Estimation Genetic Parameter and Selection of Yield Components in Two Population F2 Bird Pepper (*Capsicum frutescens* L)

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Abstract

Bird pepper *(Capsicum frutescens* L.) is one of the main commodities of horticulture in Indonesia. The process of assembling bird pepper was done by selected from the segregation population. This study aimed to obtain selected plant candidates in the F2 population by index selection on the character of the yield components on bird pepper. The results of this study showed that in population F2-285290 the correlation value showed a very significant significance for all characters on the yield component character while in the population F2-321290 only fruit thickness and fruit stalk length were not significantly correlated. The broad mean heritability value in the high category of the two populations were in fruit weight, fruit length, fruit diameter and fruit stalk length. The results of index selection in the population F2-285290 with a selection intensity 10 percent obtained by selected plants as many as 20 best plants, namely plants no 16, 30, 31, 36, 43, 50, 65, 80, 82, 102, 123, 134, 153, 190, 216, 244, 245, 263, 273 and 290 while in populations F2-321290 selected plants are no. 18, 21, 23, 30, 32, 37, 42, 154, 155, 162, 165, 167, 180, 185, 199, 220, 221, 230, 228 and 229

Keywords: bird pepper, character, correlation, heritability, index selection

A. Introduction

Bird pepper (*Capsicum frutescens* L.) is one of the main horticultural commodities in Indonesia and is one of the types of vegetables that has the potential to be developed. Productivity of bird pepper in Indonesia in 2018 around 6.69 tons ha1 (BPS and Director General of Horti 2018), even though the potential can reach 12-20 tons ha-1 (Sujinto and Dianawati, 2015). The productivity of bird pepper in Indonesia was still low due to many factors, one of which were that farmers have not used many high yielding superior varieties.

The success of the breeding program is determined by the accuracy in applying selection method by utilizing genetic information and heritability. Jalata, Z.A., Ayana, H., Zeleke (2011) said that characters whih not influenced by the environment usually have high heritability. Selection is one of the important stages in plant breeding activities. Selection can be interpreted as the

process of selecting individuals or groups of plants from mixed populations. Selection according to Barmawi (2007) is one of the activities in plant breeding programs to obtain superior varieties.

Selection is best done in population F2 because this population was the peak with maximum segregation. Selection can be done on qualitative and quantitative characters. Many quantitative characters are related to economic value, one of which is yield component. Yunandra (2016) stated that the selection on the character of yield will be more effective if it was followed by selection on the character of the other yield components. This is due to the productivity of chili was strongly influenced by the character of the yield components such as fruit weight, fruit diameter, fruit length, fruit thickness and number of fruit so that it needs to be selected on several characters at once.

Selection methods on several characters at once can be done by several methods. One method that can be done is the selection index method. According to Syukur, M., Sujiprihati, S., Yunianti, R. (2015) selection can be done on one character or several characters. Selection of several characters was divided into three types, namely sequential selection, simultaneous selection, and index selection. In this study the selection method used was index selection. According to Poespodarsono (1988) index selection was done through several characters that are considered important based on economic value, correlation genotypes and phenotypes between characters and heritability. The characters chosen are given a weighting index whose size depends on the more important nature. The highest indexed individual or population chosen to be passed on to the next generation of selection. Index selection was considered more efficient than sequential and simultaneous selection.

This study aim to obtain selected plants in the F2 population by utilizing weighted index selection on the character of the yield component.

B. Methodology

1. Research Methods

The trial was conducted from September 2016 to April 2017. The seeding was carried out at the Laboratory of Genetic and Plant Breeding, Department of Agronomy and Horticulture, IPB. Planting in the field was carried out at the Alam Sinarsari Experimental Station with an altitude of 202 m above sea level.

The genetic material used in this experiment are two populations F2-285290 and F2-321290. Each F2 population was planted with 300 plants. Population P1 (IPB C285), P1 (IPB C321), P2 (IPBC290), F1 (IPB C285 x IPB C290) and F1 (IPB C321 x IPB C290) each planted 40 plants.

