Evaluation of Some Morphological Characteristics of Several Genotypes of Capsicum Plant (*Capsicum annuum* L.) in northwestern Syria

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Abstract

For protect biodiversity and preserve local genetic types, the research was carried out to evaluate some morphological traits of several locally types from Capsicum annuum Plant (Qarn-Aljamous, Qarn-Alghazal, Haskuria, Long-Mutabasha, Short-Mutabasha, Safrania, and Harimia) of Idlib Governorate in northwestern Syria for the agricultural season 2022. The morphological characterization was carried out by applying 20 qualitative characterizations that included the characteristics of plants, flowers, fruits and seeds. The distinctive qualitative morphological characteristics were the nature of the flower growth, the shape of the fruit, the appearance or absence of the base of the fruit, and the wavy cross-section of the fruit.

Morphological characterization results of the studied types, based on some morphological characteristics, showed that there is a difference between these types, especially in the character of the nature of flower growth and fruit traits. The results of the cluster analysis also showed that the studied models were distributed into two groups: the first included (Long-Mutabasha, Short-Mutabasha, Safrania, and Qarn-Aljamous) and the second included (Qarn-Alghazal, Haskuria, and Harmia

Key words: Capsicum annuum, leaves, Flowers, fruits morphological characteristics, cluster analysis.

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1- Introduction

Capsicum (*Capsicum annuum* L.) is a small shrub that can reach a height of about 1-1.8 meters. Its leaves are rectangular to oval-shaped, w It is a length ranging from 4-13 cm and a width of 1.5-4 cm with a complete margin. Its flowers are small, white or purple in color and its fruits are red, but can also be green, orange, and yellow, growing up to 15 cm. The seeds are pale yellow, disk-shaped, and have a diameter ranging from 3-5 mm. It belongs to the Solanaceae family and is the third most important crop after tomatoes and potatoes (Hasan, 2001). Its native region is America, particularly Mexico, and it is found in hot and humid climates (Thang, 2007). The predominant fertilization method in capsicum plants is cross-fertilization, which varies greatly and ranges from 2 to 90% (Justino et al, 2018). The flowers in the Capsicum annum species are single and white in color (Melgarejo, 2004. Per 100 grams of fresh red capsicums, it contains 4.8% carbohydrates and 1.2% protein, in addition to containing vitamins (A, C), minerals (potassium, calcium), and a good amount of fiber, including flavonoids that help prevent diseases (Khaleel, 2004). Red capsicums are among vegetables high in vitamin C content, with one kilogram of red capsicums extending the daily estimated requirement of an adult (Farrag, 1980). Moreover, red capsicum contains many carotenoids that are antioxidant compounds and help prevent chronic diseases (Howard, et al, 2000) and have anti-inflammatory properties (Lee, et al, 2005). Capsicum varieties are divided into two main categories: hot capsicums and sweet capsicums. The Capsicum genus includes between 20 to 30 species (Votava et al, 2000), of which five have been bred, namely Capsicum annuum, Capsicum frutescens, Capsicum chinense, Capsicum pubescens, and Capsicum baccatum. These species are diploid and share the same number of chromosomes (2 x =2 n = 24) (Ranganathan and Jagatheeswari, 2013). Genetic traits play a significant role in determining the behavior and development of plants at different growth stages, their productivity, and their ability to benefit from nutrients based on the development and growth of their vegetative and root systems (Kaiser and Ernst, 2014). Variations in capsicum varieties were found to affect their growth, production, and fruit quality (Konner et al) and their production largely varies according to their variety (Dennis, 2013). However, it is always essential to consider the quality and taste of fruits in terms of their appearance, color, level of spiciness, and general consumer preferences. Capsicum fruits differ in shape, size, color, taste, and chemical composition due to their genetic diversity and changes in organ development and biochemical composition during maturation (Bhandari et al, 2013). Capsicum fruits of most varieties are red when ripe (Sudré et al., 2010), and multiple color and taste characteristics determine the quality of capsicum fruits (Koeda et al., 2014). Varieties of capsicums were also found to differ in the timing of fruit ripening (Radovich et al., 2010). The external appearance of the fruits is crucial in determining their quality for fresh consumption, in addition to other criteria. Capsicum farmers typically distinguish local varieties according to fruit and plant characteristics and seed sowing or transplanting times, in addition to their sensory aspects (Votava et al, 2005; Castellon et al, 2012). Choosing the fruit shape is one of the main factors for maintaining distinct appearance differences, though it is necessary to describe all the morphological variations of the plant, and farmers usually choose the varieties they want to use in cooking to maintain the fruits and seeds (Kraft et al, 2010). Morphological characterization is necessary to differentiate between different varieties of capsicum plants (Pardey et al, 20066; Olatunji et al, 2020). Quality shape traits are evaluated based on the International Plant Genetic Resources Institute's criteria (IPGRI, 1995). Due to the scarcity of scientific research and information on local capsicum varieties and their characterization, it was necessary to conduct this research to preserve biological diversity and ensure the conservation of local genetic origins.

