

Quantitative and qualitative diversity of chili (*Capsicum* spp.) genotypes

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Abstract. Sahid ZD, Syukur M, Maharijaya A, Nurcholis W. 2022. *Quantitative and qualitative diversity of chili (Capsicum spp.) genotypes. Biodiversitas 23: 895-901.* The diversity of chili species in tropical climate areas, especially Indonesia, is very diverse. Information on the performance of chili both quantitatively and qualitatively is needed to form the basis for future research. This study aimed to obtain qualitative and quantitative character information on several chili genotypes. The results showed that there were differences in chili genotypes based on qualitative and quantitative characters. The genotype that excelled quantitatively in terms of fruit weight was CK 12. In addition, this genotype had a square fruit shape that was absent in other genotypes. The highest number of fruit in this study was indicated by pure lines F8 145291-14-9-3-12-1-1 and Bara. Cluster analysis based on quantitative characters (HCA Analysis) grouped all genotypes into three major groups where the CK 12 genotype separated into one group of its own. The information in this study is very useful for research and development of chili plants.

Keywords: Chili, HCA analysis, qualitative, quantitative

INTRODUCTION

Market demand for horticultural products is urgently needed (Singh and Johari 2018) because the majority of people consume horticultural products. One of the horticultural plants that is demanded by many consumers is chili plant (Kate and Laird 2019). Chili is a horticultural crop that has high market demand and economic value (Solichatun et al. 2021), because it has a spiciness characteristic that can be utilized (Taiti et al. 2019; Oney et al. 2021). Chili consumption in Indonesia in 2020 was 549.48 thousand tons, 60.25% of consumers came from public households. This shows that the majority of those who use chili are the household sector that use chili as a basic ingredient for processed foods. The spiciness of chili is found in chili fruit which consists of seeds, skin, and flesh of chili peppers (Qiang et al. 2021). Therefore, to compensate for the high demand, high crop productivity is also required (Ouyang et al. 2017).

High chili productivity is influenced by several factors. i.e. genetic (Zboralski and Martin 2020) and environmental (Yang et al. 2018) factors. Among the two factors, genetic factor plays a more important role because the environment can be controlled using adaptive genetics (Majid et al. 2017). The assembly of superior chili varieties to deal with existing problems is carried out by plant breeders by combining various superior traits possessed by certain genotypes (Chesaria et al. 2018). Mareza et al. (2021) stated that to increase productivity, characterization,

inventory, and growth evaluation activities are needed. These various activities are useful for preventing genetic erosion which results in the loss of genetic resources (Bakhtiar et al. 2014). Plant breeders carry out conventional breeding activities at the plant genetic level (Qaim 2020). Conventionally, plant breeders require information on genetic material to be used as parents in the hybridization process (Apriliyanti et al. 2016; Marpaung et al. 2019).

Plant Breeding Laboratory, Department of Agronomy and Horticulture, IPB University has a collection of 40 chili genotypes that have the potential to be developed in further research. However, both qualitative and quantitative morphological performance information is needed to be used as a basis for further research. This collection was used in this research to study the distribution of genetic diversity based on quantitative and qualitative characters. Observation of genetic material information carried out in this study aimed to provide information about the character of various chili peppers in Indonesia. Character identification carried out in this study included quantitative and qualitative characters in several chili genotypes.

MATERIALS AND METHODS

Study area and genetic material

This research was conducted in the Alam Sinarsari D80 greenhouse for 5 months (August-December 2021). The

experimental design used in this study was a completely randomized single factor design, with the chili genotype as treatment. The genetic material used in this study was a collection of chili peppers from the Plant Breeding Laboratory, IPB University. The genotypes used in this study are presented in Table 1 and each consisted of three replicates.

Chili was planted in the Alam Sinarsari D80 greenhouse. Planting was started with sowing of seeds into the nursery tray as many as 2 seeds per seedling hole. Watering during seeding was done intensively once a day every morning. When the plant was 4 weeks old or 5 leaves had appeared, the plant was transferred to a planting pot. Fertilization was carried out using ABMix liquid fertilizer specific for chili plants with fertilization intervals of twice a week. Pest and disease treatments were carried out routinely for two weeks using an insecticide with the active ingredient Abamectin with a concentration of 2 mL L⁻¹. Observations were made every week according to a chili descriptor.

Observed variables included quantitative and qualitative characters referring to chili descriptors (IPGRI 1995). Quantitative variables included: dichotomous height, plant height, leaf length, leaf width, stem diameter, fruit length, fruit stalk length, fruit diameter, fruit flesh thickness, fruit weight, and total amount of fruit per plant. While the qualitative characters included leaf character (leaf shape and leaf undulation), stem characters (anthocyanin in stem, intensity of stem anthocyanin, anthocyanin in node and intensity of node anthocyanin), and fruit characters (fruit shape, fruit glossiness, fruit tip, fruit petals, number of locule, and fruit position).