The experimental activity begins with seedling of seeds P1, P2 and F2 at the Laboratory of Genetic and Plant Breeding, Department of Agronomy and Horticulture, IPB. Seeds were sown as much as one seed per hole in a tray containing seedling media. Maintenance includes watering, fertilizing every week and controlling plant pest organisms. The planting activity was carried out at the Alam Sinarsari Experimental Station. Planting is carried out in the field with a spacing 50 cm x 50 cm, with a system of planting two rows of plants. The beds are covered with black silver plastic mulch (MPHP). Plants were planted if they are ± 5-6 weeks old, with strong seedling growth characteristics, leafy 4-5 strands, green leaf color and not affected by pests. The maintenance carried out is watering, fertilizing with NPK solution (16:16:16) with a concentration of 10 g L-1 and leaf fertilizer 5 g L-1 carried out once a week. The dosage of each plant is given about 250 ml of fertilizer solution. Pest and disease control uses insecticides, fungicides and akaricide which are applied if needed. Water shoots are carried out so that plants can grow optimally and weed control was carried out manually.

The characters observed were: flowered time (DAP), harvested time (DAP), fruit weight (g), fruit diameter (mm), flesh thickness (mm), fruit length (cm), fruit stalk length (cm), number of fruits (fruit) and yield (g tan-1).

2. Data Analysis

Data analysis used in the study included:
1. Correlation between characters was analyzed using the Minitab 14 program, calculation of the correlation coefficient was carried out on quantitative data to calculate the closeness of the relationship between character variables with the Pearson method.
2. The estimated value of heritability was calculated using the calculation of derivative varians (Syukur *et al*., 2015) as follows:

$$\llbracket h^2 \rrbracket\_bs = (V\_F2 - [(V\_F1 + V\_P1 + V\_P2)/3])/V\_F2$$

Description: h2bs: broad sense heritabillity, VF1: population varians F1, VF2: varians population F2, VP1: population varians P1, VP2: population varians P2. Value of broad sense heritability category high if $\llbracket h^2 \rrbracket\_bs \geq 50\%$, medium $20\% \leq \llbracket h^2 \rrbracket\_bs \leq 50\%$, loe $\llbracket h^2 \rrbracket\_(bs) < 20\%$

3. Selection index. Selection was done based on weighted selection index by looking at the correlation between the character yield component to yield with the formula referring to Falconer (1978):

$$I = Z1 + Z2 + 2Z3 + 3Z4, \text{ where } Zn = (x - \bar{x}) / (\sqrt{\sigma 2})$$

Information:
I = Selection Index Value
Z1 = the standardized phenotype fruit weight
Z2 = the standardized phenotype value of fruit length
Z3 = the standardized phenotype value number of fruit
Z4 = the standardized phenotype yield
x = variable mean of a genotype
$\bar{x}$ = average variable of a total of all genotypes
$\sigma 2$ = varians

The weightings used are: weight per fruit (+1), fruit length (+1), number of fruits (+2), and fruit weight per plant (+3). The selection results are based on the highest selection index and taken 10% (20 selected plants) from each population

C. Result

Table 1 shows the correlation value analysis of other characters for yield in two bird pepper populations. Poespodarsono (1988) stated that correlation analysis was used to see the closeness of the relationship between the character of one anothers. Desita (2014) stated that there are two correlation coefficient values, namely negative and positive. Negative correlation coefficient means that the higher the value of a character, the other character values will be lower and vice versa. Positive correlation coefficient value means that the higher the value of a character, the higher the value of other characters. The characters that have positive and very significant correlations for all population characters in population F2-285290 while in populations F2-321290 all the characters that have a positive correlation and are very significant except for fruit thickness and fruit stalk length have no significant effect. The results of the research by Yunandra (2016) and Sidiq, A.R.F., Syukur, M., dan Marwiyah, S (2017) showed that the character number of fruits, fruit weight and fruit length there was positive and significant correlation with the yield character.