1- The assessment of some morphological characteristics and determination of the level of morphological diversity present in the

studied varieties (stem traits, leaf traits, flower traits, fruit traits, seed traits) and their description.
2- Identification of highly distinctive characteristic traits.
3- Classification of the studied varieties into groups based on their morphological characteristics.

2- Materials and Methods:

2-1-Research Materials:

The study was conducted on seven local genetic varieties of capsicum plants, which are:
1- Qarn-Alghazal
2- Qarn-Aljamous
3- Haskuria
4- Long-Mutabasha
5- Short-Mutabasha
6- Safrania
7- Harimia

2-2 Research Methods:

2-2-1 Research Site: The research was conducted during the 2022 agricultural season on agricultural land in Idlib, northwestern Syria, which is 334 meters above sea level.

2-2-2- Seed Preparation and Planting: Seeds were extracted from the mature red fruits of the studied capsicum varieties, dried, and stored until the time of planting. The seeds were planted in 200 ml plastic cups containing a soil mixture composed of fermented local fertilizer and red soil in a 2:1 proportion, respectively, on March 15, 2022. The seedlings appeared on April 5, 2022, and the growth continued until April 30, 2022.
The seedlings were left to grow in the plastic cups until May 15, 2022, and then randomly transplanted to the permanent soil and planted in rows at a density of 5 plants/m².
The plants were irrigated by drip, and appropriate fertilizers were added according to customary farmer additions, and a pest and disease control program was implemented for all studied varieties as needed.

2-3 Experimental Treatments: The plants were divided into seven treatments, each with three replicates (experimental units) containing five plants in each. Therefore, the total number of plants was 105. The size of each experimental unit was 1 square meter and contained 5 plants, with a total of 12 experimental units. The planting distances were (80*40): 80 cm between rows and 40 cm between plants in the same row.

3- Experimental Design and Statistical Analysis:

The complete randomization design was followed in the experimental design, within the completely randomized block RCB in the distribution of treatments. Cluster analysis was performed to classify the varieties into groups based on the degree of similarity between them, based on the studied traits.

4- Morphological Traits Studied: The morphological description of some outdoor traits was performed from the beginning of June until the end of October 2022, based on what was determined by the International Plant Genetic Resources Institute (IPGRI, 1995).

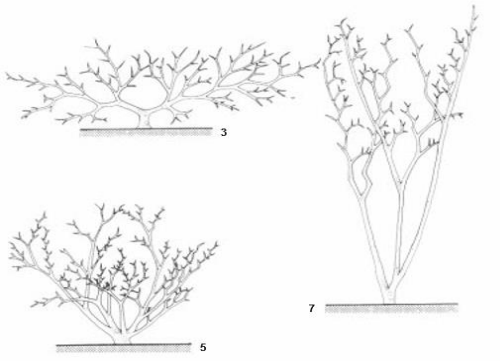
4-1- Stem density:

4-1-1- Stem color: Recorded on small plants before germination
1- Green
2- Green with purple stripes
3- Purple
4- Other

4-1-2- Stem shape: Observed at plant maturity
1- Cylindrical
2- Angled
3- Flattened

4-1-3- Plant height (cm): Recorded when in 50% of the plants the first fruit has begun to ripen
1 <25
2 25-45
3 46-65
4 66-85
5 >85

