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Study of the Genetic Architecture in Radish

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Abstract

The studied was to investigate for studying the genetic architecture in seven genotypes of radish during growing season autumn 2019/2020, at the area of the vegetable research, Department of Horticulture and landscape Designs, agriculture and forestry College, University of Mosul. The results indicated that highly significant variation among all the fifteen traits, vegetative, root and seeds parameters. The genotype Istanbul was superior than all genotypes for whole plant weight, root diameter and root length, number of leaves for each plant, while genotype, while Radish Shahry gave a higher value in fruit length (siliqua), genotype Black radish was superior than all genotypes for root total yield per area and total seed yields for each plant. In addition, the highest phenotypic, genotypic coefficient related to variation has been identified for the characteristics of whole plant gram weight, total chlorophyll content SPAD, root weight, total seed yield for each unit area and the number of fruits (siliqua) for each one of the plants. Almost all the characteristics showed high heritability broad sense ranging between 66.507 and 97.109%, high genetic advance as mean's percent was indicated regarding all the traits excepted for the leaf's number plant and seeds weight/plant. Which were 13.846, 8.769% respectively.

Keywords: Radish, Roots yield, Heritability and Genetic advance.

Abbreviation: GA-Genetic Advance and RCBD- Randomized Complete Blocks Design.

Introduction

Radish *Raphanus sativus* (2n=2x=18), belong to the genus *Raphanus*, *Cruciferae* or *Brassicaceae* family originating from Western and Central China and India [1], it is typically an insect pollinated, self-incompatible crop [2]. Also, the radish plant is one of the popular and ancient root vegetable crops that might be eaten in cooked form or raw. It has been grown for fleshy roots as well as leaves in temperate and tropical climate. In addition, the first indications regarding the consumption of radish in human nutrition reported in ancient Egypt, dating back to 2000 BC, while its cultivation date back to 400 BC in Korea and Chine [3,4]. Also, the variety related to the cultivated radish plants species is on the basis of hybridization and mutation, dispersal range and domestication and cultivation processes [5].

The genetic variability was one of the significant factors to select the best genotypes for making quick improvements in the yield along with other associated characters and selecting the possible parent with regard to hybridization programmed since the majority of plant characters were polygenic in nature and impacted via environment. Phenotypic and genotypic coefficients allow accessing the characters' divergence. Also, heritability can be defined as an index used to calculate the environments' relative influence on the expression of character between the genotypes. A study conducted by Mapari, et al, (2010) [6] specified that there is a maximum genotypic coefficient variation for leaves fresh weight, also high heritability in all the studied traits, while maximum advance was indicated in root diameter. All the cultivars were performing well in terms of yield as well as yield components. SAU line 1 was the best with regard to quality judged succeeded via Tasakisan and Red Bombay [7,8]. Ullah, et al. (2010) [9] reported a high genotypic coefficient related to variation in addition to heritability with high genetic advances in mean's rate.

The maximum genetic advances have been identified in the root yields. Also, the root yields showed positive and considerable association with the root diameter and root length, also reported just positive association with the plant height and the width of the leaf. A research that has been carried out by Naseerddin, et al. (2011) [10] specified that analysis of variance shows considerable differences between radish genotypes for all characteristics, genotypic and phenotypic coefficients of variations have been high for the leaves number, leaf's weight, weight of plant, also the yield of plant/root, heritability in the broad sense has been high for the plant weight, weight of the leaf, root weight, number of leaves, Genetic Advance (GA) in the percent of average is highest for the root yield for each plant and succeeded via the leaf's weight. Jamatia, et al. (2015) [11] showed in their research it was the maximum genotypic and phenotypic coefficient variations for the yield for each one of the plants, number of flowers for each one of the plants, also high heritability evaluations with the high GA that has been indicated for pod yield for each plant.

In addition, the variance analyses have indicated highly-considerable difference values between genotypes for majority of features. Phenotypic and genotypic variation coefficients have been considerable for total plant weight, number of leaves, weight of the leaf, root yield/plant. In broad sense, the heritability has been high for the weight of the root, weight of the leaf, root diameter, length of the leaf, leaf number and root length. The GA in the per cent of mean is highest for the weight of the leaf succeeded via root weight [12]. A study conducted by Hoque, et al. (2015) [13] specified that the radish varieties are differing in the days to 1st flowering, number of siliqua for each one of the plants, height of plant, number of seeds for each siliqua, number of branches for each plant, seeds yield per areas and seeds yield per plant. Roopa, et al. (2018) [14] showed in their study

the highest genotypic coefficient related to variation and phenotypic coefficient of variation was identified for root to leaf ratio between yield attributing traits.