Data analysis

Qualitative data were analyzed using descriptive methods, while the quantitative data were subjected to ANOVA and DMRT post hoc test, performed using the application of SAS 9.0 and R 4.0.5. Cluster Analysis (HCA), and Pearson Correlation were also carried out. Pearson correlation test was carried out using R 4.0.5 with Performance Analytics package (Waongo et al. 2021).

RESULTS AND DISCUSSION

Qualitative characters are shown in Table 2 which includes important parts of chili plants including: fruit, flowers, leaves, and stems. However, qualitative character information should also be supported by quantitative characters which will be shown in Table 3 and Table 4. Qualitative characters are characters that can be used as markers or special characteristics of a plant variety (Hasan et al. 2020). Qualitative characters in plants are influenced by major genes (Carrizo et al. 2016). This shows that the qualitative character will not change due to environmental influences (Hafsah et al. 2021).

The unique qualitative character of chili is generally found in the fruit. The observed fruit characters included fruit shape, fruit shine, fruit tip shape, fruit petals, number of locules and fruit position. The results showed that

genotypes 1 (Square), 24 (Trapezoidal), 21 (Obiate), and 27 (Coordinate) had the type of fruit shape that was only found in these fruits. While the type of chili most commonly found was Narrowly Triangular. Genotype 1 also has a characteristic on the shape of the tip of the fruit, namely Very depressed with the same number of locules as genotype 2 with four locules. The fruit glossiness of chili 1 was included in a strong and was not different from the other 28 genotypes. The position of this chili is dropping. This can be due to the type of chili that can also affect the position of the fruit (Lahbib et al. 2021).

Table 1. Chili genotypes used in this research

No.	Genotype	Species
1.	CK12	<i>C. annuum</i>
2.	CK11	<i>C. annuum</i>
3.	CK3	<i>C. annuum</i>
4.	CK2	<i>C. annuum</i>
5.	ANIES 1-5-1	<i>C. annuum</i>
6.	ARISA	<i>C. annuum</i>
7.	SELOKA 4-10-2-1-3	<i>C. annuum</i>
8.	SELOKA 3-10-2-2	<i>C. annuum</i>
9.	F6074	<i>C. annuum</i>
10.	F7 IMPERIAL 10-2-4	<i>C. annuum</i>
11.	F6074077-1-4-2-1	<i>C. annuum</i>
12.	F6074077-1-1-3-1	<i>C. annuum</i>
13.	F613074-1-4-3-1	<i>C. annuum</i>
14.	F6074136-2-3-2-3	<i>C. annuum</i>
15.	F6074035-2-1-2-4	<i>C. annuum</i>
16.	C141	<i>C. annuum</i>
17.	C37	<i>C. annuum</i>
18.	C5	<i>C. annuum</i>
19.	NAZLA	<i>C. annuum</i>
20.	SSH C6	<i>C. annuum</i>
21.	PEACH CHUPETINHO	<i>C. chinense</i>
22.	PULAIPILA PUTIH	<i>C. frutescens</i>
23.	SSH C14	<i>C. annuum</i>
24.	SSH C11	<i>C. annuum</i>
25.	ADELINA	<i>C. annuum</i>
26.	BONITA	<i>C. frutescens</i>
27.	AYESHA	<i>C. annuum</i>
28.	CIBEUREUM	<i>C. annuum</i>
29.	VIOLA	<i>C. frutescens</i>
30.	C3	<i>C. annuum</i>
31.	F8 285290-123-6-15-4-1-1	<i>C. frutescens</i>
32.	F8 285290-9-2-1-2-2-2	<i>C. frutescens</i>
33.	F8 145291-14-9-3-12-1-1	<i>C. annuum</i>
34.	F8 285290-290-2-2-4-4-1	<i>C. frutescens</i>
35.	BATRISYIA	<i>C. annuum</i>
36.	BARA	<i>C. annuum</i>
37.	F11 145291-115-15-8-1-1-2-5-1 (H)-6	<i>C. annuum</i>
38.	F11 160291-9-4-3-2-1-1-1-1-1	<i>C. annuum</i>
39.	F11 160291-14-10-10-4-9-1-1-1-1	<i>C. annuum</i>
40.	F12 160291-3-12-5-51-1-1-2-1-1-2	<i>C. annuum</i>

