies if compared to Lebat-3 variety. Flowering age ranged from 32 up to 45 DAP. Some promising lines were flowering later than the flowering time of check varieties.

Common beans yield was determined by variable observations such as: pod yield, which was consisted of fresh pods yield per hectare, number of pods, pods length, fresh weight of pods per plant. Table 1 showed that the number of pods among the tested lines was in a range from 34.58 to 61.58 $t.ha^{-1}$.

There was a significantly different in the variable of pod length among the tested lines. The CS x GI 63-33-31 line had the longest pod length compared to the other lines with the length of 15.56 cm, but not significantly different to the line CS x GI 63-

0-24 which had the pod length of 15.53 cm. The CS x GK 50-0-24 line had the shortest pod length of 13.01 cm. The tested lines had a lower pod length than the check varieties. Trustinah *et al*., (2002) mentioned that the length of pods is a quantitative trait that was influenced by the environment. The number of seed per pods was significantly different among the tested lines. The three lines that were tested had a shorter pod length than the check varieties. Research result of Uguru (1995) also indicated that the longer pods would have more number of seeds per pods.

In this research, the CS x GI 63-0-24 line (with 15.53 cm pod length) has a shorter average pod length than the CS x GI 63-0-31 line (15.56 cm). However, the CS x GI 63-0-31 line (6.32 seeds) had a number of seeds more than the CS x GI 63-0-24 line (6.29 seeds). Trustinah *et al.,* (2001) stated that the pod length character had a positive correlation with seed number per pod, even that was not significantly different. It means that the longer pods not always produce more number of seeds. In the observation on the number of pods per plant showed significantly different results among the tested lines. The CS x GK 50-0-24 line had a lower number of pods than Lebat-3 variety, while the CS x GI 63-0-24 line and the CS x GI 63-33-31 line had a higher number of pod than Lebat-3 variety.

In the observation on pod weight per plant (Table 2) showed a significantly different result among the tested lines. The CS x GI 63-33-31 line had a higher average weight per pod than Lebat-3 variety, while the two other lines of CS x GK 50-0-24 and CS x GI 63-0-24 had a lower weight per pod. The more number of clusters per plant, the more number of pods per plant. Therefore, the weight per pod will also had a higher average. The longer pods will then increase the weight of pods. The character of pod weight per plant was influenced by genotype factor, it was due to these lines had a high heritability.

In this study however, qualification of all of the tested lines to be considered as qualified for the next step of evaluation was also based on other important factors such as early-ripening, pods color, taste of pods and pod length. The most preferred beans were the one that have early flowering time and longer harvest period (Arenas *et al*., 2013). Common bean with yellow color of pod is not yet found in the market in Indonesia. The market for beans with yelow color pod would be more attractive if accompanied with the medium pod length.

The value of genetic variance in CS x GI 63-33-31 line was classified as low and moderate criteria. Likewise with heritability value on this line has a low and moderate heritability (Table 3). GCV value did not show a significant different in each character on the observed phenotypic variance due to the influence of genetic and environmental variance. Jameela *et al*., (2012) stated that quantitative characters in plants are controlled by many genes, which each of them gives small influences on the quantitative character and this character is also getting influenced by the environment. The variance values in CS x GI 63-0-24 line and CS x GK 50-0-24 line (Tables 4 and 5) were also considered as low and moderate criteria. Heritability values in these lines is considered as high criteria.

Table 1. Data of Flowering time (dap), Harvesting time of fresh pods (dap), Number of Cluster and Number of Pods

Lines	Flowering time (dap)	Harvesting time of Fresh Pods (dap)	Number of Cluster	Number of Pods
CS GK 50-0-24	41.07 b	51.75 b	9.10 a	37.04 a
CS GI 63-0- 24	34.50 a	42.80 a	28.60 c	61.58 c
CS GI 63-33-31	42.65 bc	52.53 bc	26.90 c	51.06 b
GI	34.60 a	44.47 a	29.65 d	53.52 b
GK	32.75 a	44.72 a	9.10 a	34.58 a
CS	44.79 c	54.76 c	17.15 b	61.33 c
Lebat-3	32.90 a	43.90 a	31.85 cd	48.87b
LSD 5%	2.91	2.45	1.05	4.97

