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# Study of genetic differences of carnation cultivars using phenotypic indicators

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**Abstract**

The experiment was conducted in the lathhouse of the Plant Production Department - Technical Institute - Middle Euphrates University during the agricultural season 2018 - 2019. Phenotypic indicators were used to detect genetic variation among nine carnation cultivars (Bizet, Shridea, Orange, Amprose, Mariposa, Grand, White, Viana Liberty) in addition to the local cultivars. The work steps included planting seedlings on 1/11/2018 in plastic pots of 3.5 kg, diameter 25 cm and 24 cm high, after filling them with a medium consisting of river soil and peat moss at a ratio of 1:2, respectively, with one plant per pot.The results of genetic analysis using phenotypic indicators showed a clear difference in the phenotypic traits of plant cultivars, according to the studied vegetative, flowering and root traits. The studied cultivars were divided into two main groups A and B. The main group A was divided into two subgroups a1 and a2, the subgroup a1 in turn was divided into two subgroups C and D, group C was divided into two other groups, c1 that included the plant varieties Viana and Liberty and group c2 that included the two plant cultivars Shridea and White ,While the sub-group D under the secondary plant cultivar Bizet, and the sub-group a2 with the local plant cultivar, it was isolated.As for the main group B, it was also divided into two secondary groups, b1 which included three plant cultivars: Orange, Amrose, and Mariposa, and group b2, which was unique to the Grand plant cultivar. After calculating the percentage of the genetic dimension between the cultivars, he found variations in the phenotypic traits. The high genetic variation between the carnation cultivars may be due to the geographical locations to which they belong, in addition to the breeding and improvement processes that were conducted on them.

**Keywords:** genetic differences**, carnation, phenotypic indicators**

# دراسة الاختلافات الوراثية لأصناف نبات القرنفل باستخدام المؤشرات المظهرية

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**الخلاصة**

نفذت التجربة في الظلة الخشبية العائدة لقسم الإنتاج النباتي - المعهد التقني - جامعة الفرات الأوسط خلال الموسم الزراعي 2018 - 2019. اعتمدت المؤشرات المظهرية للكشف عن الاختلافات الوراثية بين تسعة أصناف للقرنفل(Bizet ، Shridea، Orange، Amprose، Mariposa، Grand، White، Viana Liberty) بالإضافة إلى الصنف المحلي. تضمنت خطوات العمل زرعة الشتلات بتاريخ 1/11/2018 في أصص بلاستيكية سعة 3.5 كغم وقطر 25 سم وارتفاع 24 سم بعد ملئها بوسط مكون من تربة نهرية والبتموس بنسبة 1:2 على التوالي، وبواقع نبات لكل أصيص. بينت نتائج التحليل الوراثي باستخدام المؤشرات المظهرية اختلافا واضحا في الصفات المظهرية للأصناف النباتية وذلك تبعا للصفات الخضرية والزهرية والجذرية المدروسة، إن الاصناف المدروسة قسمت على مجموعتين رئيستين A و , B قسمت المجموعة

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الرئيسة A إلى مجموعتين فرعيتين a1 و , a2 تفرعت المجموعة الثانوية a1 بدورها إلى مجموعتين فرعيتين تحت ثانوية هي C و , Dانقسمت المجموعة C على مجموعتين أخرى هي c1 التي ضمت الصنفين النباتيين Vianaو Libertyوالمجموعة c2 التي ضمت الصنفين النباتيين Shrideaو Whiteفي حين انفردت المجموعة الفرعية تحت ثانوية D بالصنف النباتي Bizet والمجموعة الثانوية a2 بالصنف النباتي المحلي. أما المجموعة الرئيسة B أيضا انقسمت على مجموعتين ثانويتين هي b1 التي ضمت ثلاثة أصناف نباتية هي Orange و Amprose و Mariposaوالمجموعة b2 التي انفردت بالصنف النباتي .Grand وبعد حساب النسبة المئوية للبعد الوراثي بين الاصناف وجد تغايرات في الصفات المظهرية فيها ربما تعود الاختلافات الوراثية العالية بين اصناف القرنفل إلى المواقع الجغرافية التي تنتمي إليها إضافة إلى عمليات التربية والتحسين التي أجريت عليها.