The substantial variations in total fresh weight of a plant have been indicated, it was highest in variety ArkaNishant, while, lowest in variety PusaDesi. Also, the root diameter values have been minimum, and maximum in variety ArkaNishant. The maximum root yield per plot was produced in variety ArkaNishant [15]. Semba, et al. (2019) [16] reported in their research when they study the performance of six different varieties of radish, the varieties have been Korean cross, Menu Early, Snow white, Long red, Local check and Scarlet red globe, the analysis specified highly significant difference maximum plant height, fresh leaves' weight, leaf length, fresh weight for each one of the plants is highest in Menu Early, whereas for the fresh weight of root, length of roots, dry weight of radish root and total yield of radish root, the variety Korean cross performs excellent compared to other varieties. The goal of this studied was to investigate for studying the genetic architecture in some genotypes of radish under Nenevah conditions, Iraq.

Materials and Method

The research has been carried out at the area of the vegetable researches, Department of Landscape design, Agriculture and Forestry College, University of Mosul, throughout 2019/2020 growing season, to study the genetic architecture in even genotypes radish under condition of Nenevah government, northern of Iraq **Table 1**.

No	Name of genotype	Company or sources
1	Black Local	Department of Agric.Resea. Ninevah, Iraq
2	Istanbul	My garden, Syria, Damascus
3	Rojo punta blancea	Batlle, Huerto, Italia
4	Early radish	Best garden Co., Bakhcha
5	Radish Shahry	Every green, Erbil garden, Iraq
6	Winter radish	My garden, Syria, Damascus
7	Black radish	Every green, Erbil garden, Iraq

Table 1: The names of the genotypes and their origin.

Which were collected from the local markets spread in the governorate of Nineveh (Mosul city). Seeds of genotypes were planted on rows (line) 1.7m long and 90 cm wide and with three lines for each genotype. All agricultural service operations in terms of hoeing, weeding and irrigation were carried out on the experimental units in a uniform manner. The plants were fertilized with nitrogen fertilizer (urea) at level 30kg nitrogen/dunum, with a triple superphosphate fertilizer at level 100kg [17]. With three replicates for each genetic structure by the RCBD (i.e. the randomized complete block design). Data have been recorded on the traits from the mean line for each genotype and for each replicate by 5 plants for the second and third harvest.

The data included: Plant height (cm) was measured by metric tape. number of the leaves in each one of the plants, SPAD's total content of the chlorophyll, weight of the whole plant (roots and leaves) in grams, root weight (grams), length and diameter of the root (cm) were measured in viernes, total yield per unit area (ton/donum), length and diameter of the fruit (siliqua) cm, number of seeds /silique, number of fruits in each one of the plants, seed weight per plant and total seeds weight /donums. The phenotypic and genotypic variation coefficients have been obtained from the approach that has been given by De Vane and Burton (1953) [18]. The heritability (i.e. the broad sense) and genetic advance as mean percentage have been estimated by the use of the formula that has been described by Robinson, et al. (1949) [19] and Johnson, et al. (1955) [20] respectively. The data averages have been analysed according to design that has been used, Randomized Complete Blocks Design (RCBD) and compared to a 5% probability level [21]. Data were analyzed using an electronic computer using a system SAS, 2007 [22].

Results and Discussion

Figure 1 showed the whole plant (leaves and root) in seven genotypes which were under the study during growing autumn season 2019/2020.

Figure 1: The plant of radish genotypes under the study.

Table of variance analysis

Table 2 It appears from the table of analysis of variance of the mean square of the studied traits for genotypes of radish that was differed significantly among them in all the studied traits represented by the characteristics of vegetative growth, root characteristics, seed yield characteristics and its components. It also appears in the table that R. square was between 0.685 to 0.981. The neighbourhood ranged between 0.685-0.716 and 0.784 for the characteristics of whole plant height, characteristic of seed weight per plant, and total seed yield per unit area, respectively. Through the results of variance analysis of the studied traits for seven genotypes, were showed significant differences at a probability level of 5%, thus it is possible to continue conducting genetic analyses and studying their genetic behaviour. These results came similar with what was reported by Al-Kummer and Esho (2002) [23] for carrot analysis, Alam, et al. (2010) [7], Nasseerddin, et al. (2011) [10], Mallikarjunarao (2015) [12], Khan, et al. (2016) [24], Dongarwar, et al. (2018) [15] for radish cultivars).

