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ESTIMATION OF DIVERSITY AND GENETIC PARAMETERS OF TEN GENOTIES OF LARGE CHILE (Capsicum annuum L)

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ABSTRACT

Chili (*Capsicum annuum* L.) is one of the horticultural commodities that have high economic value which is used as vegetables or cooking spices, industrial raw materials, and has export opportunities. The development of superior chili varieties requires a large variety of germplasm that can be used as parents to be crossed with each other to obtain new superior traits. One of the efforts to determine the diversity of plants is to characterize the morphology and production. The purpose of this study was to obtain distinguishing characters among ten genotypes of large chilies, to determine the value of genetic parameter estimators for several genotypes of large chilies and to identify important characters that influence the yield of large chili genotypes. The study was a single factor field experiment in the form of 10 large chili genotypes arranged in a Randomized Completely Block Design (RCBD) with 3 blocks as replication. Genotypes of large chili are: Pilar, Arimbi, Baja, Panex, Forever, Columbus, Gada, Dewa, Rengku, Beautiful. Observation variables are plant height, stem diameter, number of leaves, width of leaves, leng of leaves, flowering age, harvest age, fruit length, fruit weight per plant, fruit diameter, and weight of fruit.. Chili characters that show high genetic diversity are leaf width, while high phenotypic diversity is in fruit weight parameters. High heritability values were found in the characters of flowering age, harvest age, and fruit diameter.
Keywords: chili, characterization, morphology, genetic parameters

INTRODUCTION

The increase in the population in Indonesia, apparently affects the amount of food needed, including large red chilies (*Capsicum annuum* L.). Based on data from the Central Statistics Agency and the Directorate General of Horticulture (2019), chili harvested area has the highest rank compared to other vegetables, large chili production is also included in the top 5 (mushrooms, potatoes, onions, cabbage, large chilies. Chili is one of the food ingredients). which has a very fluctuating price (Lestari *et al.*, 2006). On the consumption side, chili is one of the spices that must be on the daily menu of most Indonesians. If the price of chili soars, it will have an impact on people's purchasing power and also cause unrest (Nauly, 2016).

Some of the things that cause low productivity of large chilies are the presence of pest attacks, the use of low yielding varieties, and the adaptability of a variety that is less extensive. One way to overcome this problem is to develop new types of hybrid varieties (Sari *et al.,* 2014; Setiawan *et al.,* 2019). One of the most important things in the plant breeding process to produce superior varieties is to increase genetic diversity. Genetic diversity is one of the most influential factors on the success of plant breeding efforts. The existence of genetic diversity in a population means that there are variations in genotype values between individuals in the population (Sofiari and Kirana, 2009). Characterization aims to find out the information contained in each genotype from the germplasm collection owned, so that the steps that will be taken in the plant breeding program will be directed and definite (Lelang *et al.,* 2019).

Genetic diversity is one of the most influential factors on the success of plant breeding efforts. The existence of genetic diversity in a population means that there are variations in genotype values between individuals in the population (Sofiari and Kirana, 2009). Sujiprihati *et al*. (2003) stated that the diversity of plant populations has an important meaning in plant breeding. Efforts to improve the genetics of chili plants require the presence of germplasm with wide genetic diversity.

The next step after knowing genetic diversity is by visually selecting plant characters by selecting phenotypes that are considered good and have not been able to give satisfactory results without being guided by the values of selection parameters such as genetic variance, phenotype variance, coefficient of genetic diversity and heritability. Selection will be effective if the population has wide genetic diversity and high heritability. Estimation of genetic parameters in relation to the characterization of plant traits is the main component in efforts to improve plant properties as desired. The success of selection in plant breeding depends on how much genetic variability exists from the material to be selected (Akhtar *et al.*, 2007). Characters that have wide genetic variability will provide a greater opportunity to obtain the selected genotype with the best characters. Heritability is a quantitative statement of the role of genetic factors compared to environmental factors in giving the final appearance or phenotype of a character (Allard, 1960). Heritability was classified based on the criteria of low to high. Selection of characters that have high heritability will be more effective than characters that have low heritability, this is because the genetic influence is greater than the influence of the environment that plays a role in determining the phenotype of the character (Carsono *et al.*, 2004).

RESEARCH METHODOLOGY

The research was carried out at the Wedomartani Experimental Garden, Faculty of Agriculture, UPN "Veteran" Yogyakarta, with an altitude of 400 meters above sea level. The research started from May to October 2021. The materials used in this study were 10 genotypes of large chili from PT. Tani Murni Indonesia, plantera bags, insecticides, pesticides, and planting media. The tools used are tray, bucket, stake, sprayer, hoe, ruler, caliper, scissors, rope, scales, label paper, and stationery.

