Iran. J. Ichthyol. (Special Issue 2022): 110-115

P-ISSN: 2383-1561; E-ISSN: 2383-0964
http://www.ijichthyol.org

Research Article

Effect of soil mulching on the genetic performance of two radishes *Raphanus sativus* L. varieties Turkish red and white

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Abstract
This study aimed to estimate some genetic parameters of growth traits and the yield of two varieties of radish *Raphanus sativus* L., namely Turkish red and Turkish white under the influence of soil coverage viz. no mulch, green and blue. The study was carried out as a factorial experiment with six treatments according to the design of the sectors, during the autumn growing season of 2019-2020. The results indicated that the Turkish red cultivar showed a significant superiority over the Turkish white for the traits of the plant height, weight of leaves, root weight, and total yield, while Turkish white cultivar had a significantly higher number of leaves/plant. The green mulch treatment showed the highest values of root weight and total yield. The best values for root weight and total yield, appear on the cultivar Turkish red under covered plants.

Keywords: Radish, Genetic improvement, Soil mulching.

Citation: Al-Jubouri, A.A.H.; Al-Hamadany, S.Y.H. & Al-Shakarchy, W.H.A. 2022. Effect of soil mulching on the genetic performance of two radishes *Raphanus sativus* L. varieties Turkish red and white. Iranian Journal of Ichthyology 9(ICAB special issue 2022): 110-115.

Introduction

Radish *Raphanus sativus* L., a member of the family Brassicaceae, is one of the important vegetable crops in the world. Its nutritional importance comes from its leaves and roots containing some important nutrients for humans, and its high medicinal value (Tatsuzawa et al. 2010). The area cultivated with this crop in Iraq for the year 2018 according to the central statistical organization (2019) is about 238 hectares with a yield of 9.092 tons/hectare.

Radish yield is affected by many factors, including genetic, environmental features, and agricultural, as well as the use of modern technologies, such as adding organic or chemical fertilizers and controlling the environmental conditions by activating soil physiobiology (Al-Masoum 1996). Jenson (1988) mentioned that many agricultural developed countries use soil cover for many vegetable crops. Covering the soil also leads to retaining moisture, reducing the loss of nutrients, washing, and volatilization to the outside atmosphere by heavy irrigation or rain, in addition to improving the physical properties of the soil (Whiting et al. 2005; Bhardwaj & Sarolia 2012). Despite, the high efficiency of radish in absorbing solar energy arriving in the ground (Ham et al. 1993), coverage reduces weed growth because it blocks light useful for growth (AL-Masoum et al. 1993).

Genetically evaluating the varieties of horticultural crops, when the available genetic information about these varieties is not sufficient, is of particular importance in shedding light on

directing breeding programs to achieve the genetic improvement sought by plant breeders (Al-Kumer 1999). Environmental variants may block the genetic variants of horticultural crops, so the more phenotypic variants between individuals within the same genotype, more difficult it to select for genetic differences, i.e. the less the environment effects on the change of the trait compared to the differences in genetic is effective to select plant traits that inherited high-quality offsprings (Al-Mafraji 2006). Hence, the need to find a quantitative measure to describe the extent to which the environment affects the traits and the scale of the heritability ratio, which represents the ratio between the components of the genetic variation of the trait to the phenotypic variation is crucial. Inheritance has an important role in choosing the appropriate method for raising and improving the desired traits in order to the proper selection of the traits selection (Lush 1943).

Therefore, the aim of this study is to investigate the effect of soil cover on genetic performance, estimating variations and their parameters, the value of heritability in a broad sense, and the genetic improvement of the growth characteristics of two varieties of radish (*Raphanus sativus* L.) i.e. Turkish red (T-R) and Turkish white (T-W) under the influence of three types of soil coverage viz. no mulch, green and blue.