4-1-4- Plant growth habit: Observed when 50% of the plants bear ripe fruits
3 Prostrate
5 Intermediate (compact)
7 Erect
9 Othe



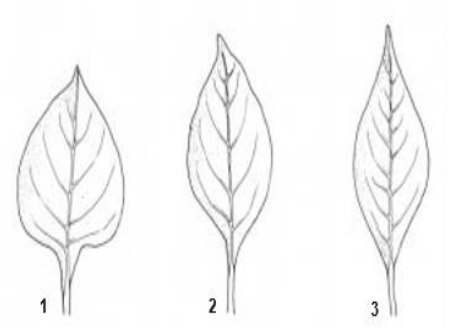
4-2- Leaf density:

4-2-1 Leaf color: Recorded when in 50% of the plants the first fruit ha begun to ripen. Average of 10 mature leaves (from the main branches of the plant)

1- Yellow
2- Light green
3- Green
4- Dark green
5- Light purple
6- Purple
7- Variegated
8- Other

4-2-2- Leaf shape: Recorded when in 50% of the plants the first fruit ha begun to ripen. Average of 10 mature leaves (from the main branches of the plant)

1- Deltoid
2- Ovate
3- Lanceolate



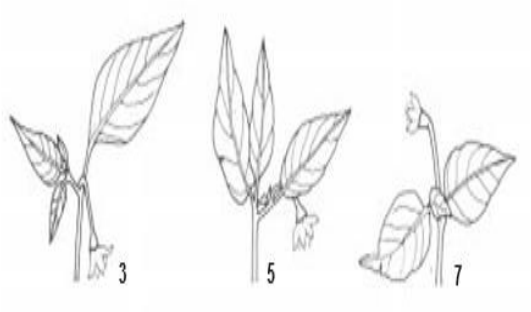
4-2-3- Leaf margin: Recorded when in 50% of the plants the first fruit ha begun to ripen. Average of 10 mature leaves (from the main branches of the plant)

1- Entire
2- Undulate
3- Ciliate

4-3- Flower density: Recorded on fully open flowers in the first fresh flowering

4-3-1- Flower position:

3 Pendant
5 Intermediate
7 Erect



4-3-2- Corolla color:

1- White
2- Light yellow
3- Yellow
4 Yellow-green
5- Purple with white base
6- White with purple base
7- White with purple margin
8- Purple
9- Other

4-3-3- Corolla shape:

1- Rotate
2- Campanulate
3- Other

4-3-4- Corolla length (cm): Average of 10 petals of dissected corolla.

1 <15
2 1.5-2.5
3 >25

4-3-5- Calyx margin:

1- Entire
2- Intermediate
3- Dentate
4- Other

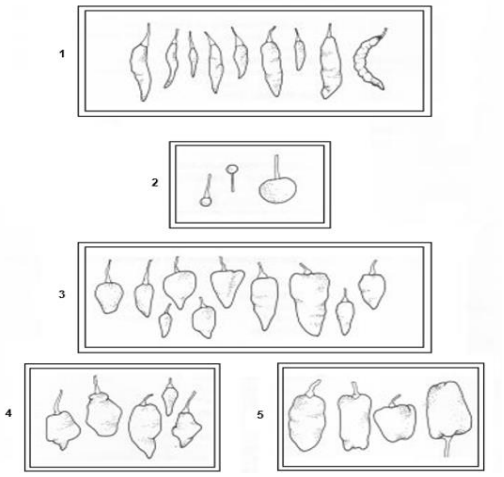
4-4- Fruit density: Recorded on mature fruits.

