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Artikel

The Estimation of Genetic Parameters of Cucumber Fruit Yield components (Cucumis sativus L.)

Harumi Farah Setyaningastuti[a], Taryono[a,b], Rahmi Sri Sayekti[b,*]

[a]Departement of Agronomy, Faculty of Agriculture, Gadjah Mada University

[b]Agrotechnology Innovation Center (AIC), Gadjah Mada University

*)Corresponding author, Email: tariono60@ugm.ac.id

ABSTRACT

Cucumber is regarded as main vegetable in Indonesian, however its production cannot match the demand and to increase production can be done by increasing diversity and productivity through plant breeding. The estimation of genetic parameters plays an important role in breeding work, therefore the objectives of this study were to obtain the estimated value of the genetic parameters of some cucumber yield components, to determine the important characteristics of cucumber yield components, and to identify cucumber accessions with high potential yield. The study was conducted at AIC UGM, Berbah, Sleman, Yogyakarta. The accessions used were 23 numbers from the AIC UGM collections and 4 controls. The study used a completely randomized design and analyzed with ANOVA. The results showed that the days to first harvest, fruit length, fruit weight, fruit diameter, and flesh thickness give high heritability. The number of fruits and potential yield per hectare gives moderate heritability, and seed rendement gives low heritability. Fruit weight, fruit breadth, and flesh thickness were found as the main important characteristics in yield component. Accession number 372 has the earliest first harvest date, accession number 329 and 390 have high potential yield/hectare, fruit weight, fruit length, flesh thickness, and fruit breadth.

Keywords: yield components, genetic parameters, heritability, coefficient of variation, cucumber

INTRODUCTION

Cucumber is regarded as main vegetable in Indonesian as it often used in various Indonesian dishes, as a complementary vegetable, pickled, or processed into drinks. Unfortunately, these good opportunities cannot be matched by the ability of cucumber production. National cucumber production in 2012 accounted to 511,525 tons, which continued to decline in 2016 at 430,201 tons. Efforts to meet the demand and availability of vegetables on the market can be done by increasing diversity and productivity through plant breeding. Assembling new varieties that have special characteristics and high potential yields are required.

One of the main components in plant breeding related to the characterization of plant traits is the estimation of genetic parameters (Wardiana and Pranowo, 2011), which is used to obtain information about the number of genes that control

traits, actions of genes, and other genetic information (Arif et al., 2014). Genetic information is very useful in efforts to improve plant's characteristic through selection or other breeding activities. Some genetic parameters that are considered for more effective and efficient selection are genotypes variance, phenotypes variance, heritability, genetic advance, and these parameters are supported by correlations between traits that are closely related to yield (Hapsari, 2014). The objectives of this study were to obtain the estimated of genetic parameters of some cucumber yield components, to determine the important characteristics of cucumber yield components, and to identify cucumber accessions with high potential yield.

MATERIALS AND METHODS

The present study was conducted at the Agrotechnology Innovation Center UGM, Berbah, Sleman, Yogyakarta with an altitude of 194 m above sea level. The materials used were 27 cucumber accessions; 23 number from AIC UGM collections and 4 controls (commercial cucumbers and local cucumbers). The experiment was carried out in Complete Random Design. Data recorded from the forming of fruit until harvest and post harvest. Observation of cucumber yield components was based on the Minimum Descriptors of Agri-Horticultural Part II: Vegetable Crops by the National Bureau of Plant Genetic Resources, India.