Table 2. Qualitative characters on chili genotypes

Parts	Character	Type	Genotype number *)
Fruit characters	Fruit shape	Cordinate	27
		Moderately triangular	3; 22; 32
		Narrowly triangular	5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; 23; 25; 26; 28; 29; 30; 33; 35; 36; 37; 38; 39; 40
		Obiate	21
		Rectangular	2; 4; 31; 34
		Square	1
		Trapezoidal	24
	Fruit glossiness	Weak	15; 17
		Medium	3; 10; 11; 12; 13; 14; 26; 28; 39; 4
		Strong	27; 22; 32; 5; 6; 7; 8; 9; 16; 18; 19; 20; 23; 25; 29; 30; 33; 35; 36; 37; 38; 40; 21; 2; 31; 34; 1; 24
	Fruit tip	Acute	10; 12; 13; 14; 26; 28; 39; 5; 6; 9; 16; 19; 20; 23; 25; 33; 35; 36; 37; 40; 21; 15
		Moderately acute	11; 27; 32; 7; 8; 18; 29; 30; 38; 17
		Moderately depressed	3; 4; 2; 31; 34
		Rounded	22; 24
		Very depressed	1
	Fruit petal	Eveloping	10; 12; 13; 14; 26 ; 28; 39; 5; 6; 9; 16; 19; 20; 23; 25; 33; 35; 36; 37; 40; 15; 11; 27; 32; 7; 8; 18; 29; 30; 38; 17; 31; 34; 22; 24
		Non eveloping	21; 3; 4; 2; 1
	Number of locule	Predominantly two	10; 12; 13; 14; 26 ; 39; 5; 6; 9; 16; 19; 23; 25; 33; 35; 36; 37; 40; 15; 11; 27; 32; 7; 8; 18; 29; 30; 22; 21; 4
		Predominantly three	28; 20; 38; 17; 31; 34; 24; 3
		Predominantly four and more	1; 2
	Fruit Position	Horizontal	20; 31; 34; 26; 32 ; 22; 21
		Erect	28; 38; 39; 19; 23; 33; 35; 36; 37; 40; 27; 29
		Dropping	2; 1; 17; 24; 3; 10 ; 12; 13; 14; 5; 6; 9; 16; 25; 15; 11; 7; 8; 18; 30; 4
Flower characters	Flower Position	Erect	28; 38; 39; 19; 23; 33; 35; 36; 37; 40; 27; 29; 20; 31; 26; 32
		Semi dropping	2; 1; 24; 5; 6; 25; 11; 30; 34; 22; 21
		Dropping	17; 3; 10; 12; 13; 14; 9; 16 ; 15; 7; 8; 18; 4
Stem characters	Anthocyanin in stem	Absent	17; 3; 10; 12; 13; 16; 7; 8; 18; 4; 28; 23; 31; 26; 32; 2; 1; 5; 6; 34; 22
		Present	14; 9; 15; 38; 39; 19; 33; 35; 36; 37; 40; 27; 29; 20; 24; 25; 11; 30; 21
	Intensity of stem anthocyanin	Weak	17; 3; 10; 12; 13; 16; 7; 8; 18; 4; 28; 23; 31; 26; 32; 2; 1; 5; 6; 34; 22; 14; 9; 15; 38; 39; 33; 35; 36; 37; 40; 27; 29; 20; 24; 25; 30; 21
		Medium	11; 19
	Anthocyanin in node	Absent	3; 10; 18; 4; 28; 23; 31; 26; 32; 2; 1; 34; 22; 21
		Present	19; 11; 17; 12; 13; 16; 7; 8; 5; 6; 14; 9; 15; 38; 39; 33; 35; 36; 37; 40; 27; 29; 20; 24; 25; 30
	Intensity of node anthocyanin	Weak	3; 10; 18; 4; 28; 23; 31; 26; 32; 2; 1; 34; 22; 21; 17; 12; 16; 7; 8; 5; 6; 15; 38; 39; 35; 27; 29; 20; 24
		Medium	13; 14; 9; 33; 36; 25; 30
	Strong		19; 11; 37; 40
			1; 4; 21
Leaf characters	Leaf shape	Broad elliptic	13; 14; 9; 33; 36; 25; 30; 19; 11; 37; 10; 28; 23; 17; 12; 16; 7; 8; 5; 6; 15; 38; 39; 35; 27; 29
		Lanceolate	40; 3; 18; 31; 26; 32; 2; 34; 22; 20; 24
		Ovate	1; 21; 13; 14; 36; 25; 30; 19; 11; 37; 10; 28; 12; 16; 7; 8; 5; 6; 15; 38; 39; 35; 27; 29; 40; 3; 18; 26; 20
	Leaf undulation	Weak	4; 9; 33; 23; 17; 31; 32; 2; 34; 22; 24
		Medium	