4-4-1- Fruit colour at mature stage:

1- White
2- Lemon- yellow
3- Pale orange-yellow
4- Orange-yellow
5- Pale orange
6- Orange
7- Light red
8- Red
9- Dark red
10- Purple
11- Brown
12- Black
13- Other

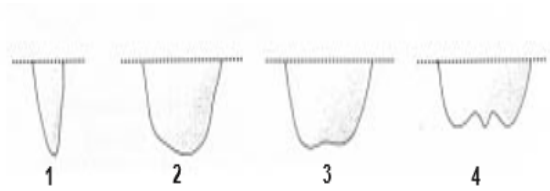
4-4-2- Fruit shape:

1- Elongate
2- Almost round
3- Triangular
4- Campanulate
5- Blocky
6- Other



4-4-3- Fruit shape at blossom end: Average of 10 fruits

1- Pointed
2- Blunt
3- Sunken
4- Sunken and pointed
5- Other



4-4-4- Neck at base of fruit:

0 Absent
1 Present

4-4-5 Fruit cross-sectional corrugation: Average of 10 fruits (1/3 from pedicel end)

3 Slightly corrugated
5 Intermediate
7 Corrugated

4-5-Seed density:

4-5-1- Seed color:

1- Straw (deep yellow)
2- Brown
3- Black
4- Other

4-5-2- Seed size: Average of 10 randomly selected seeds.

3 small
5 Intermediate
7 large

4-5-3- Seed diameter (mm): Maximum diameter of 10 seeds to two decimal places

4-5-4- Number of seeds per fruit: Average of at least 10 fruits selected from 10 random plants

1 <20
2 20-50
3 >50

5- Results and Discussion:

5-1- Stem characteristics: All studied genotypes had green stems with a moderate (compact) growth habit and a stem angle. The plant height was greater than 85 cm, except for the short bushy capsicum genotypes whose plant height ranged between 66-85 cm (Figure 1).

Figure (1): Leg shape in Embroidery Designs

5-2- Leaf characteristics: All studied genotypes had light green, oval-shaped leaves with a smooth (entire) margin (Figure 2).

Figure (2): Leg shape in Embroidery Designs

5-3- Flower characteristics: All studied genotypes had upright growth habits, except for Safrania capsicum plants whose flowers exhibit a pendulous growth habit. Horned capsicum plant flowers have a semi-pendulous growth habit. The corolla of all genotypes was bell-shaped, white in color, with a length of less than 1.5 cm and a moderately serrated cup edge (Figure 3).

Figure (3): Floral Shape in Embroidery Designs

5-4- Fruit characteristics: All studied genotypes had dark red elongated fruits at the mature stage, except for the long and short bumpy capsicum genotypes, whose fruits are swollen. The horned capsicum and Safrania capsicum genotypes had triangular-shaped fruits. The fruit base was visible in all genotypes, except for the deer horn, Haskuria, and Harimia genotypes, whose fruit base was absent. The fruit cross section of all studied genotypes was undulating, except for the deer horn genotype, whose fruit cross section was moderately undulating. The Haskuria and Harimia capsicum genotypes had slightly undulating fruit cross sections. The fruit end was hollow and tapered in all studied genotypes, except for the Haskuria and Harimia capsicum genotypes, which had a pointed fruit end (Figure 4).

Figure (4): Fruit Shape in Embroidery Designs

5-5- Seed characteristics: All studied genotypes had large, dark yellow seeds, except for the Haskuria and Harimia capsicum genotypes, whose seeds were of medium size. The number of seeds in all studied genotypes was more than 50 seeds per fruit, except for the Haskuria capsicum genotype, whose seeds ranged from 20 to 50 seeds per fruit (Figure 5).

Figure (5): Seed Shape in Embroidery Designs

5-6- Cluster analysis of the studied morphological traits:

From Figure 6, the distribution of the studied genotypes in the first stage can be observed in four clusters. The first cluster included three genotypes (Long-Mutabasha, Short-Mutabasha, Qarn-Aljamous), the second cluster included two genotypes (Qarn-Alghazal, Harimia capsicum), the third cluster included only one genotype (Haskuria capsicum), and the fourth cluster included only one genotype (Safrania capsicum). In the second stage, the studied genotypes were distributed among three clusters. The Haskuria capsicum genotype moved from the third cluster in the first stage to the second cluster in the first stage, while the Safrania Haskuria capsicum genotype moved from the fourth cluster in the first stage to the third cluster in the second stage. In the third stage, the studied genotypes were distributed among only two clusters, and the Safrania Haskuria capsicum genotype moved from the third cluster in the second stage to the first cluster in the third stage.