Cucumber yield components which were observed include days to first harvest, number of fruits per plant, fruit weight, fruit length, fruit breadth, flesh thickness, seed rendement per fruit, and potential yield per hectare. The genetic parameters include the genotypic coefficient of variation (GCV) and heritability. The observational data were analyzed using ANOVA at the α 5% significance level, then the estimation of genetic parameters is calculated based on the expected mean square obtained from the analysis of variance. The genotypic coefficient of variation (GCV) and heritability in broad sense (h2) of each characteristic can be obtained based on Singh dan Chaudary, (1979) through:

σ^2_g (Genotypic variance) = $\frac{Accession\ Mean\ Square - Error\ Mean\ Square}{r}$

σ^2_e = mean square of the error

σ^2_f (Phenotypic variance) = $\sigma^2_g + \sigma^2_e$

GCV = $\frac{\sqrt{\sigma^2 g}}{\overline{X}} \times 100\%$

$\overline{X}$ = general mean of the population

$h^2 = \frac{\sigma^2 g}{\sigma^2 f}$

The GCV is determined based on the coefficient of variation in the range of 0-100% quartile, i.e. low (0% ≤ 25%), rather low (25% ≤50%), moderate (50% ≤ 75%), and high (75% ≤ 100%). These values rearrange using the highest coefficient of variation of observed data as a value of 100% (Moedjiono and Mejaya, 1994). The estimated heritability in a broad sense were classified as low (h2 <0.20), moderate (0.20 ≤ h2 ≤ 0.50), high (h2> 0.50) (Stansfield, 1991).

RESULTS AND DISCUSSION

Yield components of cucumber yield include days to first harvest, fruit shape, color of marketable fruit, fruit stalk length, fruit length, fruit breadth, flesh thickness, stem-end fruit shape, blossom-end fruit tip, and fruit weight (Suryadi et al., 2004). The cucumber yield component observed include days to first harvest, number of fruits per plant, fruit weight, fruit length, fruit breadth, flesh thickness, seed rendement per fruit, and potential yield per hectare. The estimated of genetic parameters analyzed includes the coefficient of genotype variability and heritability. The estimated GCV ranged from 0.36-30.80% with the days to first

Table 1. Heritability dan genotypic variance of cucumber yield components

Yield component	Range	σ²g	GCV(%)	Heritability
Days to first harvest (dat)	25.00-39.00	0.014572	0.363 L	0.997263 H
Number of fruit	2.80-8.80	0.05732	4.045 L	0.439166 M
Fruit weight (gram)	67.72-502.15	10526.2	30.804 H	0.761433 H
Fruit length (cm)	10.46-31.00	0.2303	2.177 L	0.784133 H
Fruit breadth (cm)	3.89-6.17	0.009664	1.817 L	0.73024 H
Flesh thickness (cm)	0.91-1.90	0.015106	8.481 R	0.556677 H
Seed rendement (%)	0.24-0.95	1.29E-06	11.658 R	0.102038 L
Potential yield (ton/ha)	15.17-123.13	368.56	30.424 H	0.49587 M

*)L = low, R = relatively low, M = moderate, H = high.
GCV : low (0.36% ≤ x ≤ 7.70%), relatively low (7.70% <x ≤ 15.40%), quite high (15.40% <x ≤ 23.10%), high (23.10% <x ≤ 30.80%).
h2: low (h2 <0.20), medium (0.20 ≤ h2 <0.50) and high (h2 ≥ 0.50).

harvest as lowest GCV and the seed rendement as the highest GCV (table 1). The estimated GCV were classified as low (0.36% ≤ x ≤ 7.70%), rather low (7.70% <x ≤ 15.40%), moderate (15.40% <x ≤ 23.10%), and high (23.10% <x ≤ 30.80%). The estimation of heritability can indicate the function of genetic factor (Lestari et al., 2006). The estimation of heritability plays an important role as the degree of population response to natural and artificial selection (Handayani and Hidayat, 2012).

Days to first harvest exhibited low GCV (0.363%) so it is categorized as narrow diversity among genotypes (table 1), whereas its heritability has the highest value of 0.997 so it is categorized as high heritability. Similar findings were also reported by Pal *et al.* (2016), which is a high heritability at the days to first harvest but with a low GCV. It is not recommended to select these acessions by using days to first harvest and if the days to first harvest will become the important characteristic, it is suggested to add the gene pool by exploring new accessions with early flowering.