## Introduction

The carnation plant Dianthus caryophyllus L. is one of the plants of the Caryophyllaceae family, whose plants grow in the temperate zone of the northern hemisphere. This family includes 2,100 species and 89 genera, one of which is the genus Dianthus, which includes about 300 species, most of which are annual or perennial herbaceous plants, and a few are shrubs ( Jurgens et al., 2003).It is a perennial herbaceous plant with special breeding, where it needs high technical expertise in order to produce its flowers with good commercial quality. The carnation is one of the most important global and economic cut flowers of high coordination and aesthetic value. The morphological indicators (morphological, morphological) are among the oldest indicators that were used as criteria in the characterization of plant cultivars and the study of genetic relationships and genetic diversity, where they depend on finding differences between individuals based on phenotypic traits such as plant height, flower color or fruit size and other characteristics (Peeraullee and Ronghoo). -Sanmukhiya, 2013). These indicators have many advantages, including the ease of application and measurement even by non-specialists, their lack of need for accurate devices and great expertise, the possibility of direct discrimination between phenotypic variables, and genetic variations for more than one trait can be studied at the same time and the possibility of finding a correlation between them. The use of phenotypic indicators has achieved tangible results in many studies with multiple goals and on different plant cultivars of many crops, including rye (Mikulski and Dopierala, 1996) and wheat (Beuningen and Busch, 1997). cabbage (Koutsos and Koutsika-Sotiriou, 2001), climbing beans (Santalla et al., 2004), barley (Kutkoot, 2007), carrots (Maalla et al., 2007), date palm (Al-Asasfa et al., 2015) and European grapes (Karim and Al Janabi, 2018).This research aims to study the genetic diversity and determine the genetic relationships of ten cultivars of carnation suitable for commercial cutting based on the degree of phenotypic similarity between them and to determine the genetic identity through some phenotypic indicators.

## Materials and methods

The experiment was conducted in the lath house of the Plant Production Department - Technical Institute - Middle Euphrates University during the agricultural season 2018-2019. To study the phenotypic traits of several genotypes of carnation suitable for commercial cutting based on phenotypic indicators. Small seedlings, not excelled four nodes, and a length of 10-8 cm, was used from nine carnation cultivars suitable for commercial cutting, produced by the Dutch company Hilverd Kooij, and multiplied by tissue culture method in the laboratories of the Palm Garden Company in Baghdad / Kadhimiya, which are (Bizet, Shridea, Orange, Amprose, Mariposa, Grand, White, Viana Liberty) in addition to the seedlings of the local cultivar that were propagated by the same method and in the same laboratories and were homogeneous in length and number of nodes for the seedlings of the nine plant cultivars .These seedlings were cultivated in the autumn season 1/11/2018 in plastic pots of 3.5 kg, diameter 25 cm and 24 cm high, after filling them with a medium

consisting of river soil and peat moss at a ratio of 1:2, respectively, with one plant per pot. Tables (1 and 2) show some chemical properties of the cultivation medium. All servicing operations were conducted for all plot units and whenever needed.Due to the low temperatures during the winter season, the plants were covered with a transparent plastic cover (polyethylene) for the period from 10/12/2018 until 28/2/2019.

Table (1) Some chemical and physical traits of river soil before cultivation

| units | values | | Traits | |
|---|---|---|---|---|
| | second experiment | first experiment | | |
| | 7.5 | 7.4 | pH | |
| $dsm^{-1}$ | 2.12 | 1.7 | EC | |
| % | 0.92 | 0.83 | Organic matter | |
| $mg.kg^{-1}$ soil | 12.3 | 16.8 | nitrogen | available ions |
| $mg.kg^{-1}$ soil | 7.15 | 10.5 | phosphorous | |
| $mg.kg^{-1}$ soil | 152.6 | 168.3 | potassium | |
| $g.kg^{-1}$ soil | 907 | 322 | sand | Soil Separators |
| $g.kg^{-1}$ soil | 63 | 345 | silt | |
| $g.kg^{-1}$ soil | 30 | 333 | clay | |
| | sand | Sandy loam | ***Soil*** Texture | |

Table (2) Chemical properties of peat moss used in cultivation

| $K_2O$ $mg.L^{-1}$ | $P_2O_5$ $mg.L^{-1}$ | N $mg.L^{-1}$ | pH | Ec |
|---|---|---|---|---|
| 190-80 | 180-70 | 160-70 | 6.5-5.7 | 0.9-0.7 |

To know the genetic dimension and determine genetic relationships among the carnation cultivars included in the study, the average of a number of phenotypic, flowering and root traits were measured, including:

1- Vegetative growth traits : - main stem length (cm), main stem diameter (mm), number of leaves (leaf. plant 1-), leaf area (cm2), dry matter percentage in leaves (%), chlorophyll content of leaves Total (mg. 100gm-1 fresh weight).