Note: *) all genotype numbers based on Table 1

The flower position character is a character that can be used to predict the fruit position. Several genotypes observed have the same flower and fruit positions as shown in genotypes 28, 38, and 39 which have erect flower and erect fruit positions. The genotype is a type of cayenne pepper which with its characteristic has an erect fruit and flower position. Information on flower position is needed by chili breeders for the hybridization process and calculating cross contamination (Lin et al. 2020). The observed qualitative characters of stem included the presence and intensity of anthocyanins both in stems and nodes. 19 genotypes had no anthocyanins in stems, and the other 21 genotypes had anthocyanins in stems. Anthocyanin intensity in the 21 genotypes of chili, only 2 genotypes (11, and 19) had medium anthocyanin intensity. For the observed leaf characters, three types of leaf shapes were found in this study, namely Ovate (40, 3, 18, 31, 26, 32, 2, 34, 22, 20, and 24), Lanceolate (13, 14, 9, 33, 36, 25, 30, 19, 11, 37, 10, 28, 23, 17, 12, 16, 7, 8, 5, 6, 15, 38, 39,

35, 27, and 29), and Broad elliptic (1, 4, and 21). Meanwhile, the observed leaf undulation was divided into two, namely weak undulation and medium undulation.

The growth characters observed in this study are presented in Table 3. The height of the chili genotype dichotomous observed was in the range of 10.00-76.67 cm. The highest and shortest dichotomous were exhibited by the Cibeureum and SSH C11 genotypes. Meanwhile, the highest plant height and leaf length were shown by pure line F8 285290-123-6-15-4-1-1. Leaf width measured in this study was in the range of 2.27-7.83 cm. The narrowest leaf width was exhibited by the Ayesha genotype. Ayesha is a type of ornamental chili pepper that has small leaves with a length of 5.77 cm and a width of 2.27 cm. The widest leaf character was shown by the pure line genotype F8 285290-290-2-2-4-4-1. In addition, this genotype also had the thickest stem diameter compared to all other genotypes of 11.52 mm.