Materials and Methods

The seeds of the two varieties were planted in the land in pits on 10/10/2019 on lines by length 3-meter with a distance of 20cm between plants, a distance of 60cm between lines and a distance of 1m between each replicate. A factorial experiment within the full randomized sector design Randomized Complete Block Design (RCBD) was performed with three replications and the number of treatments was 6 (2×3=6), each represented by three lines, i.e. the number of experimental units was as 2×3×3×3=54. All agricultural service operations were conducted, including irrigation, hoeing, weeding, control and fertilization, as recommended for radish fields (Matlab et al. 1989). Harvesting of all treatments was carried out on 25/1/2020 where eight plants were selected for each treatment and from each repeated randomly to assess and measure some growth characteristics.

To analyze the results, the mean values were compared at a probability level of 0.05 according to the Duncan polynomial test in SAS (1996) program. Genetic analysis (Table 5) were performed according to Steel & Torrie (1980) (Table 1)

Results and Discussion

There are significant differences between the two varieties of radish in the number of leave/plant (N-L-/P) (P<0.01), plant height (P-H), root weight (g) (R-W), root length (cm) (R-L), and total yield (t/h) (T-Y) (P<0.05). These results are in agreement with the findings of Chapagain et al. (2010), Zaki et al. (2012), and Poudel et al. (2012), indicating significant differences between genotypes of P-H, N-L-/P, R-W, R-L, and T-Y The coverage showed significant differences from each other in N-L-/P, R-W, root diameter (cm) (R-D), root/leaf ratio (R-/L-R), and T-Y (P<0.01).

The overlap between (cultivars × coverage) showed a significant difference for R-D (P<0.05) and for N-L-/P (P<0.01) (Table 1). This is an indication of overlap between genetic variation and environmental variation, represented by the coverage of these two traits, which was high in relation to the total variance, which will have a significant impact in the future on the breeding programs.

Table 2 shows significant differences for most of the studied traits, and these differences are mainly due to the difference in the varieties in the genetic makeup between the T-R cultivar that was significantly superior in P-H**,** leaf fresh weight (g) (L-F-W), R-W and T-Y, while the T-W cultivar was significantly superior in N-L-/P.

This is in line with findings of Yamane et al. (2009), Dilbag & Singh (2012), Kopta & Pokluda (2013), Rajput & Pal (2014), Dongarwar et al. (2018) and Semba et al. (2019).

Table 1. Analysis of variance for studied traits in radish.

		(M.S.)							
(S.D.)	(D.F.)	(P-H.)	(N-L-/P.)	(L-F-W.)	(R-W.)	(R-L.)	(R-D.)	(R-/L-R.)	(T-Y.)
(R.)	2	75.180	5.041	1035.513	11504.888	4.202	0.301	0.570	460.082
(C.)	1	95.680 *	4.500**	210.125	2725.680 *	5.227 *	0.347	1.196	109.125 *
(M.)	2	35.097	6.166**	79.013	8000.222 **	1.135	2.046 **	4.899 **	319.865 **
(C.) × (M.)	2	66.013	6.167**	259.041	732.722	1.335	0.575 *	1.583	29.304
(T.E.)	10	26.613	0.575	170.130	2497.838	1.082	0.165	0.711	99.927

*, ** are significant at the probability level (5% and 1%), respectively. (S.D.) = Sources of difference, (R.)=Repeaters, (C.)=Cultivars, (M.)=Mulch, (C.) × (M.)=Cultivars × Mulch, (T.E.)=Trial Error, (D.F.)= Degrees of Freedom, (M.S.)= Mean Squares, (P-H.)= Plant Height (cm), (N-L-/P.)= Number of Leave/plant, (L-F-W.)=Leaf Fresh Weight (g), (R-W.)= Root Weight (g), (R-L.)=Root Length (cm), (R-D.)=Root Diameter (cm), (R-/L-R)=Root / Leaf Ratio, (T-Y.)=Total Yield (t/h).

Table 2. Means of the effect of varieties on the studied traits of radish.