2- flowering growth traits : - Number of days required for the first flower to open on the plant (day), flower diameter (cm), flower length (cm), number of petals (petal. flower 1-), flower dry weight (cm), flower stalk length (cm), flower stalk diameter (mm), Flower duration on the plant (day), vase life (day), flower content of carotene pigment (mg. 100 gm-

1 fresh weight), flower content of anthocyanin pigment (mg. 100 gm-1 fresh weight), flower color (white, pink, mottled pink, light red , light mottled red, dark red, orange, mottled yellow, lemon yellow).In order to create the phenotypic traits table, the phenotypic characteristics that were recorded from the color of the flowers of plants were given numerical values as in Table (3).

**Table (3) phenotypic characterization of the flower color of the plants understudy**

| Symbol | color |
|---|---|
| 1 | white |
| 2 | Pink |
| 3 | mottled pink |
| 4 | light red |
| 5 | mottled light red |
| 6 | Dark red |
| 7 | orange |
| 8 | mottled yellow |
| 9 | lemon yellow |

3- Root growth traits : - The main root length(cm), the number of main roots (root.1 plant), and the percentage of dry matter of the roots (%).

The experiment was conducted according to the RCBD (Randomized Complete Block Design) with three replications for each plant cultivar, each replication contains ten treatments and five plants for each experimental unit. (Duncan's Multiple Range Test) at a probability level of 0.05 (Sahoki and Waheeb, 1990). A cluster analysis scheme for relationships and phenotypic dimensions was drawn based on the results of phenotypic traits by creating a matrix of results rates for the studied traits. The traits were analyzed using the PAST program and based on the Euclidean scale to show the kinship and phenotypic dimensions among the plant cultivars under the experiment.

**Results and discussion**

The results in Table (4) showed that there were significant and insignificant differences between the studied vegetative traits, where we find that the highest average of plant height was for the plant cultivar V7 (Grand) which amounted to 61.90 cm, and the lowest rate of

plant height for the cultivar V9 (Viana) was 48.00 cm, While the rest of the averages were mediated between the highest and lowest values of plant height for cultivars V6 (Mariposa), V4 (Orange), V5 (Amprose), V2 (Bizet), V8 (White), V1 (local) and V3 (Shridea), which amounted to 60.00 cm. 59.90 cm, 58.40 cm, 57.50 cm, 53.80 cm, 52.90 cm and 52.10 cm respectively. cultivars V7 (Grand), V6 (Mariposa), V5 (Amprose) and V4 (Orange) recorded the highest average for main stem diameter of 4.92 mm, 4.82 mm, 4.65 mm and 4.63 mm, and the lowest average was for cultivars V9 (Viana), V10 (Liberty) ), V1 (domestic) and V3 (Shridea), which were 2.88 mm, 2.95 mm, 3.00 mm and 3.25 mm respectively.While the average main stem diameter for cultivars V2 (Bizet) and V8 (White) averaged 3.88 mm and 3.50 mm, respectively. V1 (Local) cultivar significantly excelled on all cultivars in giving the highest average number of leaves reached 141.36 leaves.plant-1, while the lowest average number of leaves for cultivars V9 (Viana) and V10 (Liberty) was 107.59 leaves.plant-1 and 109. 99 leaves. Plant-1 respectively The rest of the averages for cultivars V7 (Grand), V6 (Mariposa), V4 (Orange), V5 (Amprose), V2 (Bizet), V8 (White) and V3 (Shridea), which amounted to 134.06 leaves.plant-1, 132.33 leaves. Plant-1, 130.63 leaves.plant-1, 129.98 leaves.plant-1, 125.11 leaves.plant-1, 121.36 leaves.plant-1 and 117.06 leaves.plant-1 respectively. cultivar V7 (Grand) recorded the highest average leaf area of 272.80 cm2, while the lowest rate of this trait was for cultivars V9 (Viana), V10 (Liberty), V8 (White), V3 (Shridea) and V1 (local), which averaged 202.60. cm 2, 206.50 cm 2, 213.80 cm 2, 214.80 cm 2 and 214.00 cm 2 respectively, and the rest of averaged between the highest and lowest leaf area for cultivars V6 (Mariposa), V4 (Orange), V5 (Amprose) and V2 (Bizet) at an average of 260.30 cm 2, 251.56 cm 2, 248.80 cm2 and 228.90 cm2 respectively. The cultivars V7(Grand), V6(Mariposa), V4(Orange) and V5(Amprose) had the highest percentage of dry matter in leaves that reached 25.17, 25.02, 24.93 and 24.79 respectively, while the lowest percentage was in the two cultivars V9 (Viana) and V10 (Liberty). ) with an average of 107.59 and 109.99, respectively. Varieties V2 (Bizet), V1 (domestic) and V3 (Shride) were mediated. the highest and lowest percentage of dry matter in the leaves was 22.66, 20.79 and 20.20, respectively. As for the total chlorophyll content of leaves, it reached the highest in cultivars V7 (Grand) and V6 (Mariposa) at an average of 61.72 mg. 100 g-1 fresh weight and 60.90 mg. 100 g-1 fresh weight, respectively.While it was below in cultivar V9 (Viana) with a rate of 49.80 mg.100 g-1 fresh weight and the rest of the cultivars were average.