The number of fruits had a low GCV (4.045%) so it is categorized as a narrow diversity. Estimated value of heritability of the number of fruits included in the moderate category (0.439). These results can occur when the variance of phenotypes (observed variance) is higher than the variance of genotypes. The estimated value of heritability indicates a considerable environmental effect. The number of fruit can be related to the number of female flowers (Wiguna 2014). However, the type of flowering of cucumbers is not only Monoecious, but also suspected to be Gynoecious so that the number of fruit is less precise if it is only related to the number of female flowers because no fruit can be obtained if no male flowers are available. The emergence of plants that only have female flowers can be caused by photoperiod and temperature. Cucumber variety "Higan-fushinari" which is planted in spring, if induced by low temperatures will emerge female flowers (Matsuo, 1968). If the variety is planted in the summer, then day-long conditions will induce the emergence of female flowers. The ratio of the number of male flowers and female flowers has no significant effect on the number of fruit, while the time of pollination has a significant effect on the number of fruits (Wijaya et al., 2015).

The estimated GCV of fruit length had a low value (2.177%) and is categorized as narrow variability among genotypes. The estimated heritability of fruit length had a high value of 0.761 so it is categorized as high heritability. Even though the heritability was high, it is better not to use this trait in the selection due to its narrow diversity.

Fruit weight had the highest estimated GCV (30.804%) so it is categorized as having a broad diversity among genotypes. The estimated value of fruit weight heritability was 0.784 so it is categorized as having high heritability. These findings are in line with Kumar et al. (2013). Trait with high GCV and heritability can be used in selection because of their wide diversity among genotypes and this trait has a high chance of being passed on to subsequent generations (Lestari *et al*., 2006).

The flesh thickness exhibited rather low value of GCV (8.481%) so that it was categorized as having a narrow diversity among genotypes. The estimated value of flesh thickness heritability is 0.557, so it is categorized as having high heritability. In a previous study conducted by Golabadi *et al*. (2012), it is also found similar result, which were a low estimated GCV and a high estimated heritability on flesh thickness.

Based on table 1, fruit breadth had low estimated value of GCV (1.817%) so that it is categorized as having a narrow diversity among genotypes. The estimated value of fruit breadth heritability had a value of 0.730 so it is categorized as having high heritability. Similar results were obtaained by Kumar et al. (2013), which was a low estimated GCV but had a high heritability on fruit breadth.

The seed rendement exhibited rather low GCV (11,658%) so it is categorized as having a narrow diversity among genotypes. The estimated value of seed rendement heritability had a value of 0.102 so it is categorized as having a low heritability. The low estimated heritability can be caused by the variance of phenotypes (the observed diversity) is higher than the varinace of genotypes. The low heritability also indicated that seed rendement had considerable environmental impact. If the estimated value of heritability is low, the selection is carried out in the next generation because it is difficult to be passed on to the next generation (Fehr, 1987). Seed rendement on Cucurbitaceae are mainly affected by environmental factors such as light intensity, temperature, and also cultivation factors such as irrigation, fertilization, pest, and plant disease. When Cucurbitaceae cultivated under protected cultivation (such as greenhouses), even though environmental factors are controlled, unexpected events can still occur. Plant population was one of main factors that determine the seed rendement and a larger population was required to obtain maximum seed yield (Nerson, 2007).

The potential yield per hectare ranged between 15.17-123.13 tons/ha. Based on table 1, this trait exhibited high GCV (30.424%) so it is categorized as having a broad diversity among genotypes. The estimated value of heritability of potential yield per hectare is categorized as moderate heritability with a value of 0.496. These results can occur due to variance of phenotypes which was higher than the diversity of genotypes. The estimated value of heritability indicated a considerable environmental influence.