Average values of the studied features

Table 3 shows the average values of the studied features of the genotypes of radish, as it can be seen from the table that the genotype (Black local) differed significantly in characteristic of fruit length (pod) reached 5.333cm compared with the rest of the genotypes, while the genotype Rojo punta blancea gave the lowest value in that. The significance limit did not reach between genotypes Istanbul, Rojo punta blancea, and winter radish for this trait. The genotype Istanbul also gave the maximal values in each trait, the weight of the whole plant (roots with leaves), the length of the whole plant, number of leaves for each one of the plants, diameter and length of the root, and the characteristic of the number of fruits in each one of the plants compared to the rest of genetic makeup for these traits as well as the genotype produced. Genotype Rojo punta blancea gave highest values

S. of V. / Traits	Block	Genotypes	Error	Total	R. squares	Coeff. Var.	MSE	F Value	Pr> f
Degree of freedom	2	6	12	20					
Vegetative parameters	**Mean Square**								
plant weight (gm)	127.476	1610.19**	155.476	1893.142	0.842	7.426	12.469	10.36	0.0004
plant length (cm)	7.251	172.015**	40.135	219.401	0.685	8.883	6.335	4.29	0.0154
Number of leaves /plant	0.619	10.873*	1.063	12.555	0.839	9.844	1.031	10.22	0.0004
Root parameters	**Mean Square**								
Root length (cm)	0.346	22.271**	1.035	23.652	0.915	9.174	1.017	21.52	<0.0001
Root diameter (cm)	0.096	3.660*	0.214	3.97	0.896	8.117	0.463	17.1	<0.0001
Root weight (gm)	13.166	168.392**	7.797	189.355	0.917	5.353	2.792	21.6	<0.0001
Chlorophyll (SPAD)	3.366	4493.848**	44.16	4541.374	0.981	2.72	6.645	101.76	<0.0001
Total yield (ton/donum	0.258	3.351**	0.258	3.867	0.87	5.52	0.508	13.01	0.0001
Seed parameters	**Mean Square**								
Fruit length (siliqua) cm	0.074	1.716**	0.025	1.815	0.972	3.497	0.159	67.58	<0.0001
Siliqua diameter (cm)	0.0005	0.0732**	0.003	0.077	0.931	5.897	0.052	27.12	<0.0001
Number of seed /fruit	0.263	8.239**	0.231	8.733	0.948	5.559	0.48	35.74	<0.0001
Fruit (siliqua) weight (gm)	0.009	0.081**	0.004	0.094	0.912	7.506	0.064	20	<0.0001
Number of fruits /plant	173.44	1736.051**	896.347	2805.838	0.907	6.883	29.939	19.45	<0.0001
Seeds weight /plant (gm)	3.523	4.472*	1.121	9.116	0.716	6.037	1.059	3.99	0.0199
Total seeds yield(kg/donum))	2344.33	17462.937**	2510.056	22317.32	0.784	9.354	50.1	6.96	0.0023

Table 2: Analyses of the variance for yield parameters in radish genotypes. **Note:** *, ** significant at 5 or 1% levels.