**Table (4) Some vegetative traits of the plant cultivars under study**

| cultivars | Total chlorophyll content of leaves (mg.100gm fresh weight) | Leaves dry matter percentage (%) | Leaf area (cm2( | Number of leaves (leaf. plant-1) | Main stem diameter (mm) | plant height (cm) |
|---|---|---|---|---|---|---|
| **local $V_1$** | 56.22 abcd | 20.79 bc | 214.00 d | 141.36 a | 3.00 c | 52.90 abc |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Bizet $V_2$** | 54.91 abcd | 22.66 ab | 228.90 c | 125.11 cd | 3.88 b | 57.50 abc |
| **$V_3$ Shridea** | 50.80 cd | 20.20 bc | 214.80 d | 117.06 e | 3.25 c | 52.10 abc |
| **$V_4$ Orange** | 58.94 ab | 24.93 a | 251.50 b | 130.63 bc | 4.63 a | 59.90 ab |
| **$V_5$ Ampros** | 57.57 abc | 24.79 a | 248.80 b | 129.98 bc | 4.65 a | 58.40 abc |
| **$V_6$ Mariposa** | 60.90 a | 25.02 a | 260.30 ab | 132.33 b | 4.82 a | 60.00 ab |
| **Grand $V_7$** | 61.72 a | 25.17 a | 272.80 a | 134.06 b | 4.92 a | 61.90 a |
| **White $V_8$** | 52.24 bcd | 22.36 ab | 213.80 d | 121.36 de | 3.50 bc | 53.80 abc |
| **Viana $V_9$** | 49.80 d | 18.11 c | 202.60 d | 107.59 f | 2.88 c | 48.00 c |
| **$V_{10}$ Liberty** | 50.53 cd | 18.32 c | 206.50 d | 109.99 f | 2.95 c | 49.00 bc |