Table 3. Quantitative character of growth in chili genotypes

Genotype	DH	PH	LH	LW	SD
CK12	24.33 ^{pq}	141.67 ^e	12.50 ^e	7.40 ^b	8.71 ⁿ
CK11	16.33 st	100.67 ^k	8.33 ^m	5.10 ^e	8.75 ^m
CK3	18.33 ^{rs}	121.00 ^g	11.63 ^g	3.80 ^{jk}	8.71 ^{mn}
CK2	24.00 ^{pq}	108.33 ^j	6.53 ^q	4.20 ⁱ	6.70 ^z
ANIES 1-5-1	24.67 ^p	71.00 ^t	10.40 ^h	3.70 ^{kl}	8.11 ^s
ARISA	33.33 ^{i-l}	88.67 ^{mn}	11.93 ^f	4.80 ^{fg}	7.51 ^w
SELOKA 4-10-2-1-3	21.00 ^{qr}	84.00 ^{op}	8.63 ^l	3.20 ^{no}	7.43 ^x
SELOKA 3-10-2-2	13.33 ^{tu}	87.33 ^{no}	9.50 ⁱ	3.30 ^{mn}	6.14 ^z
F6074	32.00 ^{k-n}	101.33 ^k	9.00 ^{jk}	4.10 ⁱ	6.98 ^y
F7 IMPERIAL 10-2-4	36.33 ^{f-i}	131.33 ^f	9.60 ⁱ	3.80 ^{jk}	8.87 ^l
F6074077-1-4-2-1	30.33 ^{lmn}	110.00 ^{ij}	9.07 ^{jk}	3.63 ^{kl}	9.35 ⁱ
F6074077-1-1-3-1	30.67 ^{lmn}	76.00 ^{rs}	9.43 ⁱ	3.00 ^{op}	4.27 ^z
F613074-1-4-3-1	37.00 ^{gh}	115.00 ^h	13.00 ^d	4.77 ^g	8.19 ^r
F6074136-2-3-2-3	39.33 ^f	107.67 ^j	13.13 ^d	4.43 ^h	6.94 ^y
F6074035-2-1-2-4	38.67 ^{fg}	132.33 ^f	7.47 ^o	2.60 ^q	8.69 ⁿ
C141	29.33 ^{mn}	89.33 ^{mn}	6.87 ^{pq}	3.07 ^{op}	7.57 ^v
C37	35.67 ^{g-j}	76.33 ^{rs}	9.60 ⁱ	4.13 ⁱ	8.58 ^o
C5	25.33 ^{op}	77.67 ^{rs}	10.17 ^h	4.60 ^{gh}	7.64 ^u
NAZLA	10.67 ^u	25.33 ^w	6.20 ^r	3.00 ^{op}	8.49 ^p
SSH C6	13.33 ^{tu}	66.00 ^u	8.73 ^{kl}	4.10 ⁱ	6.04 ^z
PEACH CHUPETINHO	16.00 st	52.33 ^v	7.57 ^o	4.10 ⁱ	6.75 ^z
PULAIPILA PUTIH	62.00 ^{de}	177.33 ^b	10.23 ^h	7.53 ^b	9.49 ^h
SSH C14	39.33 ^f	87.67 ^{no}	6.83 ^{pq}	3.37 ^{mn}	7.88 ^t
SSH C11	10.00 ^u	67.00 ^u	7.13 ^p	3.80 ^{jk}	10.13 ^f
ADELINA	17.33 ^s	87.00 ^{no}	8.03 ⁿ	3.50 ^{lm}	8.43 ^q
BONITA	60.00 ^e	165.00 ^d	9.33 ^{ij}	5.00 ^{ef}	11.37 ^b
AYESHA	12.33 ^u	52.00 ^v	5.77 ^s	2.27 ^r	6.05 ^z
CIBEUREUM	76.67 ^a	172.33 ^c	9.00 ^{jk}	5.20 ^e	9.15 ^j
VIOLA	12.00 ^u	63.67 ^u	6.57 ^q	2.90 ^p	5.35 ^z
C3	32.67 ^{j-m}	88.67 ^{mn}	6.67 ^q	2.50 ^q	7.59 ^v
F8 285290-123-6-15-4-1-1	66.67 ^{bc}	186.00 ^a	17.20 ^a	5.53 ^d	10.64 ^c
F8 285290-9-2-1-2-2-2	64.00 ^{cd}	163.00 ^d	15.17 ^c	6.83 ^c	10.36 ^e
F8 145291-14-9-3-12-1-1	32.00 ^{k-n}	95.33 ^l	11.97 ^f	4.80 ^{fg}	8.57 ^o
F8 285290-290-2-2-4-4-1	69.00 ^b	179.33 ^b	16.40 ^b	7.83 ^a	11.52 ^a
BATRISYIA	29.00 ^{mn}	79.00 ^{qr}	5.23 ^t	2.53 ^q	6.12 ^z
BARA	29.33 ^{mn}	92.33 ^{lm}	8.77 ^{kl}	4.10 ⁱ	10.53 ^d
F11 145291-115-15-8-1-1-2-5-1 (H)-6	28.33 ^{no}	72.00 ^t	9.03 ^{jk}	5.57 ^d	9.03 ^k
F11 160291-9-4-3-2-1-1-1-1-1	35.00 ^{h-k}	113.00 ^{hi}	10.17 ^h	4.00 ^{ij}	8.55 ^o
F11 160291-14-10-10-4-9-1-1-1-1	31.00 ^{lmn}	82.00 ^{pq}	10.23 ^h	4.00 ^{ij}	8.53 ^{op}
F12 160291-3-12-5-51-1-1-2-1-1-2	29.67 ^{lmn}	74.67 st	5.50 st	2.87 ^p	9.86 ^g

Note: Numbers followed by the same letter in the same column were not significantly different according to DMRT 5%, DH: dichotomous height, PH: plant height, LH: leaf height, LW: leaf width, SD: stem diameter

The observed characteristics of chili peppers in this study are specifically shown in Table 4. The results showed that the CK12 genotype was the genotype that had the highest fruit diameter, fruit flesh thickness, and fruit weight compared to all observed genotypes. The chili genotype that has the longest fruit in this study is Arisa. Fruit length measured in this study was in the range of 1.37 cm to 14.37 cm. Peach Chupetinho genotype had the shortest fruit length. However, the study results showed that the shortest fruit length did not necessarily have the shortest fruit stalk. The shortest fruit stalk in this study was exhibited by the SSH C11 genotype. Bara cayenne pepper was the genotype that had the smallest fruit weight compared to all observed genotypes. However, this genotype actually had the second

highest number of fruit planted after the pure line genotype F8 145291-14-9-3-12-1-1.

HCA analysis (Figure 1) was used to determine the relationship between the observed genotypes and between observed variables. The results showed that the genotype and the observed variables were separated into three large groups. Growth characters (TFP, SD, DH, PH, LW, and LH) were grouped into group one. Fruit characters are separated into two groups, with the second group consisting of: FWP, FW, FD, and TFF. While the third group consists of two variables, namely: Fruit Stalk Length and Fruit Length. This is in line with research (Hakim et al. 2019) that the fruit length character is different from other fruit observations.