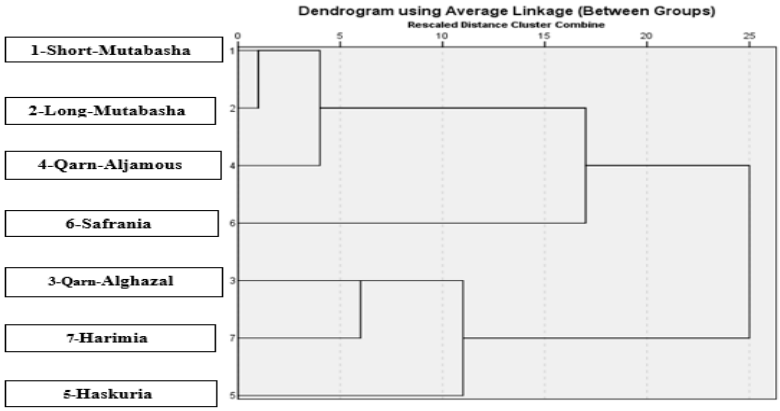


Figure (6) displays the dendrogram of the studied genotypes obtained through hierarchical cluster analysis with qualitative variables based on the morphological characterization of seven local capsicum genotypes.

6- Conclusions:

6-1-According to the results of the cluster analysis, the studied genotypes were divided into two groups: The first group included the genotypes (Long-Mutabasha, Short-Mutabasha, Safrania, Qarn-Aljamous), and the second group included the genotypes (Qarn-Alghazal, Harimia, Haskuria).

6-2- The studied genotypes: were described based on some qualitative morphological traits defined by the International Plant Genetic Resources Institute (IPGRI) as follows:

6-2-1- Qarn-Alghazal capsicum genotype: A capsicum plant that has green angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have an upright growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a lobed calyx. The fruit, at the mature stage, is dark red, elongated in shape with a present base. Its cross-sectional appearance is wavy, and its end is indented and pointed. The seeds are numerous, large, and yellow in color.

6-2-2- Qarn-Aljamous capsicum genotype: A capsicum plant that has green angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have a moderately dangling growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a lobed calyx. The fruit, at the mature stage, is dark red, triangular with a present base. Its cross-sectional appearance is wavy, and its end is indented and pointed. The seeds are numerous, large, and yellow in color.

6-2-3- Short-Mutabasha capsicum genotype: A capsicum plant that has green

angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have an upright growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a lobed calyx. The fruit, at the mature stage, is dark red and swollen in shape with a present base. Its cross-sectional appearance is wavy, and its end is indented and pointed. The seeds are numerous, large, and yellow in color.

6-2-4- Long-Mutabasha capsicum genotype: A capsicum plant that has green angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have an upright growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a lobed calyx. The fruit, at the mature stage, is dark red and swollen in shape with a present base. Its cross-sectional appearance is wavy, and its end is indented and pointed. The seeds are numerous, large, and yellow in color.

6-2-5- Safrania capsicum genotype: A capsicum plant that has green angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have an erect growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a moderately lobed calyx. The fruit, at the mature stage, is dark red and Triangular in shape with a present base. Its cross-sectional appearance is wavy, and its end is indented. The seeds are numerous, large, and yellow in color.

6 -2-6- Harimia capsicum genotype: A capsicum plant that has green angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have an upright growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a moderately lobed calyx. The fruit, at the mature stage, is dark red and elongated in shape with an absent base. Its cross-sectional slightly corrugated is wavy, and its end is indented and pointed. The seeds are medium number, medium size, and yellow in color.

6-2-7- Haskuria Capsicum genotype: A capsicum plant that has green angular stems and is taller than 85 cm. It has a compact growth habit and light green leaves with an entire egg-shaped margin. Its flowers have an upright growth with a bell-shaped white corolla that measures less than 1.5 cm in length and a lobed calyx. The fruit, at the mature stage, is dark red and elongated in shape with an absent base. Its cross-sectional slightly corrugated is wavy, and its end is indented and pointed. The seeds are medium number, medium size, and yellow in color.

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