The results in Table (5) showed that there were significant and insignificant differences between the average of flowering growth traits under study, where we note the lowest average number of days required for flowering was for the cultivar V1 (local) and amounted to 171.10 days, and the most average number of days required for flowering was for the cultivar V3 (Shridea) amounted to 213.00 day, while the rest of the cultivars averaged between less and more than the number of days required for flowering.The two cultivars V7 (Grand) and V6 (Mariposa) gave the largest flower diameter of 4.10 cm and 3.99 cm, and the largest flower length of 4.90 cm and 4.92 cm, respectively, while the cultivar V1 (local) gave the least flower diameter and flower length of 2.58 cm and 3.18 cm, respectively, and average rates Flower diameter and flower length were between the largest and least valued for cultivars V4 (Orange), V5 (Amprose), V2 (Bizet), V8 (White), V3 (Shridea), V10 (Liberty), V9 (Viana) and V1 (domestic). (3.93 cm and 4.79 cm), (3.86 cm and 4.69 cm), 3.64 cm and 4.56 cm), (3.58 cm and 4.49 cm), 3.40 cm and 4.36 cm), (3.26 cm and 4.27 cm), (3.17 cm and 4. 4.04 cm) and (2.58 cm and 3.18 cm) respectively. The cultivar V7 (Grand) gave the highest average number of petals, which was 31.94 petals. Flower-1, and the lowest average was for the cultivar V1 (Local) 15.05 petals. Zahra-1 and the cultivars V6 (Mariposa), V5 (Amprose), V4 (Orange), V2 (Bizet), V8 (White), V3 (Shridea), V10 (Liperty) and V9 (Viana) were medium, with average of 29.61. petal.flower-1 ,29.56 petal.flower-1,28.40 petal.flower-1,27.72petal.flower-1,25.24petal.flower-1,24.60petal.flower1,23.20petal.flower-1 and 22.64 petal .flower-1 respectively. and the highest average of dry weight of flowers was for flowers of cultivars V7 (Grand), V6 (Mariposa), V5 (Amprose), V4 (Orange) and V2 (Bizet) at a rate of 1.97 g, 1.91 g, 1.88 g, 1.83 g and 1.79 g, respectively, and less The dry weight of the flowers of the cultivar V1 (local) was 1.00 g, while the average of this trait were for cultivars V8 (Whita), V3 (Shridea), V10 (Liberty) and V9 (Viana) at a rate of 1.49 g, 1.41 g, 1.39 g and 1.28 g sequentially. The cultivar V7 (Grand) was distinguished by giving it the longest flower stalk, which reached 50.20 cm.While the cultivar V1 (local)

recorded the lowest flower stalk length of 32.20 cm, and the rest of the average flower stalk length averages were for cultivars V6 (Mariposa), V4 (Orange), V5 (Amprose), V2 (Bizet), V8 (White), V3 (Shridea). , V10 (Liberty) and V9 (Viana) averaged 47.40 cm, 45.50 cm, 45.10 cm, 42.10 cm, 40.20 cm, 40.10 cm, 39.20 cm and 39.10 cm respectively. The largest of flower stalk diameter of the cultivars V7 (Grand) was 3.96 mm, which did not differ significantly from all foreign cultivars, while the minimum diameter of the flower stalk of the cultivar V1 (domestic) was 2.42 mm. There were no significant differences in the average of the two traits of the duration of flower on the plant and the vase life of the flowers of the cultivars under study. cultivar V10 (Liberty) gave the highest average of carotene pigment which was 5.16 mg. 100 g-1 fresh weight, while the rest of the cultivars were average. As for the anthocyanin pigment, its highest average was in the V1 (local) cultivar 12.99 mg. .100g-1 fresh weight and 2.76mg-1 fresh weight, respectively. The rest of the average were mediated between the highest and lowest values for the cultivars V7 (Grand), V2 (Bizet), V10 (Liberty), V9 (Viana), V8 (White) and V4 (Orange) at an average of 10.65 mg.100 g-1 fresh weight, 9.75 mg. 100 g -1 fresh weight, 5.96 mg. 100 g -1 fresh weight, 5.45 mg. 100 g -1 fresh weight, 4.11 mg. 00 g -1 fresh weight, and 3.81 mg. 100 g -1 fresh weight, respectively.

