Characterization of qualitative and quantitative characters of the hybridized chili (*Capsicum* sp) genotype C10 x C2

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**Abstract.** This study aims to determine the diversity of qualitative and quantitative characters of hybridized chili plants. The research was carried out at the Screen House of the Faculty of Agriculture, Syiah Kuala University, Banda Aceh from April to December 2019. The genotypes used in this research were hybridized chili (IPB C2, IPB C10, F1 C10xC2, BCp1 (C10xC2)xC10, BCp2 (C10xC2)xC2, F2(C10xC2). The Completely Randomized Non Factorial Design was used only for the placement of plant in the field. Data analysis was performed by calculating the average value, variance, and standard deviation. The results showed that the quantitative characters that could be made as selection characters were plant height, and number of fruit per plant. There is diversity in the qualitative character, the shape of lancet leaves are dominant to the shape of oval leaves. This can be seen in IPB C2, F1 (C10 x C2), BCp1 (C10 x C2) x C10 has the shape of a lancet leaf. On IPB C10 has an oval leaf shape then for BCp2 (C10 x C2) x C2 dan F2 (C10 x C2) have the same shape as oval and lancet leaves. Diversity is also seen in the position of flowers there are three types, namely upright, semi-erect and dangling, but all genotypes have the shape of elongate fruit. The result of this research showed the quantitative characters that can be used as selection characters were plant height and fruit number per plant.

**1. Introduction**

The national average chili productivity of the Indonesian national big chili productivity in 2015 was 8.65 tons ha\(^{-1}\) and chili pepper 6.45 tons ha\(^{-1}\). This figure is still far from the needs of chili in Indonesia. One of the improvements in chili production is the provision of high yielding superior seeds. The superior seeds can be through plant breeding activity approach. One of the plant breeding activities in producing superior seeds is by crossing techniques. Crossing between plants with different genetic makeup is one way to obtain greater genetic diversity. Diversity is a substance that needs to be considered to determine the success of plant selection. The higher the genetic diversity the more likely the combination of traits will be obtained [1].

The higher the genetic diversity the more likely the combination of traits will be obtained. This study used chili genotypes from IPB C10 x C2 in which the two elders used have their own advantages. IPB C2 genotype has a high heritability value for disease resistance character while IPB C10 genotype has a heritability value from low to high [2]
Characterization of genotypes IPB C2 and IPB C10 showed significant differences where in the study [3] obtained results of crop fruit weight produced by IPB C2 genotype of 360.85 g compared with IPB C10 Genotype which produced lower crop fruit weight.

The ability of a genotype to inherit its genetically owned character is called heritability [4]. Heritability of an important character is known, especially to estimate the magnitude of the influence of the environment on plant growth and development as well as the selection of an appropriate environment for the selection process [5]. Diversity must be considered in the selection of a population that will be selected to determine the success of plant breeding. If genetic diversity is higher, then the combination of traits obtained for selection is likely to be even greater [6]. Based on the above problems, it is necessary to do further research to characterize the qualitative and quantitative character of chili genotypes resulted from hybridization of IPB C10 x IPB C2

2. Materials and methods

2.1. Place and time
The research was carried out at the screen house and the Laboratory of genetics and plant breeding at the Faculty of Agriculture, Syiah Kuala University, Banda Aceh from April to December 2019.

2.2. Tools and Materials
The tools used in this study consisted of analytical scales, a hoe, polybag (size: 10 kg), nursery tray, meter, hand sprayer, and fat. The chili seeds used in this study were hybridized chili seeds (IPB C2, IPB C10, F1 C10xC2, BCP1 (C10xC2) XC10, BCP2 (C10xC2) XC2, F2 (C10xC2). Manure used in this study was mixed with soil 1: 2 ratio (manure: soil) Pearl NPK fertilizer used is compound fertilizer with a recommended dosage of 250 kg ha⁻¹. NPK fertilizer (brand: Mutiara) is dissolved at a concentration of 1.25 g L⁻¹. Application of NPK fertilizer using a 220 ml container Gandasil D fertilizer is given during the vegetative phase while Gandasil B fertilizer applied during the generative phase of plants with concentration of 1 g L⁻¹. Curacron pesticide applied as an insecticide to prevent insect attacks when the plant has been transferred into polybags with a concentration of 1 ml per 1 liter of water.