Table 4. Quantitative character of fruit in chili genotypes

Genotype	FL	FSL	FD	FFT	FW	TFP
CK12	6.63 ^l	3.53 ^{f-j}	76.88 ^a	7.18 ^a	109.59 ^a	23.33 st
CK11	6.73 ^{kl}	2.77 ^k	44.94 ^b	5.07 ^b	40.48 ^b	27.00 ^{rst}
CK3	12.67 ^{bc}	5.07 ^b	35.23 ^c	3.29 ^c	35.73 ^{bc}	17.67 ^t
CK2	6.70 ^{kl}	3.67 ^{d-i}	32.07 ^d	5.23 ^b	31.84 ^c	29.67 ^{q-t}
ANIES 1-5-1	11.30 ^{ef}	3.13 ^{h-k}	12.80 ^{l-o}	1.39 ^{o-s}	9.00 ^{f-l}	55.00 ^{j-n}
ARISA	14.37 ^a	3.10 ^{h-k}	10.69 ^{qrs}	1.98 ^{f-i}	9.24 ^{f-k}	62.67 ^{ij}
SELOKA 4-10-2-1-3	7.33 ^{jk}	3.60 ^{e-j}	11.75 ^{o-r}	1.68 ^{j-n}	4.46 ^{g-n}	48.67 ^{k-o}
SELOKA 3-10-2-2	9.10 ^h	4.23 ^{cde}	15.39 ^{ghi}	2.21 ^{ef}	7.40 ^{f-n}	48.33 ^{k-o}
F6074	11.87 ^{de}	3.50 ^{f-j}	14.97 ^{hij}	1.76 ^{i-l}	12.82 ^{ef}	77.33 ^{gh}
F7 IMPERIAL 10-2-4	10.13 ^g	3.00 ^{ijk}	12.61 ^{m-p}	2.05 ^{e-h}	9.54 ^{f-j}	70.00 ^{hi}
F6074077-1-4-2-1	11.97 ^d	4.60 ^{bc}	13.94 ^{i-m}	2.88 ^d	11.49 ^{efg}	64.67 ^{hij}
F6074077-1-1-3-1	12.80 ^b	4.00 ^{c-f}	16.56 ^g	1.92 ^{g-j}	11.11 ^{e-h}	63.00 ^{ij}
F613074-1-4-3-1	13.97 ^a	4.30 ^{cd}	12.90 ^{k-o}	1.26 ^{q-u}	11.13 ^{e-h}	57.00 ^{i-m}
F6074136-2-3-2-3	12.07 ^{cd}	3.00 ^{ijk}	12.48 ^{m-p}	1.97 ^{f-i}	8.48 ^{g-m}	59.67 ^{i-l}
F6074035-2-1-2-4	13.00 ^b	3.17 ^{h-k}	13.54 ^{j-n}	2.14 ^{efg}	8.83 ^{f-l}	61.33 ^{ijk}
C141	9.80 ^g	3.93 ^{d-g}	16.10 ^{gh}	1.85 ^{h-k}	11.64 ^{efg}	48.67 ^{k-o}
C37	13.03 ^b	4.07 ^{c-f}	24.09 ^{ef}	2.26 ^e	25.32 ^d	34.33 ^{p-s}
C5	11.00 ^f	4.13 ^{c-f}	23.09 ^{ghi}	2.92 ^d	17.17 ^e	61.67 ^{ijk}
NAZLA	3.17 ^q	2.93 ^{jk}	11.10 ^{pqr}	1.73 ^{i-m}	2.58 ⁱ⁻ⁿ	84.33 ^{fg}
SSH C6	7.37 ^{jk}	3.20 ^{h-k}	11.24 ^{o-r}	1.88 ^{g-k}	5.96 ^{f-n}	36.00 ^{o-s}