	M.(S.)							
(C.)	(P-H.)	(N-L-/P.)	(L-F-W.)	(R-W.)	(R-L.)	(R-D.)	(R-/L-R.)	(T-Y.)
(T.R.)	19.166 a	9.666 b	33.110 a	78.780 a	5.666 a	5.055 a	2.400 a	15.758 a
(T.W.)	14.556 b	10.666 a	26.281 b	54.166 b	4.588 a	4.777 a	1.884 a	10.833 b

Whereas: (C.)=Cultivars, (T. R.)= Turkish Red, (T.W.)=Turkish White

Table 3. Averages of the effect of mulch on the studied traits.

	(M.S.)							
(M.)	(P-H.)	(N-L-/P.)	(L-F-W.)	(R-W.)	(R-L.)	(R-D.)	(R-/L-R.)	(T-Y.)
(N.M.)	14.500^{b}	9.666^{b}	26.170^{b}	30.585^{b}	4.716^{a}	4.350^{c}	1.151b	6.120^{b}
(G.)	19.333^{a}	9.500^{b}	33.417^{a}	103.585^{a}	5.583^{a}	4.883^{b}	2.921^{a}	20.717^{a}
(B.)	16.750^{ab}	11.333^{a}	29.500^{ab}	65.250^{ab}	5.083^{a}	5.516^{a}	2.353^{a}	13.050^{ab}

Table 3 shows the significant effect of the average coverage coefficients for the studied traits except for R-L**.** The green mulching treatment had the highest P-H, L-F-W, R-W, R-/L-R, and T-Y compared to the others, where they differed only significantly with the exposed mulch treatment, the differences were not significant with the blue coverage treatment. The treatment of soil mulch in blue showed the highest significance for N-L-/P and R-D, in comparison to open cultivation and green coverage treatments. The differences were not significant between the three mulch types in R-L. The extra heat by covering the soil warms the perimeter of the roots of the plants, and this leads to the rapid growth of the roots increasing their efficiency by absorbing the water and nutrients necessary for the photosynthesis process. This is also a method for resisting the bush and preserving soil moisture by reducing evaporation and increasing water infiltration into the soil. During the growing season, this is reflected in an increased shoots volume and yield (Kazi 2016; Jerffson et al. 2016; Yong 2020).

Table 4 showed that the T-R variety covered with B had the highest P-H, significantly higher than T.W**.** The highest N-L-/P observed in the T-W variety covered with B, which showed a significant superiority over all other studied factors, whereas N-L-/P in the T-R variety covered with G was lowest. The lowest L-F-W was found in the T-W variety, which showed a significant difference with other factors. For the R-W and T-Y, the T-R variety covered with G showed the highest values, significantly higher than to most of the other interactions, whereas the lowest values of these traits was recorded in the T.W. variety. The highest values for R-L**,** R-D and R-/L-R were in B covered plants of the T-R variety and the lowest R-L in the T-W variety, and the lowest R-D in the open plants of the T-R variety, and the lowest R-/L-R in the open plants in the variety T-W. The average of the traits ranged between 2.142-66.473. The $^{\delta 2}$- P was high for P-H, L-F-W, R-W and T-Y, while it was low for the other

Table 4. Average effect of the interaction between varieties and mulch on the studied traits.

		(M-S.)							
(C.)	(M.)	(P-H.)	(N-L-/P.)	(L-F-W.)	(R-W.)	(R-L.)	(R-D.)	(R-/L-R.)	(T-Y.)
(T.R.)	(N.M.)	18.333^{ab}	10.333^{bc}	37.170^{a}	41.670^{c}	5.000^{ab}	4.233^{b}	1.176^{c}	8.340^{bc}
	(G.)	17.833^{ab}	8.333^{d}	32.830^{ab}	105.500^{a}	5.833^{ab}	4.933^{b}	2.823^{ab}	21.100^{a}
	(B.)	21.333^{a}	10.333^{bc}	29.330^{b}	89.170^{b}	6.166^{a}	6.000^{a}	3.200^{a}	17.833^{ab}
(T.W.)	(N.M.)	10.667^{b}	9.000^{cd}	15.170^{c}	19.500^{d}	4.433^{ab}	4.466^{b}	1.126^{c}	3.900^{c}
	(G.)	20.833^{ab}	10.666^{b}	34.004^{a}	101.670^{a}	5.333^{ab}	4.833^{b}	3.020^{ab}	20.333^{a}
	(B.)	12.167^{ab}	12.333^{a}	29.670^{b}	41.330^{c}	4.000^{b}	5.033^{b}	1.506^{bc}	8.267^{bc}