2.3. Data analysis
The experimental design in this study was a completely randomized non factorial design which was used only for the method of laying plant polybags in the field. Data analysis was performed by calculating the average and variance values. Chili genotypes consist of 6 genotypes namely IPB C2, IPB C10, F1 C10 x C2, BCP1 (C10 x C2) x C10, BCP2 (C10 x C2) x C2, F2 (C10 x C2)

The coefficient of genetic diversity (GDC) and phenotificity (PDC)

\[ GDC = \sqrt{\frac{\sigma^2_g}{x}} \times 100\% \]  \[ PDC = \sqrt{\frac{\sigma^2_p}{x}} \times 100\% \] \[ \text{[1]} \]

2.4. Implementation
The seeds were first soaked using aerator water for 24 hours to increase seed germination, then the seeds were planted in tray. Growing media in the form of a mixture of topsoil soil and manure with a ratio of 2: 1 is inserted into polybags with a size of 10 kg, sowing plants were transferred into polybags after leafy 4-5 strands or 20 DAS (days after seedling).
Fertilization is given after the plant is 1 MST (weeks after planting) using a NPK fertilizer solution (16:16:16) at a dose of 1.25 g L-1, each plant is given as much as 220 ml. Fertilizers are given once a week [7]. In addition, Gandasil D leaf fertilizer was used during the vegetative period and Gandasil B during the generative period, each with a dose of 1 g L-1. Maintenance activities include watering, replanting, marker installation, control of plant pests and pruning.

2.5. Harvesting
Harvesting of chilies was done five times at the age of 90 to 120 days, which was marked with red color fruit. Harvesting was carried out by picking fruits and their petioles.

2.6. Observation Parameters
Qualitative variables include: leaf shape, flower position, and fruit shape. Quantitative observations included: plant height, stem diameter, flowering age, weight per fruit, fruit weight per plant, number of fruits per plant.

3. Results and discussion
3.1. Qualitative character
Qualitative characters are the characters that are controlled by a few genes. This character is a distinguishing feature between one genotype and another. The qualitative parameters observed in this study were leaf shape, flower position and fruit shape.

Table 1. Qualitative characters of some chili genotypes resulting from crossing of IPB C10 x IPB C2.

| Genotype           | Observed character                  |
|--------------------|-------------------------------------|
|                    | Leaf shape  | Fruit shape | Flower position |
| IPB C2             | Lancet      | Elongate    | Semi-erect     |
| IPB C10            | Oval        | Elongate    | Erect          |
| F₁ (C₁₀ x C₂)      | Lancet      | Elongate    | Erect and semi-erect |
| BC₁₁ (C₁₀ x C₂) x C₁₀ | Lancet      | Elongate    | Drooping, erect and semi-erect |
| BC₂₂ (C₁₀ x C₂) x C₂ | Oval and lancet | Elongate | Erect and Semi erect |
| F₂ (C₁₀ x C₂)      | Lancet dan Oval | Elongate | Drooping, erect and semi erect |

Based on the results of leaf shape character, it can be assumed that the shape of lancet leaves is dominant to the shape of oval leaves. This can be seen in IPB C2, F₁ (C₁₀ x C₂), BC₁₁ (C₁₀ x C₂) x C₁₀ have the shape of a lancet leaf. While in IPB C10 has an oval leaf shape and for BC₂₂ (C₁₀ x C₂) x C₂ and F₂ (C₁₀ x C₂) both have an oval leaf shape and lancet (Figure 1). It is thought that the shape of the leaf is controlled by a gene and there is an influence of the dominance of the lanceolate shape. According to [8] states that the shape of chili leaves varies depending on the type of leaf varieties. In general, oval-shaped leaves, but there are also lancet shaped. This is consistent with the statement of [4] that the shape of leaves or qualitative characters are generally determined by genetics with little or no influence on the environment.
Figure 1. Leaf shape a and 2 oval; b and 3 lancet.