Table 1 Pearson Correlation of character yield components to yield in two bird pepper populations

Character	Correlation Coefficient			
	F2-285290		F2-321290	
fruit weight (g)	0.264	**	0.325	**
fruit length (cm)	0.234	**	0.357	**
fruit diameter (mm)	0.203	**	0.266	**
flesh thickness (mm)	0.212	**	0.172	ns
fruit length (cm)	0.222	**	0.087	ns
flowered time (DAP)	-0.337	**	-0.476	**
harvested time (DAP)	-0.371	**	-0.479	**
number of fruit	0.789	**	0.870	**

Selection in order to increase yield can be done based on several characters. Selection based on several characters can be more effective than just based on yield. According to Sutjahjo, S.H., Rustikawati, A.W., Sandhi, S.G (2007) said that selection becomes effective if character selection into index selection was based on the value of heritability and correlation of the character to fruit weight per plant.Character fruit weight, fruit length and number of fruits were chosen as the basic characters in determining the genotype which will be continued to the next generation. The

selection of these three characters as the basis for index selection was due to having a better correlation coefficient compared to other characters. Based on heritability and correlation values, we selected characters fruit weight, fruit length, number of fruits and yield which were the characteristics of index selection. The same thing was done in Yunandra (2016) studied for these characters which were used as the basis for selection index .

Weighting was done differently between the selected characters. The weighting value used was the same as the weighting value in the study conducted by Yunandra, Syukur, M., Maharijaya, A. (2017), the yield has the highest weighting, given a score 3. number of fruits was given a score 2 because this character has the highest correlation compared to characters others. Fruit length and fruit weight are each given a score 1.

Table 2   Index selection values of fruit weight, fruit length, number of fruits and yield population of bird pepper population F2321290

Genotype	fruit weight	fruit length	number of fruits	yield	Index selection
F2321290-42	-0.28	-0.59	8.89	12.61	20.64
F2321290-220	-0.66	-0.16	8.41	11.92	19.51
F2321290-199	-0.36	-0.89	7.05	9.96	15.76
F2321290-23	1.77	1.87	4.67	6.54	14.85
F2321290-228	-0.28	0.07	4.78	6.70	11.27
F2321290-37	1.09	2.36	3.16	4.38	10.99
F2321290-162	1.23	1.38	2.97	4.09	9.67
F2321290-229	2.19	1.28	2.57	3.52	9.56
F2321290-155	-1.17	-0.69	4.61	6.46	9.21
F2321290-21	-0.06	0.16	3.70	5.15	8.96
F2321290-18	-0.10	0.03	3.70	5.15	8.79
F2321290-154	1.09	1.05	2.77	3.81	8.72
F2321290-185	0.31	-0.79	3.82	5.32	8.66
F2321290-30	1.35	2.59	1.95	2.63	8.52
F2321290-221	1.60	1.15	2.34	3.20	8.28
F2321290-165	1.31	0.62	2.57	3.52	8.02
F2321290-32	-0.45	0.16	3.36	4.66	7.74
F2321290-230	0.64	1.25	2.46	3.36	7.70
F2321290-180	0.14	0.56	2.94	4.05	7.69
F2321290-167	1.21	1.15	2.14	2.91	7.42

The selection intensity used in this study was 10%, its mean that from 200 F2 plants, 20 F2 individuals will be selected to be followed to F3 generation. The results of the selection based on selection index were 20 genotypes in the population F2-321290 can be seen in Table 2. Genotypes F2321290-42 was genotypes that have the highest index value, which is equal to 20.64. Genotypes F3321290-220, F2321290-119, F2321290-23, F2321290-228 and F2321290-37 are genotypes that have a fairly high index value with an index value of more than 10 (Table 2).