Traits	Genotypes						
	Black local	Istanbul	Rojo punta blancea	Early Radish	Radish shahry	Winter radish	Black radish
Plant weight(root and leaves (gm)	146.00 dc	199.67 a	183.33ab	188.00ab	150.dc	167.67bc	139.00d
plant length (cm)	74.133ab	83.300a	71.767ab	73.700ab	72.300ab	64.533	59.500c
Number of leaves /plant	9.667bc	13.33a	8.667c	10.667b	12.667a	10.00bc	8.333c
Root length (cm)	9.133c	15.933a	12.200b	9.300c	12.867b	10.033c	8.167c
Root diameter (cm)	5.400bc	6.667a	3.833d	5.967ab	4.733c	6.667a	6.633a
Root weight (gm)	50.300b	43.833c	42.267c	50.967b	59.267a	61.833a	56.700a
Chlorophyll (SPAD)	269.733b	215.300d	187.933e	240.067c	223.233d	276.733	297.300a
Total yield (ton/donum	9.933ab	9.300bc	7.233d	9.00bc	8.700c	9.667a-c	10.533a
Fruit length (siliqua) cm	5.333a	3.800c	3.733c	4.867b	5.433a	3.800c	4.933b
Siliqua diameter (cm)	0.733d	0.700d	1.167a	0.833c	0.900cb	0.967b	0.867c
Number of seed /fruit	7.567b	6.133c	10.033a	10.367a	8.267b	10.4	7.700b
Fruit (siliqua) weight (gm)	0.767c	0.567d	0.967ab	0.867bc	1.067a	0.767c	0.933b
Number of fruits /plant	487.63b	560.53a	467.90cb	385.20d	330.90e	418.53cd	394.10d
Seeds weight /plant (gm)	17.033bc	19.467a	18.633ab	16.700bc	16.333c	16.433c	18.167a-c
Total seeds yield(kg/donum)	440.00c	593.33a	603.33a	480.00bc	456.33c	549.67ab	626.67a

Table 3: The mean value of traits in radish genotypes during growing season 2019/2020.

in both the characteristic of the diameter of the fruit (siliqua) and the number of seeds per siliqua, and it has been considerably superior to the rest of genotypes limiting the study as the genotype was significantly superior to the characteristic of the number of seeds per fruit compared to the rest of the genotypes, but it did not differ significantly with Genotype Rojo punta blancea. Also appears from the same table that the genotype Radish shahry was significantly superior in the characteristics of the number of leaves in each one of the plants and the length of siliqua (fruit) and weight of the fruit, reaching (12,667), (5,433) (cm) and (1,067) (gm) respectively.

Also, genotype winter radish was significantly superior in root diameter trait, but it did not reach the significant limit between Istanbul and Black radish genotypes, for this trait. As for the total yield of the roots, the genotype Black radish was significantly superior to the rest of the genotypes in this characteristic, reaching 10.533 tons per dunum. It produced the highest yield for each of the seeds per unit area, but it did not reach the limit of significance with genotypes Istanbul, Rojo punta blancea and winter radish, as it reached 626.67, 593.33, 603.33 and 549.67kg/dunum, respectively. The results of the analysis of these traits indicate the possibility of continuing to study the genetic structure of these genotypes in order to be included in the improvement programs for them, and the reason for these discrepancies in the characteristics of the genotypes is due to the variations in the genetic characteristics of them and the variations in the characteristics of the vegetative growth, the root characteristics and the components of the outcome to the genetic factors of each Genetic improved. The same results recorded as Mather and Jinks (1982) [25], Norbut (1985) [26], Daoud, et al. (2000), Panwar, et al. (2003) [27], Esho (2004) [8], Yamane, et al. (2009) [5], Dongarwar, et al. (2010) [15] and Semba (2019) [16].

Study the genetic parameters

Table 4 shows the genetic parameters of fifteen of the studied traits for seven radish genotypes, represented by each of the variation of phenotypic, genetic and environmental variation, the coefficient of genetic and phenotypic variation, the percentage of inheritance in a broad sense, the expected genetic improvement, and the rate of genetic improvement as a percentage of the genetic improvement. As it appears from the table that the phenotypic coefficient was high for the characteristics of whole plant gram weight, total chlorophyll content SPAD, number of fruits (siliqua) per plant, root weight, and total seed yield per unit area. Whereas, the minimum phenotypic variation was for the characteristics of the length of the siliqua (fruit), the diameter of the fruit and the weight of the fruit. As for the genetic variance, it took the same trend. The table also shows that the phenotypic variation coefficient has been high for characteristics of the number of leaves per plant, the number of seeds in each fruit (siliqua), the length of the root, the weight of the fruit, the number of fruits per plant in addition to the root diameter.

