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Evaluating effective traits on yield of two medicinal amaranths (*Amaranthus hypochondriacus* L. var. Cim and var. Kharkofski) in Karaj, Iran

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ABSTRACT

*Regarding the primary cultivation of Amaranthus hypocundriacus var. Cim and var. Kharkofski in Iran, evaluation of the direct and indirect effect of each yield component on the final yield, by the means of path analysis is highly important. This research was conducted in 2010 at the Veterinary Science Institute, Karaj, Iran. Experimental design was split plot in time in the form of a randomized complete block design with four replications. The main factor was planting season (spring and summer) and the sub factor was two amaranth varieties (Amaranthus hypocundriacus L. var. Cim and var. Kharkofski). Results indicated a significant positive correlation between stem yield with plant height (0.98**), leaf length (0.89**), leaf width (0.45*), petiole length (0.83**) and stem diameter (0.92**). There was also a significant correlation between total biomass yield with plant height (0.98**), leaf length (0.87**), leaf width (0.47*), petiole length (0.92**) and stem diameter (0.91**). The result of principle component analysis indicated that in the first prin, traits such as plant height, stem yield, leaf yield, flower and biomass yield contributed to about 80% of variations. The result of stepwise analysis of the traits that affect the dependent variable (biomass yield) indicated that four traits including flower yield, stem yield, leaf yield and petiole yield entered to the model respectively. The result of path analysis showed that stem yield had the highest positive direct effect on biomass yield and had determination of 0.482 of the total variations. Flower yield which was the first trait entering the model, was the second most effective trait on biomass yield with determination of 0.294. Therefore, it can be concluded that stem yield had the highest effect on biomass yield and after that, flower yield, leaf yield and petiole yield were the most effective traits on biomass yield, respectively.*

Keywords: amaranth, correlation, path analysis, stepwise analysis, principle component analysis.

INTRODUCTION

Amaranth is an annual plant with great variability in height; in some species it may reach to more than 2 m [16]. This genus has 60 species worldwide, nine of them are found in Iran. Leaves and seeds of this plant are valuable in medicine, spice and forage production [6]. Multiple uses has caused this plant is cultivated in different parts of the world such as China, south eastern

Asia, Africa and America [5]. Amaranth is a warm season plant with C_4 photosynthetic pathway that has made it highly adapted to tropical sunny regions [12, 13]. The minimum temperature for amaranth germination is 13-15^{o}C [11].

Amaranth is a medicinal plant with high value. It provides body with vitamin C, purifies blood, soothes cough and improves general heath [2, 7]. Different compounds are detected in amaranth such as alkaloids, triterpenoids, anthocyanins, vitamin C, amaranthine and isoamaranthine [10].

The correlation between traits can be caused due to the complicated interactions, uncontrolled influences or unknown factors [15]. The objective of coefficients path analysis is to combine the quantitative information of the correlations with the qualitative information to reach a quantitative analysis [1]. Coefficients path analysis, as a standardized partial regression analysis, is able to determine the direct effect of traits on each other. Moreover, it makes it possible to split the correlation coefficient to its direct and indirect components [15]. Genetic correlation coefficient is more important than phenotype correlation coefficient, because in genetic correlation coefficient, the effect of external and environmental factors is removed or minimized [15].The double correlation between the morphological and biochemical traits has been a method conducted on different Menta sp. [3, 8]. Mirzaie-Nodoushan et al. (2006) conducted path analysis over the traits which were effective on essential oils content in three thymus species and concluded that the number of stomata and leaf length had the highest direct effect on essential oils content [9]. Abbaszadeh et al. (2011) reported that in *Mentha longifolia* var. amphilema, essential oil yield was significantly correlated to flower yield, flower essential oil content and yield, leaf yield, leaf essential oils content and yield ($P \leq 0.01$) [4].

The objective of this experiment was to evaluate two amaranth varieties and find the most effective traits on their yield.

MATERIALS AND METHODS

This experiment was conducted in 2010 at the Veterinary Science Institute, Karaj, Iran, to evaluate the traits with the highest effect on shoot yield of two imported amaranth varieties (*Amaranthus haypocoundriacus*). The field is located in 35^{o} 48' N, 51^{o} E and 1320 m above the sea level. Mean annual precipitation of the area is 235 mm, minimum temperature is -20^{o}C, the maximum temperature is 28^{o}C and the dominant winds blow from west to east and south west. Experimental design was split plot in time in the form of a randomized complete block design with four replications. The main factor was planting season (spring and summer) and the sub factor was amaranth varieties (*Amaranthus haypocoundriacus* L. var. Cim and var. Kharkofski), which were imported to Iran for the first time.