The study was a single factor field experiment in the form of 10 large chili genotypes arranged in a Randomized Completely Block Design (RCBD) with 3 blocks as replication. The genotypes of large chilies are: Arimbi, Baja, Beautiful, Dewa Rengku, Gada, Jayadi, Jenio, Simpatik, Panex, and Thunder. Each treatment unit consisted of 10 plants in the planter bag, 3 of which were used as sample plants.

Parameters observed included plant height, number of leaves, flowering age, stem diameter, leaf length, leaf width, harvest age, fruits length, fruits diameter. number of fruits, and fruit weight. Analysis of genetic diversity and estimation of genetic parameters include analysis of phenotypic variance, analysis of genetic variance and heritability.

RESULT AND DISCUSSION

The results of observations on 10 genotypes of large chilies showed significant differences in the characters of plant height, stem diameter, leaf width, flowering age, harvest age, fruit length, fruit diameter, number of fruit and fruit weight. Character number of leaves and leaf length did not show significant differences (Table 1). Pinaria *et al.* (1996), the genetic diversity of a population depends on the population being the segregated generation of a cross, in what generation and how the genetic background. In this study, ten genotypes were used which are F1 hybrids, so that there will be segregation of traits in the next generation. Hybrid varieties are varieties with heterozygous constitution at all loci. The existence of selfing will cause genetic diversity in the observed characters. Harvest age and fruit weight are components in the selection of chili plant breeding.

The results of the Scott-Knot average cluster test are presented in Table 2. Syukur *et al.,* (2012) stated that the harvest age character is one of the characters used to measure the superiority of a variety. The desired variety is a variety that has an earlier harvest age (early). The genotypes of Dewa Rengku, Gada and Jayadi showed a more early harvest age than the other genotypes. Based on the character of fruit diameter, it can be grouped into three, namely large chili (fruit diameter 15.75–16.66 mm), rather large (11.00-13.69 mm fruit diameter) and curly chili (fruit diameter <11mm). Arimbi and Panex genotypes had large fruit diameters compared to other genotypes.

Table 1. F-count values for the eleven observed characters

Number	Characters	F-count 5%
1	Plant height 30 dap (cm)	2,84*
2	Stem diameter (mm)	4,37*
3	Number of leaves 30 dap (leaf)	1,67^{ns}
4	Width of leaves (cm)	5,09*
5	Length of leaves (cm)	2,10^{ns}
6	Flowering age (day)	2,84*
7	Harvest age (day)	3,27*
8	Length of fruits (cm)	9,10*
9	Fruit diameter (mm)	22,73*
10	Number of fruit (pieces)	6,77*
11	Fruit weight (gram)	10,42*

Note : * = significant, ns = non-significant

The coefficients of genetic diversity and the coefficients of phenotypic diversity of ten chili genotypes are presented in Table 3. Moedjiono and Mejaya (1994) state that the low to moderately low diversity coefficient values can be categorized as narrow diversity, while high to high diversity values can be categorized into wide diversity. Sa'diyah et al., (2009) explained that the effectiveness of selection is influenced by the availability of diversity in the population to be selected. The greater the level of diversity in the population, the effectiveness of the selection to select a character that suits the desire is also greater. According to Syukur *et al.* (2012) quantitative characters in plants are controlled by many genes, each of which has a small effect on that character. This character is heavily influenced by the environment. There needs to be a statement that has a quantitative character between the role of genetic factors and environmental factors in giving the final appearance or observed phenotype.

Table 2. Average observed chili character and Scott Knot test results

Genotypes	PH 30 dap (cm)	SD (mm)	NL 30 hst (leaf)	WL (cm)	LL (cm)	FA (day)	HA (day)	FL (cm)	FD (mm)	FN (pieces)	WF (gram)
Arimbi	39,5 a	7,65 a	21,9 a	6,5 a	17,0 a	31 a	74 b	12,37 c	15.75 a	34 b	293,67 b
Baja	30,4 a	6,01 b	16,6 a	4,8 b	16,0 a	29 a	74 b	13,20 b	13.39 b	37 b	283,00 b
Beautiful	41,7 a	6,34 b	22,7 a	4,7 b	15,7 a	29 a	72 a	12,33 c	12.23 b	35 b	262,67 b
Dewa Rengku	37,1 a	7,39 a	20,8 a	6,0 a	17,3 a	31 a	69 a	11,33 d	13.21 b	26 c	269,67 b
Gada	34,9 a	6,59 b	20,2 a	4,5 b	14,0 a	29 a	72 a	12,17 c	11.00 b	53 a	374,67 a
Jayadi	37,6 a	7,75 a	21,0 a	6,5 a	17,0 a	32 a	71 a	10,67 d	13.68 b	34 b	416,33 a
Jenio	32,8 a	5,35 b	19,3 a	3,9 b	14,3 a	30 a	73 b	15,20 a	7.90 c	20 c	85,00 c
Panex	29,9 a	6,41 b	18,9 a	4,9 b	16,7 a	30 a	75 b	12,37 c	16.66 a	29 c	216,00 b
Simpatik	35,0 a	6,33 b	18,0 a	5,3 b	15,2 a	31 a	77 b	12,33 c	11.90 b	23 c	271,33 b
Thunder	34,5 a	6,36 b	16,9 a	4,7 b	14,0 a	33 a	77 b	10,43 d	7.16 c	28 c	61,33 c