These traits have high genetic variation, so they can be used in selection programs to improve the yield under different environmental conditions, Table 4 also shows that the genetic variance coefficient was high for the characteristics of root length, number of leaves in each one

of the plants, root diameter, number of seeds per fruit, fruit weight, in addition to the number of fruits (Siliqua) in each one of the plants. Those results came with all that was mentioned by Rabbani, et al. (1998) [28] in radish, Al-kummar and Esho (2002) [23] for carrot plant; Ullah, et al. (2010) [9]. Sivathanu, et al. (2014) [29],

Mallikarjunarao, et al. (2015) [12] and Roopa, et al. (2018) [14]. When studying the performance of the heritability ratio in a broad sense, the results showed that the heritability ratio for the studied traits ranged from 49.904 for the seed weight characteristic for each plant to 97.109 for the chlorophyll content trait, while for the rest of the traits a high inheritance rate has been recorded for features of the number of seeds per fruit 92.05% and the root weight 87.287 The length of the root is 87.243%, the root diameter is 84.292%, the length of the fruit (mustard) is 95.688%, and the rate of genetic improvement as a percentage of the genetic improvement, the results showed that it was high for root length traits 46.159%, for number of the seeds in the fruit 37.384%, and for the weight of fruit 36.162% The root diameter was 35.562% and the lowest percentage for the whole plant height was 13.8465.

This result was consistent with Mapari, et al. (2010) [6] for fresh weight of leaves and root diameter, Ullah, et al. (2010) [9] for the trait of root length and weight, Naseeruddin, et al, (2011) [10] for number of the leaves/plant, root yield, total plant weight, Sivathanu, et al. (2014) [29] for the trait of root length and number of leaves in each one of the plants and with Mallikarjunarao, et al. (2015) [12] for the root weight trait and Jamatia, et al. (2015) [11] for the trait. Root quotient, Hoque et al., 2015, for the number of fruits in each one of the plants and number of seeds per fruit, and with Roopa, et al. (2018) [14] for most of the characteristics of vegetative growth and root traits studied.

Conclusion

After study, this result showed highly significant variation among all the fifteen traits, vegetative growth , root and seeds parameters, with high The maximum phenotypic, genotypic coefficient of variation, heritability was more than 60% for all traits , were observed for the characteristics of whole plant weight, total chlorophyll content SPAD, number of fruits (siliqua) per plant, root weight, and total seed yield per unit area, with high GA as percentage of the average for the majority of the features.

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Traits	Range	Medium	Genetic parameters							
			σ2p	σ2g	σ2e	PCV	GCV	H2b.s	GA	GA%
Plant weight(root and leaves (gm)	139.00 – 188.000	167.91	640.38	484.9	155.5	16.78	13.115	75.721	3947.3	23.51
plant length (cm)	59.500 -83.300	71.319	84.095	43.96	40.14	13.66	9.297	52.275	987.51	13.85
Number of leaves /plant	8.333 -13.333	10.476	4.333	3.27	1.063	31.74	17.261	75.458	323.68	30.89
Root length (cm)	8.167 -15.933	11.09	8.114	7.079	1.035	25.93	23.99	87.243	511.92	46.16
Root diameter (cm)	3.833 -6.667	5.7	1.363	1.149	0.214	22.92	18.803	84.292	202.7	35.56
Root weight (gm)	42.267 -61.833	52.167	61.329	53.53	7.797	17.06	14.025	87.287	1408.1	26.99
Chlorophyll (SPAD)	187.933 -297.300	244.33	1527.4	1483	44.16	19.55	15.763	97.109	7818.1	32
Total yield (ton/donum	7.233 -10.533	9.195	1.289	1.031	0.258	17.83	11.042	80.007	187.09	20.35
Fruit length (siliqua) cm	3.733 -5.433	4.557	0.589	0.564	0.025	21.43	16.475	95.688	151.29	33.2
Siliqua diameter (cm)	0.700 -1.167	0.881	0.026	0.023	0.003	22.01	17.398	89.697	29.903	33.94
Number of seed /fruit	6.133 -10.400	8.638	2.9	2.67	0.231	28.04	18.915	92.05	322.93	37.38
Fruit (siliqua) weight (gm)	0.567 -1.067	0.848	0.03	0.026	0.004	25.71	18.889	86.364	30.651	36.16
Number of fruits /plant	330.90 -560.53	434.97	6409.6	5513	896.3	23	17.07	86.016	14186	32.61
Seeds weight /plant (gm)	16.333 -19.467	17.538	2.238	1.117	1.121	9.32	6.026	49.904	153.79	8.769
Total seeds yield(kg/donum)	440.00 -626.67	535.62	7494.3	4984	2510	19.05	13.181	66.507	11861	22.14

Table 4: The genetic parameters in radish genotypes during growing season 2019/2020.

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