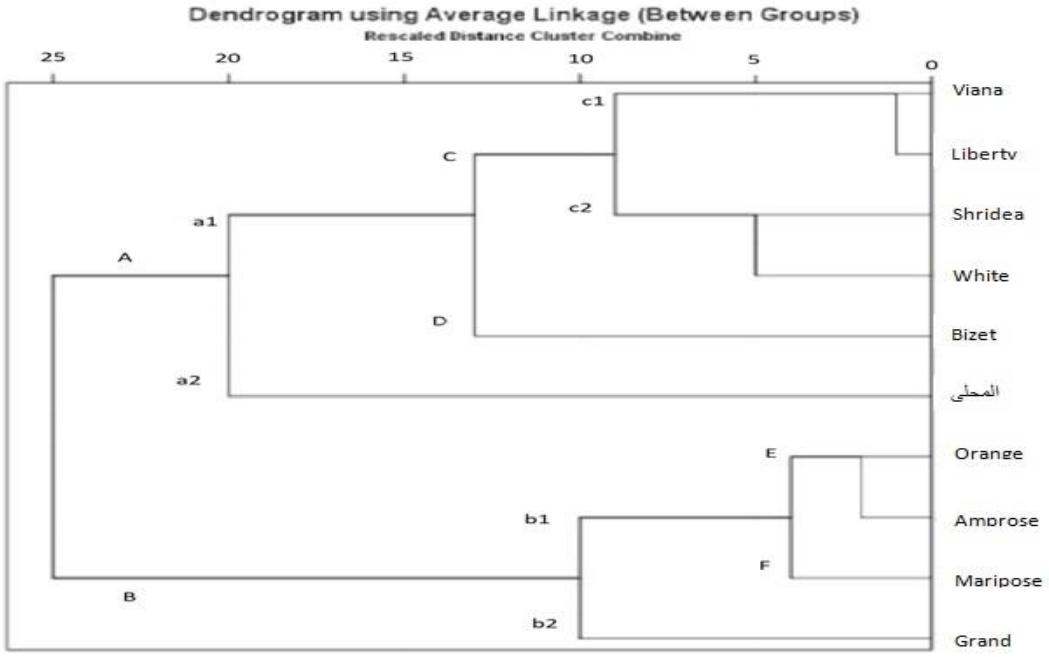
**Table (5) Some flowering traits of the plant cultivars under study**

| Cultivars | flower color | flower content of anthocyanin pigment (mg. 100 gm-1 fresh weight) | flower content of carotene pigment (mg. 100 gm-1 fresh weight) | vase life (day) | Flower duration on the plant (day) | flower stalk diameter (mm) | flower stalk length (cm) | flower dry weight (g) | (cm) Number of petals( petal.flower-1) | flower length(cm) | flower diameter( Day) | Number of days for flowering( day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| local $V_1$ | white | 12.99 a | 2.04 cd | 4.21 a | 8.64 a | 2.42 b | 32.2 c | 1.00 c | 15.05d | 3.18 b | 2.58 b | 171.1 f |
| Bizet $V_2$ | Pink | 9.75 b | 1.80 d | 7.10 a | 13.12 a | 3.46 a | 42.1 ac | 1.79 a | 27.72 ac | 4.56 ab | 3.64 ab | 191.3 be |
| Shridea $V_3$ | mottled pink | 2.55 e | 2.12 cd | 6.10 a | 10.20 a | 3.23 a | 40.1 ac | 1.41 b | 24.60 bc | 4.36 ab | 3.40 ab | 213.0 a |
| Orange $V_4$ | light red | 3.81 de | 4.10 ab | 7.10 a | 13.60 a | 3.56 a | 45.5 ab | 1.83 a | 28.40 ac | 4.79 ab | 3.93 ab | 181.1 ef |
| Ampros $V_5$ | mottled light red | 2.69 e | 2.76 bd | 7.10 a | 13.40 a | 3.52 a | 45.1 ab | 1.88 a | 29.56 ab | 4.69 ab | 3.86 ab | 187.3 ce |
| $V_6$ Mariposa | Dark red | 2.76 e | 2.17 cd | 7.24 a | 13.91 a | 3.59 a | 47.4 ab | 1.91 a | 29.61 ab | 4.92 a | 3.99 a | 185.3 de |
| Grand $V_7$ | orange | 10.65 b | 2.00 cd | 7.42 a | 13.20 a | 3.96 a | 50.2 a | 1.97 a | 31.94 a | 4.90 a | 4.10 a | 193.2 be |
| White $V_8$ | white | 4.11 cde | 3.90 ac | 6.74 a | 11.04 a | 3.32a | 40.2 ac | 1.49 b | 25.24 bc | 4.49 ab | 3.58 ab | 200.6 b |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Viana $V_9$** | **mottled yellow** | **5.96 c** | **4.51 ab** | **5.30 a** | **10.20 a** | **3.23 a** | **39.1 bc** | **1.28 b** | **22.64 c** | **4.06 ab** | **3.17 ab** | **198.0 bd** |
| **Liberty $V_{10}$** | **lemon yellow** | **5.45 cd** | **5.16 a** | **6.00 a** | **10.31 a** | **3.33 a** | **39.2 bc** | **1.39 b** | **23.20 c** | **4.27 ab** | **3.26 ab** | **198.6 bc** |