Remarks : GK = Gogo Kuning, CS = Cherokee Sun, GI = Gilik Ijo

Table 2. Data of Pods Diameter (cm), Pods Length (cm), Number of pods, Weight of pods (g) and Yield (ton.ha-1)

Lines	Pod Diameter (cm)	Pod Length (cm)	Number of Seed per Pod	Weight of Pod (g)	Yield (ton.ha^{-1})
CS GK 50-0-24	0.94 ab	13.01 a	4.75 a	6.74 ab	2.79 cd
CS GI 63-0-24	1.07 cd	15.53 b	7.45 c	7.27 bc	1.84 ab
CS GI 63-33-31	1.04 abc	15.56 b	6.32 b	8.75 d	3.09 d
GK	1.17 d	16.75 b	7.54 c	8.94 d	3.74 e
CS	0.93 a	12.26 a	5.90 b	6.46 a	1.67 a
GI	1.05 bc	11.51 a	4.53 a	6.64 a	2.12 b
Lebat-3	1.06 cd	16.17 b	6.29 b	7.68 c	2.69 c
LSD 5%	0.46	1.43	0.74	0.50	0.37

Remarks: GK = Gogo Kuning, CS = Cherokee Sun, GI = Gilik Ijo

Table 3. Value of σ2e, σ2f σ2g, GCV and Heritability of CS x GI 63-33-31 line

No	Character	σ^2p	σ^2g	σ^2e	GCV (%)	h^2
1	Flowering time	0.30	0.08	0.22	1.00	0.26
2	Seed Number per Pod	1.02	0.02	0.98	16.47	0.02
3	Pod Diameter	0.03	0.02	0.03	15.26	0.08
4	Harvesting time of Fresh pod	0.55	0.09	0.46	1.50	0.16
5	Pod Length	0.35	0.12	0.23	3.70	0.35
6	Number of Pod	39.00	4.67	34.33	12.40	0.12
7	Weight of Pod	0.33	0.04	0.30	11.65	0.08
8	Number of Cluster	2.68	4.67	2.68	3.10	0.37
9	Number of Leaves at 14 DAP	0.20	0.05	0.15	9.93	0.25
10	Number of Leaves at 30 DAP	7.50	2.80	4.58	20.59	0.21
11	Number of Leaves at 60 DAP	7.55	4.01	3.54	18.11	0.53
12	Plant Length at 14 DAP	1.26	0.45	0.81	7.83	0.35
13	Plant Length at 30 DAP	15.67	2.87	12.80	8.76	0.18
14	Plant Length at 60 DAP	2.73	15.33	12.60	3.10	0.17

Remarks: CV value ranges from 0 to 25% is considered as low, while the value of CV ranges from 25% to 50% is considered as medium, and CV value >50% is considered as high (Moedjiono and Mejaya, 1994).

Table 4. Value σ^2e, σ^2f, σ^2g, GCV and Heritability of CS x GI 63-0-24 line

No.	Character	σ^2p	σ^2g	σ^2e	GCV (%)	h^2
1	Flowering time	0.25	0.30	0.25	1.40	0.12
2	Seed Number per Pod	1.01	0.04	0.98	21.34	0.03
3	Pod Diameter	0.03	0.01	0.03	15.10	0.05
4	Harvesting time of Fresh pod	0.55	0.09	0.46	1.20	0.16
5	Pod Length	0.28	0.05	0.23	3.10	0.17
6	Number of Pod	36.55	4.67	34.33	12.40	0.06
7	Weight of Pod	0.47	0.18	0.30	7.45	0.37
8	Number of Cluster	5.35	2.67	2.68	5.94	0.49
9	Number of Leaves at 14 DAP	0.25	0.10	0.15	9.56	0.40
10	Number of Leaves at 30 DAP	4.65	1.85	4.58	16.50	0.39
11	Number of Leaves at 60 DAP	6.25	2.70	3.55	11.18	0.43
12	Plant Length at 14 DAP	1.15	0.34	0.81	6.65	0.29
13	Plant Length at 30 DAP	46.10	33.30	12.80	28.98	0.72
14	Plant Length at 60 DAP	63.20	50.06	12.60	24.17	0.80

Remarks : CV value ranges from 0 to 25% is considered as low, while the value of CV ranges from 25% to 50% is considered as medium, and CV value >50% is considered as high (Moedjiono and Mejaya, 1994).