The results of the selection based on the selection index were 20 genotypes in the population F2-285290 can be seen in Table 3. Genotypes F2285290-82 was genotypes that have the highest index value, which is equal to 22.11. Genotypes F2285290-50, F2285290-31, F2285290-16, F2285290-245, F2285290-190, F2285290-273, F2285290-273, F2285290-216, F2285290-153, F2285290-153, F2285290-65 and F2285290-30 are genotypes that have the selection index value was high with an index value of more than 10 (Table 3)

Table 3   Index selection values of fruit weight, fruit length, number of fruits and yield population of bird pepper population F2285290

Genotype	fruit weight	fruit length	number of fruits	yield	Index selection
F2285290-82	1.62	2.24	6.15	12.10	22.11
F2285290-50	0.87	1.49	7.23	10.39	19.97
F2285290-31	-0.68	-1.00	8.56	7.51	14.39
F2285290-80	0.33	0.82	4.39	7.20	12.74
F2285290-16	0.07	0.11	3.87	7.84	11.89
F2285290-245	0.63	1.00	5.47	4.78	11.87
F2285290-190	-0.01	0.24	4.02	7.54	11.80
F2285290-273	0.08	0.69	3.53	7.25	11.54

F2285290-216	0.22	0.42	3.39	7.01	11.05
F2285290-153	0.23	0.78	2.95	6.99	10.94
F2285290-65	2.20	-0.73	2.27	7.10	10.84
F2285290-30	0.21	-0.96	3.95	6.86	10.05
F2285290-290	3.33	3.49	-0.20	2.31	8.93
F2285290-244	-0.96	-1.27	5.05	5.97	8.79
F2285290-134	0.06	-0.20	3.39	5.49	8.75
F2285290-123	2.47	0.96	1.82	3.24	8.48
F2285290-263	1.09	2.73	0.88	3.70	8.39
F2285290-102	0.75	0.11	2.84	4.65	8.35
F2285290-36	0.42	-1.22	2.76	5.91	7.87
F2285290-43	-0.82	-0.02	3.47	5.14	7.77

The component values of variability and heritability of populations F2-285290 was presented in Table 4. The value of heritability of broad sense for quantitative characters ranges from 14.21% - 71.25. Characters that have broad heritability values included in the high category were fruit weight (FW), fruit length (FL), fruit diameter (FD) and fruit stalk length (FSL). Characteri of flesh thickness (FT), number of fruits (NF), yield (Y) and harvested time (HT) were included in the medium category. Flowered time (FLT) characters wa in the low category.

High heritability indicate that these characters was more influenced by genetic factors than environmental factors so that characters who have high heritability illustrate that these characters are easily inherited (Widyawati, W., Izmi, Y., Respatijarti, 2014). A.D., Dewi, W., Qosim, W.A., Rahardja, M., Rostini, N., Setiamihardja, R (2006) and Zen (1995) said that characters with high heritability predictions can be selected in the early generations because these characters was easily inherited to their offspring, whereas if the estimated heritability was low then the selection is carried out in the next generation.

Some studies on chilli showed that the predicted high mean broad heritability was found in flowered time characters (Lestari *et al.*, 2006), yield, number of fruits per plant, fruit length (Syukur, M., Sujiprihati, S., Yunianti, R., Undang 2010); fruit weight, fruit length, fruit diameter, fruit thickness, number of fruitt, yield, flowered time, harvested time, (Widyawati, 2014); flowered time (Hastuti, N.M.D., Yulianah, I., dan Saptadi, D., 2016); harvested time (Arif, B.A., Sujiprihati, S., Syukur, M. 2012); fruit length (Dewi, A.A., Ainurrasjid, Saptadi, D., 2016); fruit weight, fruit diameter, yield, harvested time, number of fruits (Qosim, W.A., Rachmadi, M., Hamdani, J.S., Nuri, I, 2013); number of fruits, fruit length, yield (Meena, M.L., Kumar, N., Meena, J.K., Rai, T., 2016); number of fruits, yield, fruit length and fruit weight (Farhad, M., Hasanuzzaman, M., Biswa, S.B.J., Azad, A.K., Arifuzzaman, M., 2008, Chakrabarty and Islam 2017) fruit weight, fruit length and fruit thickness (Hakim, A., Syukur, M., Wahyu, Y., 2019). Heritability values for fruit diameter characters (FD) are included in the medium category.