PEACH CHUPETINHO	1.37 ^r	1.90 ^m	15.13 ^{g-j}	1.55 ^{l-p}	1.45 ^{mn}	45.33 ^{m-p}
PULAIPILA PUTIH	5.60 ^{mn}	4.17 ^{c-f}	12.25 ^{n-q}	1.74 ^{i-m}	2.58 ⁱ⁻ⁿ	47.33 ^{l-p}
SSH C14	4.00 ^p	2.10 ^{lm}	12.76 ^{l-p}	1.62 ^{k-o}	2.54 ⁱ⁻ⁿ	53.00 ^{j-n}
SSH C11	5.17 ^{no}	1.83 ^m	24.99 ^e	2.20 ^{ef}	9.95 ^{f-i}	42.67 ^{n-q}
ADELINA	8.03 ⁱ	3.17 ^{h-k}	9.44 st	1.27 ^{q-u}	5.43 ^{g-n}	49.00 ^{k-o}
BONITA	4.07 ^p	3.00 ^{ijk}	11.48 ^{o-r}	1.21 ^{r-u}	2.34 ^{j-n}	107.67 ^{cd}
AYESHA	1.87 ^r	1.97 ^m	11.61 ^{o-r}	1.23 ^{q-u}	1.26 ^{mn}	65.00 ^{hij}
CIBEUREUM	4.80 ^p	3.70 ^{d-h}	14.39 ^{i-l}	1.94 ^{g-j}	3.49 ⁱ⁻ⁿ	38.33 ^{o-r}
VIOLA	2.87 ^q	2.63 ^{kl}	11.65 ^{o-r}	1.72 ^{i-m}	2.79 ^{j-n}	44.33 ^{m-p}
C3	7.83 ^{ij}	3.53 ^{f-j}	16.66 ^g	1.47 ^{m-q}	6.28 ^{f-n}	42.33 ^{n-q}
F8 285290-123-6-15-4-1-1	4.93 ^o	3.30 ^{g-k}	14.93 ^{hij}	1.44 ^{n-r}	4.18 ^{h-n}	93.67 ^{ef}
F8 285290-9-2-1-2-2-2	4.00 ^p	6.03 ^a	14.45 ^{ij}	1.49 ^{l-q}	2.66 ⁱ⁻ⁿ	108.33 ^{cd}
F8 145291-14-9-3-12-1-1	4.13 ^p	3.57 ^{e-j}	10.28 ^{rs}	1.08 ^{tu}	2.02 ^{k-n}	133.67 ^a
F8 285290-290-2-2-4-4-1	4.03 ^p	3.50 ^{f-j}	14.39 ^{i-l}	1.86 ^{h-k}	4.51 ^{g-n}	101.33 ^{de}
BATRISYIA	4.10 ^p	3.17 ^{h-k}	9.23 st	1.16 ^{stu}	2.33 ^{j-n}	63.00 ^{ij}
BARA	3.13 ^q	3.10 ^{h-k}	6.85 ^v	1.09 ^{tu}	1.14 ⁿ	133.00 ^a
F11 145291-115-15-8-1-1-2-5-1 (H)-6	5.93 ^m	3.67 ^{d-i}	9.51 st	1.63 ^{k-o}	2.56 ⁱ⁻ⁿ	94.67 ^{ef}
F11 160291-9-4-3-2-1-1-1-1-1	3.97 ^p	3.50 ^{f-j}	7.18 ^{uv}	1.15 ^{stu}	1.74 ^{lmn}	128.00 ^{ab}
F11 160291-14-10-10-4-9-1-1-1-1	2.97 ^q	4.97 ^b	8.39 ^{tu}	1.04 ^u	1.27 ^{mn}	120.00 ^{bc}
F12 160291-3-12-5-51-1-1-2-1-1-2	4.90 ^o	3.73 ^{d-h}	8.45 ^{tu}	1.33 ^{p-t}	2.23 ^{j-n}	115.00 ^c