Table (6) that the highest average root length was for the cultivar V7 (Grand), reaching 20.92 cm, and without a statistical difference with the cultivars V6 (Mariposa), V4 (Orange), V5 (Amprose), V2 (Bizet), V8. White), V1 (domestic) and V3 (Shridea), which averaged 19.50 cm, 19.34 cm, 19.21 cm, 18.82 cm, 17.91 cm, 17.45 cm and 16.48 cm respectively, while the two cultivars V9 (Viana) and V10 (Liberty) had the lowest average length the main root was 12.82 cm and 13.10 cm, respectively.The cultivar V7 (Grand) achieved the highest average number of main roots of 16.80 root.plant-1, while the lowest average of main roots was at V9 (Viana) 11.10 root.plant-1, and the rest of the average of this trait were mediated for cultivars V6 (Mariposa), V5 (Amprose), V4 (Orange), V2 (Bizet), V8 (White), V1 (domestic), V3 (Shridea) and V10 (Liberty) at an average of 15.40 root.plant-1, 15.21 root.plant-1, 15.10 root.plant-1, 14.82 root.plant-1, 14.54 root.plant-1, 14.10 root.plant-1, 14.02 root.plant-1and 11.87 root.plant-1respectively, while there were no significant differences in the average percentage of dry matter percentage in the roots of the cultivars under study.The tree diagram of genetic relationships based on the results of the phenotypic characteristics of the cultivars under study was shown using the PAST program and based on the Euclidean scale. Figure (1) The distribution of the studied samples in two main groups A and B, The major group A was divided into two subgroups, a1 and a2, and the minor group a1 in turn was subdivided into two subgroups, C and D.Group C was divided into two other groups: c1 which included the plant cultivars Viana and Liberty, which were closest to each other with a distance of 5.379, and group c2, which included the plant cultivars Shridea and White, with a distance of 14.087 ,While the sub-group D under the secondary plant cultivar Bizet, and the sub-group a2 with the local plant cultivar, it was isolated. The main group B was also divided into two subgroups, b1 which included three plant cultivars: Orange, Amrose and Mariposa, in which the two cultivars Orange and Amrose were more close to each other with a distance of 8.918 compared to the cultivar Mariposa and group b2 that was unique to the Grand plant cultivar.

Figure (1) Genetic relationships tree of plant cultivars based on the results of phenotypic traits.




The results of the genetic dimension between plant cultivars, depending on the phenotypic characteristics shown in Table (7), show the extent of similarities and differences between the cultivars under study. As we find that the highest percentage of genetic similarity corresponding to the lowest genetic dimension was 5.379 between the two cultivars Viana and Liberty, where they formed a small group in the genetic relationships tree diagram (Fig. 1), while the lowest percentage of genetic similarity corresponding to the largest genetic dimension was 80,099 between the two cultivars Grand and Viana . While the results of the genetic dimension for the rest of the cultivars averaged between the highest genetic dimension and the lowest value.

**Table (7) Genetic divergence (%) between plant cultivars based on phenotypic traits**

| Liberty | Viana | White | Grand | Mariposa | Amprose | Orange | Shridea | Bizet | local | cultivars |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 0.0000 | local |
| | | | | | | | | 0.0000 | 35.116 | Bizet |
| | | | | | | | 0.0000 | 29.712 | 51.793 | Shridea |
| | | | | | | 0.0000 | 52.977 | 27.068 | 46.769 | Orange |
| | | | | | 0.0000 | 8.918 | 46.650 | 22.750 | 46.922 | Amprose |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.0000 | 12.733 | 11.374 | 58.132 | 34.729 | 55.988 | Mariposa |
| | | | 0.0000 | 17.589 | 27.673 | 26.858 | 67.573 | 46.658 | 69.384 | Grand |
| | | 0.0000 | 63.942 | 52.264 | 39.882 | 45.357 | 14.087 | 20.268 | 39.787 | White |
| | 0.0000 | 22.050 | 80.099 | 68.373 | 56.448 | 60.352 | 24.014 | 36.388 | 47.621 | Viana |
| 0.0000 | 5.379 | 18.086 | 75.399 | 63.792 | 51.880 | 55.835 | 20.677 | 32.019 | 45.534 | Liberty |

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