Table 4 Components of variability and heritability in the character of yield components the bird pepper population of IPB 285x IPB C290

population	fruit weight	fruit length	fruit diameter	fruit thickness	fruit stalk length	number of fruit	yield	flowered time	harvested time
varians P1	0.08	0.09	1.19	0.04	0.12	4938.58	3353.38	15.90	25.92
varians P2	0.14	0.09	0.92	0.02	0.11	1565.00	4585.89	15.42	29.22
varians F1	0.05	0.08	0.25	0.01	0.13	2801.47	6901.60	12.09	28.00
varians F2	0.30	0.21	2.16	0.04	0.24	5808.98	8913.74	16.86	42.30
varians E	0.09	0.09	0.79	0.02	0.12	3101.68	4946.96	14.47	27.71
varians G	0.22	0.12	1.37	0.02	0.12	2707.30	3966.78	2.40	14.58
h^2bs	71.25	58.64	63.48	45.58	51.04	46.61	44.50	14.21	34.48

varians E : varians of environmental; varians G : varians of genetic; h^2bs : heritability broad sense

Table 5 Components of variability and heritability in the character of yield   components of the bird pepper population of IPB 321x IPB C290

population	fruit weight	fruit length	fruit diameter	fruit thickness	fruit stalk length	number of fruit	yield	flowered time	harvested time
varians P1	0.01	0.03	0.18	0.01	0.03	4350.40	3723.12	18.61	35.95

varians P2	0.14	0.09	0.92	0.02	0.11	1565.00	4585.89	15.42	29.22
varians F1	0.04	0.05	0.88	0.01	0.08	3641.17	4949.30	21.49	18.63
varians F2	0.19	0.37	2.11	0.03	0.44	4974.76	5416.41	20.28	61.02
varians E	0.06	0.06	0.66	0.01	0.07	3185.52	4419.44	18.51	27.93
varians G	0.12	0.32	1.45	0.02	0.36	1789.24	996.97	1.77	33.09
h²bs	66.20	84.84	68.69	54.20	83.15	35.97	18.41	8.74	54.23

The component values of the variety and heritability of the population F2-321290 are presented in Table 5. The broad mean heritability values ranged from 8.74 - 84.84%. Characters that have broad mean heritability values included in the high category are weight per fruit (BB), fruit length (PB), fruit diameter (DB), flesh thickness (TDB) and harvest (UP) age. The character of the number of fruits per plant belongs to the medium category. The character of fruit weight per plant and flowering age are in the low category. Ruchjaningsih, A., Imran, M., Thamrin, dan Kanro, M.Z. (2000) state that selection of a character is effective if the character's heritability is high

D. Conclusion

The population of F2-285290 correlation values showed a very significant significance for all characters on the character of fruit weight per plant while in the population F2-321290 only the character of fruit flesh thickness and the length of the fruit stalks were not significantly correlated. The broad mean heritability value in the high category of the two populations is in the weight character per fruit, fruit length, fruit diameter and fruit stalk length. The results of index selection in the population F2-285290 with a selection intensity of 10 percent obtained by selected plants as many as 20 best plants, namely plants no 16, 30, 31, 36, 43, 50, 65, 80, 82, 102, 123, 134, 153, 190, 216, 244, 245, 263, 273 and 290 while in populations F2-321290 selected plants are no. 18, 21, 23, 30, 32, 37, 42, 154, 155, 162, 165, 167, 180, 185, 199, 220, 221, 230, 228 and 229.

E. References

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