Note: Numbers followed by the same letter in the same column were not significantly different according to DMRT 5%, FL: fruit length, FSL: fruit stalk length, FD: fruit diameter, FFT: fruit flesh thickness, FW: fruit weight, TFP= total amount of fruit per plant

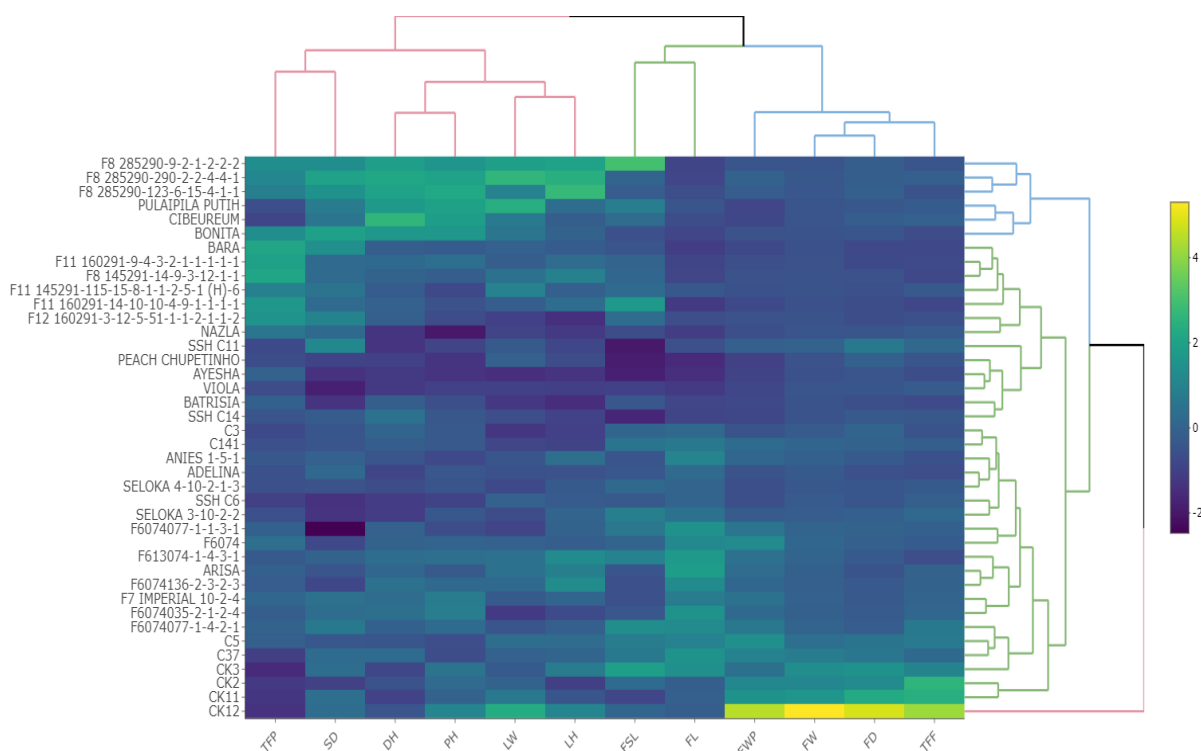


Figure 1. Cluster analysis (HCA) on chili genotypes

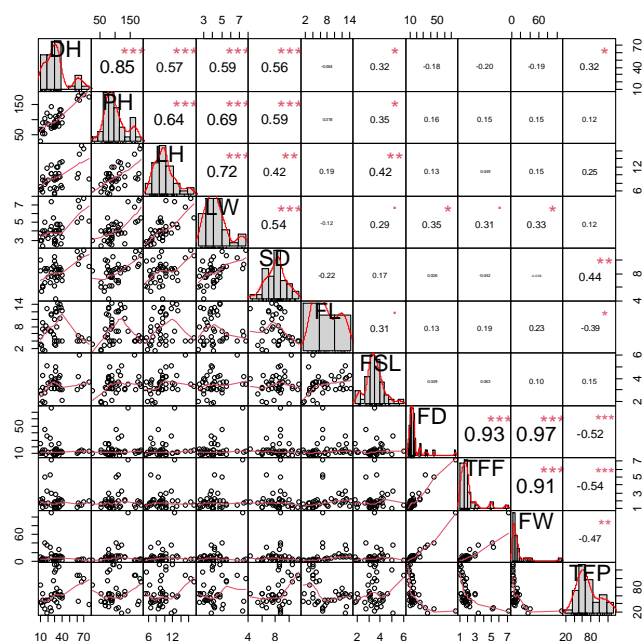


Figure 2. Pearson correlation on chili genotypes

The CK12 genotype separated itself into group one. While the second group consisted of six genotypes (Bonita, Cibeureum, Pulaipila white, F8285290-9-2-1-2-2-2, F8285290-290-2-2-4-4-1, F8285290-123-6-15-4-1-1). The remaining thirty-three Genotypes fall into the third group.

The grouping of the genotype was based on the vegetative growth and fruit characters of chili. This is in line with the research of Sahid et al. (2020) which showed that the grouping of chili based on growth and fruit characters was also divided into three major groups.

Pearson correlation between observed quantitative observation variables can be seen in Figure 2. Pearson correlation is useful for determining which observational variables support each other (positive correlation) and vice versa (negative correlation) (Adeel et al. 2019). The results in this study indicate that the TFP character is significantly negatively correlated with several other characters (FW, TFF, FD and FL). On the other hand, this character is significantly positively correlated with the characters of DH and SD. The FD character has a significant positive correlation with the TFF, FW, and LW characters. This shows that the thicker the diameter of the fruit, the thicker the flesh of the chili. The thickness of the fruit diameter also affects the higher fruit weight. Interestingly in this study, the character of fruit diameter was significantly positively correlated with leaf width. This shows that the results of the photosynthesis process in the wider leaves will affect the thickness of the fruit diameter (Jiang et al. 2017).

It was concluded that some of the genotypes used in this study had different qualitative and quantitative characteristics. Striking differences can be seen in the fruit, leaves, and stem characters. The clustering based on HCA analysis divided the genotypes into 3 major groups. The CK 12 genotype formed its own cluster based on quantitative observations. Qualitatively, this genotype

belongs to the paprika group which has unique characteristics such as the number of locules of four, very depressed fruit tip, and box-shaped fruit. The fruit weight of CK 12 was also observed to be the highest compared to other genotypes (109.59 g) but the highest number of fruits in this study was shown by cayenne pepper genotype Bara and pure lines F8 145291-14-9-3-12-1-1.

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