The character of the flower position shows the difference in the genotype of IPB C10 which has an erect flower position. While the IPB C2 genotype has a semi-erect flower position. Then in F1 (C10 x C2), BCP2 (C10 x C2) x C2 has an erect and semi-erect position of interest. Whereas the BCP1 genotype (C10 x C2) x C10 and F2 (C10 x C2) have three forms of flower position namely dropping, erect and semi-erect (Figure 2).

Figure 2. Flower position a and 3 (dropping); b and 5 (semi-erect); c and 7 (erect).

This is consistent with the statement of [9] that crossing between plants that have semi-upright flower positions and plants that have upright flower positions is produced by plants with first derivatives (F1 and F1R) with semi-upright and upright flower positions. If F1-derived plants with semi-upright flowers are self-pollinated, there are some plants from the F2 population with different flower positions than the two parents, namely the drooping flower position. It is suspected that the genotype of semi-upright flower positions in a heterozygous state. If F1-derived plants with semi-upright flowers are crossed with older plants with semi-upright flowers, some of the derived plants in BCP1 population with dangling flower position.
Figure 3. Fruit shape chili pepper on each genotype with shape elongate.

The fruit shape character showed that in all genotypes of chili resulted from crossing of IPB 2 x IPB10 the shape of fruit was in the form of elongate. This is due to the genetic influence of the parents being tested. This is in accordance with the statement of [10] the fruit shape of all chili genotypes from the crossing of the two elongate elders will produce all elongate derivatives.

3.2. Quantitative character and coefficient of diversity

The coefficient of genetic diversity (GDC) and the phenotype diversity coefficient (PDC) in the observed characters show a variety of results that can be seen in Table 4. The GDC values are rather narrow in the stem diameter and flowering age characters, while the GDC values are rather broad in the character of weight per fruit, then the GDC values broad is found in the character of plant height, and the number of fruit plants. A high GDC value indicates that the diversity of characters in a population is very diverse or very different, the higher the GDC value will be more beneficial in the plant selection process because the genotype characters tested are increasingly different.

Table 2. Value of genetic diversity coefficient (GDC) and phenotype diversity coefficient (PDC) on the quantitative character of chili genotypes resulting from crossing of IPB C10 with IPB C2.

| Character               | GDC  | Criteria     | PDC  | Criteria   |
|-------------------------|------|--------------|------|------------|
| Plant height            | 71.20| rather broad | 91.69| broad      |
| Stem diameter           | 29.44| rather narrow| 40.42| rather narrow |
| Flowering Age           | 26.30| rather narrow| 45.94| rather narrow |
| Weight Per Fruit        | 14.43| narrow       | 58.96| rather broad |
| Number of Fruits Per Plant | 60.95| rather broad | 97.27| broad      |

Note: Coefficient of Genetic Diversity: narrow (0% <x≤25%), rather narrow (25% <x≤50%), rather broad (50% <x≤75%), broad (75% <x≤100%).
States that the genotype of chili produced from biparental is almost an average of all agronomic characters having a criterion coefficient of genetic diversity that is narrow to rather narrow, except for the number of fruit per plant is rather broad. It is assumed that these characters have a narrow level of genetic diversity so selection for these characters is not effective to be done. This is in line with the statement of [8] the amount of diversity in the population affects the effectiveness of selection. The greater the level of diversity in the population, the greater the effectiveness of selection to choose a desired character. If the diversity value of some characters in the population is high, the selection in these characters is effective.

The PDC value is rather narrow found in the character of stem diameter, flowering age, while the PDC value is rather broad in the character weight per fruit, then the broad PDC value is found in the character of plant height and number of planted fruit. [9] States the high and low diversity of phenotypes illustrates the appearance of plants in the field. High phenotype diversity is caused by a large diversity of the environment.

4. Conclusions

GDC values are quite extensive in the parameters of plant height, and the number of fruit per plant. PDC values are rather extensive in the fruit weight. PDC that have broad values are found in the parameters of plant height and number of fruit per plant. Observation of quantitative parameters that can be used as a selection character that is the parameters of plant height, and the number of fruit per plant. Observation of qualitative parameters there are differed in all parameters tested except in the form of fruit. It is hoped that further research can be carried out on estimating the genetic parameters of several chili genotypes resulting from hybridization of IPB C10 x C2 to get more selection characters by increasing genetic diversity.

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