Note : PH = Plant height, SD = Stem Diameter, NL = Number of Leaves, LL = Leaf Length, FA= Flowering Age, HA = Harvest, FL = Fruit Length, FD = Fruit Diameter, FN = Fruits Number, WF = Weight Fruits

Table 3. The value of the coefficient of diversity for the observed characters

Number	Characters	GCD (%)	Classification*	PCD (%)	Classification *
1	Plant height 30 dap (cm)	11,57	Low	6,05	Low
2	Stem diameter (mm)	61,81	High rather	11,08	Low
3	Number of leaves 30 dap (leaf)	20,83	Low	14,74	Low
4	Width of leaves (cm)	79,38	High	25,98	Low rather
5	Length of leaves (cm)	26,00	Low rather	13,09	Low
6	Flowering age (day)	13,41	Low	7,02	Low
7	Harvest age (day)	5,57	Low	5,11	Low
8	Length of fruits (cm)	41,76	Low rather	14,88	Low
9	Fruit diameter (mm)	41,56	Low rather	17,44	Low rather
10	Number of fruit (pieces)	15,98	Low	7,35	Low
11	Fruit weight (gram)	14,40	Low	53,29	High rather

Note : GCD and PCD scores are low (0% 25%), rather low (25% 50%), medium high (50% 75%), high (75% 1005); Coefficient of Diversity narrow CD (0% 50%), high (50% 100%)

Based on Table 4, it is known that the characters of plant height, stem diameter, number of leaves, leaf length, leaf width, flowering age, harvest age, and diameter fruit have high heritability values, meaning that these characters are controlled by genetic factors rather than environmental factors. The characters of fruit length, fruit number and fruit weight have low heritability values, which means that these characters are strongly influenced by environmental factors.

Heritability is a genetic parameter used to measure the ability of a genotype in a plant population to pass on its characters. This study uses heritability in a broad sense, namely the comparison between the total genotypic variance and the phenotypic variant. Mangoendidjojo (2003) there are three criteria for heritability values, namely: high if the h^2 value > 0,5, moderate if the h^2 value lies between 0,2 – 0,5 and low if the h^2 value < 0,2. Machfud and Sulistyowati (2009) add that heritability will describe a character influenced by genetic or environmental factors, which can be used to determine the genetic relationship between parents and the resulting offspring. The observed heritability values for the ten chili genotypes are presented in table 4. High heritability values indicate that genetic factors have a greater influence than environmental factors. Characters with high heritability values for age at harvest and fruit diameter, while for fruit length, number of fruits per plant and fruit weight showed low heritability values. According to Lestari *et al*. (2006) estimated heritability value indicates whether a character is controlled by

genetic factors or environmental factors. so that it can be seen to what extent these characters can be passed down to the next generation.

Table 4. Estimation of observed character heritability values

No	Characters	σ_g^2	σ_p^2	$h^2 bs$	Classification
1	Plant height 30 dap (cm)	5,112	7,15	0,71	High
2	Stem diameter (mm)	1726,9	1727,26	1,00	High
3	Number of leaves 30 dap (leaf)	12,265	13,09	0,94	High
4	Width of leaves (cm)	2,3139	2,80	0,83	High
5	Length of leaves (cm)	4,2264	6,62	0,64	High
6	Flowering age (day)	5,1157	7,16	0,71	High
7	Harvest age (day)	16,777	21,96	0.76	High
8	Length of fruits (cm)	0,635125	3,318125	0,19	Low
9	Fruit diameter (mm)	2,792125	4,604125	0,61	High
10	Number of fruit (pieces)	0,01875	2.0566	0,04	Low
11	Fruit weight (gram)	49,875	35,.875	0,14	Low

Note : low heritability ($h^2 < 0.2$), medium ($0.2 < h^2 < 0.5$), high ($h^2 > 0.5$)

CONCLUSION

Chili characters that show high genetic diversity are leaf width, while high phenotypic diversity is in fruit weight parameters. High heritability values were found in the characters of flowering age, harvest age, and fruit diameter. Characters with heritability indicate that these characters are controlled by genetic factors rather than environmental factors, so they can be used as the basis for the next generation of plant breeding programs.

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