Principal Component Analysis (PCA) was required to simplify data sets that have a large number of interrelated and observable variables from many dimensions. This can be done by changing previous variables into new sets of variables (Jolliffe, 2002).

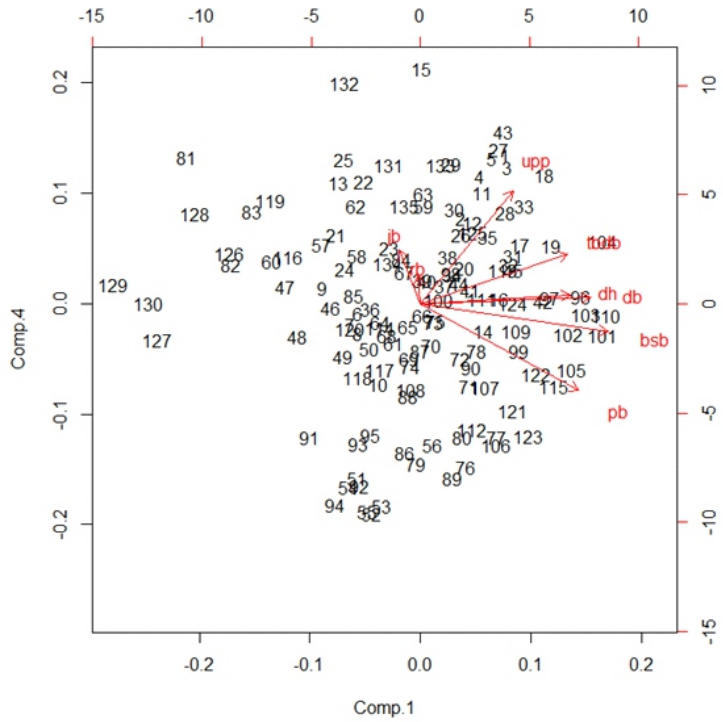

Figure.1. Plot of the 27 cucumber accession with respect to their PCs

Based on Figure 1, the distribution of data was marked with numbers 1-135 which was the total number of individuals (from 27 accessions each taken 5 replications). In the graph, there were eight arrows that represent each observation variable, i.e potential yield per hectare (hbs), days to first harvest (upp), fruit weight (bsb), flesh thickness (tbsb), fruit breadth (db), fruit length (pb), number of fruits (jb), and seed rendement (rb). For potential yield per hectare (dh), fruit weight (bsb), flesh thickness (tbsb), fruit breadth (db) have a high correlation. This showed that the fruit weight, fruit thickness, fruit diameter, and fruit length are closely related to yield per hectare. While for the days to first harvest, the number of fruits and seed rendement, this variable has a low correlation due to the direction of the arrow were away from other variables. If the desired trait was early maturity then the accession number 372 was preffered. If the desired traits were fruit weight, flesh thickness, fruit breadth, and high potential yield then accession numbers 390 and 329 were chosen. If the desired trait was the fruit length, then accession number 390 could be good candidate.

CONCLUSION

1. The Genetic coefficient of variability of fruit weight and potential yield per hectare GCV were categorized in the broad diversity. Days to first harvest, number of fruits, fruit length, fruit breadth, flesh thickness, and seed yield were in the narrow GCV category. The days to first harvest, fruit length, fruit weight, fruit diameter, and flesh thickness give high heritability. The number of fruits and potential yield per hectare gives moderate heritability, and seed rendement gives low heritability.
2. Fruit weight, fruit breadth, and flesh thickness were found as the main important characteristics in yield component.
3. Accession number 372 has the earliest first harvest date, accession number 329 and 390 have high potential yield/hectare, fruit weight, fruit length, flesh thickness, and fruit breadth.

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REFERENCES

Arif, A.B., S. Sujiprihati dan M. Syukur. 2014. Pendugaan parameter genetik karakter umur panen dan bobot per buah pada persilangan cabai besar dan cabai keriting(*Capsicum annuum* L.).Jurnal Agronomi Indonesia 40(2):119-124.