Table 5. Genetic Constants of the studied traits in the radish plant.

Traits	Genetic Constants							
	(M-A.)	(δ^2- P.)	(δ^2- G.)	(δ^2- E.)	(P-C-V.)	(G-C-V.)	H_2 (b-s.)	(E-G-A.)
(P-H.)	16.861	49.635	23.022	26.613	41.783	28.456	46.382	39.923
(N-L-/P.)	10.166	1.883	1.308	0.575	13.498	11.250	69.463	19.315
(L-F-W.)	29.696	183.461	13.331	170.130	45.611	12.295	7.266	6.827
(R-W.)	66.473	2573.785	75.947	2497.838	76.320	13.110	2.950	4.637
(R-L.)	5.127	2.462	1.381	1.082	30.604	22.920	56.092	35.362
(R- D.)	4.916	0.225	0.060	0.165	9.648	4.982	26.666	5.300
(R-/L-R.)	2.142	0.872	0.161	0.711	43.595	18.732	18.463	16.580
(T-Y.)	13.296	102.993	3.066	99.927	76.327	13.169	2.976	4.679

(M-A.) = Main Average, (δ^2- P.), (δ^2- G.), (δ^2- E.)=Phenotypic, Genotypic, Environment variance, (P-C-V.), (G-C-V.)=Phenotypic, Genotypic Coefficients of variance, H_2(b-s.) = Heritability.broad sense, (E-G-A.)= Expected Genetic Advance.

traits, and δ^2- G was high for R-W, medium for P-H and L-F-W, and low for the other traits, while the δ^2- E values were high for L-F-W, R-W and T-Y, medium for P-H, and low for the others (Table 5).

The high variance values of these traits can be explained by being one of the quantitative traits that are characterized by their great influence by the environmental conditions. Therefore, selection is effective for them based on the values of the external appearance (Al-Kamar 1999). This is in line with the findings of Mapari et al. (2010), Ullah et al. (2010), Mallikarjunarao et al. (2015), Chandel et al. (2015), and Singh et al. (2017).

The P-C-V had the highest P-H, L-F-W**,** R-W**,** R-L**,** R-/L-R and T-Y. This is in line with the findings of Ullah et al. (2010), Kumar et al. (2012), Jabal et al. (2015) and Mallikarjunarao et al. (2015). The values of H_2 (b-s.) are high only for the N-L-/P, and medium for P-H and R-L, and low to other traits. The high values of H_2.(b-s.) is an indication of the possibility of improving these traits through selection and this gives an indication that the appearance of the individual has a great relationship with his genetic makeup (Allard 1960) that is in agreement with the results of Mukhdoomi et al. (2007) and Singh et al. (2017). High E-G-A for the P-H and R-L**,** and medium for the N-L-/P and R-/L-R**,** while they were low for the other traits.

The increase in the H_2.(b-s.) is accompanied by the increase in the E-G-A, which gives an indication of the prediction that we will obtain by selection compared to using the values of inheritance only, whereas, the high values of H_2.(b-s.) correlates with the E-G-A is an indication of the presence of the influence of the host genes.

Therefore, the method of total selection achieves the require and this is in agreement with the findings of Mapari et al. (2010), Kumar et al. (2012), and Singh et al. (2017).

Acknowledgment

The author is very grateful to the College of Agriculture and Forestry, University of Mosul for providing facilities, which helped to improve the quality of this work.

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