Table 5 Value σ^2e, σ^2f, σ^2g, GCV and Heritability of CS x GK 50-0-24 line

No.	Character	σ^2p	σ^2g	σ^2e	GCV (%)	h^2
1	Flowering time	0.25	0.03	0.25	1.40	0.12
2	Seed Number per Pod	1.01	0.04	0.98	11.04	0.04
3	Pod Diameter	0.03	0.01	0.03	14.83	0.05
4	Harvesting time of Fresh pod	0.50	0.04	0.46	1.20	0.08
5	Pod Length	0.25	0.02	0.23	3.08	0.08
6	Number of Pod	48.95	4.67	34.33	12.40	0.29
7	Weight of Pod	0.05	0.02	0.03	1.93	0.43
8	Number of Cluster	5.32	2.55	2.68	7.15	0.47
9	Number of Leaves at 14 DAP	1.31	0.50	0.15	6.27	0.38
10	Number of Leaves at 30 DAP	8.25	5.45	4.58	16.08	0.66
11	Number of Leaves at 60 DAP	4.45	3.55	0.90	18.74	0.20
12	Plant Length at 14 DAP	1.31	0.50	0.81	6.27	0.38
13	Plant Length at 30 DAP	24.00	11.20	12.80	2.85	0.46
14	Plant Length at 60 DAP	33.70	21.17	12.60	4.35	0.62

Remarks: CV value ranges from 0 to 25% is considered as low, while the value of CV ranges from 25% to 50% is considered as medium, and CV value >50% is considered as high (Moedjiono and Mejaya, 1994).

Heritability of all characters in the tested lines were in the criteria of low, medium and high. Besides to increase the value of genetic variance, heritability values also affect the success of plant breeding program. Heritability is genetic parameters used to measure the ability of a genotype in a population of plants to inherit the character. Machfud and Sulistyowati (2009) explained that the heritability will give an image of a character is dominantly affected by genetic or environmental factors, which can be used to determine the genetic relationships between parental plants with its offspring. Thus, the heritability value indicates whether a character is controlled by genetic or environmental factors. Therefore, it could be seen the number of characters that could be inherited to the next offspring (Lestari *et al.*, 2006).

There are several characters on this three lines that had high heritability values. Heritability is one method to estimate how strong the character is influenced by genetic or environmental condition. High heritability values indicate that the role of the genetic factors were higher than the environmental factors (Maftuchah *et al.,* 2015). According to *Sutopo et al.* (2003), high heritability showed the small influence of environment on heredity, so the selection is more effective and efficient to do in the earlier generation. The high heritability for agronomic characters is caused by the homogeneous trial locations and small differences between both experimental plots within a block or between the block itself. Environmental conditions and soil fertility will also affect the number of pods per plant (Soedomo *et al.,* 1992).

CONCLUSION

Of the three tested lines, CS x GI 63-0-31 line had higher average pod weight per plant and yield per hectare than the two other lines and check varieties. The pod weight in CS x GI 63-0-31 line was 8.75 g and the yield per hectare was 3.09 tons.ha^{-1}. CS x GK 50-0-24 line and CS x GI 63-33-31 line had uniform qualitative characters of the type of growth, flower color and the base color of pods. CS x GI 63-0-24 line still had a variation in qualitative characters of flower color and pod morphology. Heritability and genotypic coefficient of variance in the three lines were varies. In all of the characters that were observed showed a low heritability, it means that genetic variance in a line were low or uniform.

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