Fehr, W.R. 1987. *Principle of Cultivar Development. Volume 1: Theory and Technique.* Macmillan Publishing Company. New York.

Golabadi, M., P. Golkar, and A. Eghtedary. 2012. Assessment of genetic variation in cucumber (*Cucumis sativus* L.) genotypes. European J. Exp. Bio. 2(5): 1382-1388.

Handayani, T., dan I.M. Hidayat. 2012. Keragaman genetik dan heritabilitas beberapa karakter utama pada Kedelai Sayur dan implikasinya untuk seleksi perbaikan produksi. J. Hort. 22(4):327-33.

Hapsari, R.T. 2014. Pendugaan keragaman genetik dan korelasi antara komponen hasil kacang hijau berumur genjah. Buletin Plasma Nutfah 20(2):51-58.

Jolliffe, I. T. 2002. *Principle Component Analysis*. 2nd ed. Springer. New York.

Kumar, S., D. Kumar, R. Kumar, K. S. Thakur, and B. S. Dogra. 2013. Estimation of genetic variability and divergence for fruit yield and quality traits in cucumber (*Cucumis sativus* L.) in North-western Himalayas. Universal J. Pl. Sci. 1(2): 27-36.

Kumar, R., S. Kumar, D. Kumar, and R.K. Gupta. 2014. Characterization of cucumber (*Cucumis sativus* L.) genotypes through principle component and regression analysis. Indian Journal of Agricultural Science 84(6):765-769.

Lestari, A.D., W. Dewi, W. A. Qosim, M. Rahardja, N. Rostini, dan R. Setiamihardja. 2006. Variabilitas genetik dan heritabilitas karakter komponen hasil dan hasil lima belas gebotip cabai merah. Zuriat 17(1):97-98.

Matsuo, E. 1968. Studies on the photoperiodic sex differentiation in cucumber, *Cucumis sativus* L. : I. Effects of temperature and photoperiod upon the sex differentiation. Journal of the Faculty of Agriculture, Kyushu University 14(4):483-506.

Moedjiono dan M. J. Mejaya. 1994. Variabilitas genetik beberapa karakter plasma nutfah jagung koleksi Balittas Malang. Zuriat 5(2):27-32.

Nerson, H. 2007. Seed production and germinability of cucurbit crops. Seed Science and Biotechnology 1(1):1-10.

Pal, S., H. R. Sharma, A. K. Raj, R. K. Bhardwaj. 2016. Genetic variability, heritability, and genetic gain for yield and quality traits in cucumber (*Cucumis sativus* L.). The Bioscan 11(3):1985-1990.

Singh, R. K. and B.D. Chaudary, 1979. Biometrical methods in quantitative genetics analysis. Kalyani Publisher. New Delhi.

Stansfield. W.D. 1991. *Theory and Problem of Genetics*. 3rd ed. Schaum's Outline Series. Mc Graw-Hill Inc. Singapore.

Suryadi, Luthfy, Y. Kusandriani, dan Gunawan. 2004. Karakterisasi plasma nutfah mentimun. Buletin Plasma Nutfah 10(1) : 28-31.

Wardiana, E. dan D. Pranowo. 2011. Pendugaan parameter genetik, korelasi, dan klasterisasi 20 gentotipe Jarak Pagar (*Jatropha curcas* L.). Buletin Plasma Nutfah 17(1) : 46-3

Wiguna, G. 2014. Keragaan fenotifik beberapa genotipe mentimun (*Cucumis sativus* L.). Mediagro 10(2) : 45-56.

Wijaya, S. A., N. Basuki, and S. L. Purnamaningsih. 2015. Pengaruh waktu penyerbukan dan proporsi bunga betina dengan bunga jantan terhadap hasil dan kualitas benih mentimun (*Cucumis sativus* L.) hibrida. Jurnal Produksi Tanaman 3(8):615-622.