Plots size was 5 × 6 m, rows were 75 cm apart and seeds were planted with interspace of 50 cm. At the time of field preparation, 50 kg urea/ha was added as the starter to support plants growth. Irrigation and weeding were conducted during the growing season.

At the end of the growing season, when plants were at seed maturity stage, yield components were evaluated to measure the total dry weight. Plants were harvested and were quickly weighted to obtain the fresh yield. Then, samples were dried in open air condition and some parts of them were put in 75ºC oven for 48 hours, and were weighted to obtain the yield in hectare. Data were first tested for their normality and were then analyzed by SAS software. Path analysis was also performed by path software.

RESULTS

Table 1. The correlation of the measured traits

	Plant height	Leaf length	Leaf width	Petiole length	Stem diameter	Internode length	Inflorescence length	Leaf dry weight	Stem dry weight	Petiole dry weight	Flower dry weight	Total dry weight
Plant height	1											
Leaf length	0.90**	1										
Leaf width	0.42*	0.23ns	1									
Petiole length	0.90**	0.82**	0.55*	1								
Stem diameter	0.92**	0.90**	0.47*	0.95**	1							
Internode length	0.23ns	0.14ns	-0.16ns	0.05ns	0.06ns	1						
Inflorescence length	0.89**	0.85**	0.50*	0.91**	0.91**	0.13ns	1					
Leaf dry weight	0.93**	0.79**	0.51*	0.83**	0.81**	0.28ns	0.83**	1				
Stem dry weight	0.98**	0.89**	0.45*	0.93**	0.92**	0.22ns	0.95**	0.93**	1			
Petiole dry weight	0.96**	0.86**	0.46*	0.88**	0.89**	0.32ns	0.86**	0.95**	0.95**	1		
Flower dry weight	0.98**	0.86**	0.48*	0.92**	0.91**	0.26ns	0.91**	0.96**	0.99**	0.97**	1	
Total dry weight	0.98**	0.87**	0.47*	0.92**	0.91**	0.25ns	0.92**	0.96**	0.99**	0.97**	0.99**	1

*ns, nonsignificant; *, significant at P≤0.05; **, significant at P≤0.01.*

Determining the correlation of the measured traits (Table1) indicated that leaf length was significantly correlated to plant height (0.90**). Leaf width was significantly correlated to plant height (0.42*). Petiole length was significantly correlated to plant height (0.90**), leaf length (0.82**) and leaf width (0.55*). Stem diameter was significantly correlated to plant height (0.92**), leaf length (0.90**) and leaf width (0.47*). Inflorescence length was significantly correlated to plant height (0.89**), leaf length (0.85**), leaf width (0.50*), petiole length (0.91**) and stem diameter (0.91**). Leaf dry weight was significantly correlated to plant height (0.93**), leaf length (0.79**), leaf width (0.51*), petiole length (0.83**) and stem diameter (0.81**). Stem dry weight was significantly correlated to plant height (0.98**), leaf length (0.89**), leaf width (0.45*), petiole length (0.83**) and stem diameter (0.92**). Flower dry weight was significantly correlated to plant height (0.98**), leaf length (0.86**), leaf width (0.48*), petiole length (0.92**) and stem diameter (0.92**). The total dry weight was significantly correlated to plant height (0.98**), leaf length (0.87**), leaf width (0.47*), petiole length (0.92**) and stem diameter (0.91**). Plant height was significantly correlated to inflorescence length (0.89**), leaf dry weight (0.93**), stem dry weight (0.98**), petiole dry weight (0.96**), flower dry weight (0.98**) and total dry weight (0.98**). Leaf length was significantly correlated to inflorescence (0.85**), leaf dry weight (0.79**), stem dry weight (0.89**), petiole dry weight (0.86**), flower dry weight (0.86**) and total dry weight (0.87**). Leaf width was significantly correlated to inflorescence length (0.50*), leaf dry weight (0.51*), stem dry weight (0.45*), petiole dry weight (0.46*), flower dry weight (0.86**) and total dry weight (0.87**). Stem diameter was significantly correlated to inflorescence length (0.91**), leaf dry weight (0.81**), stem dry weight (0.92**), flower dry weight (0.91**) and total dry weight (0.91**). Inflorescence length was significantly correlated to leaf dry weight (0.83**), stem dry weight (0.95**), flower dry weight (0.91**) and total dry weight (0.92**). Leaf dry weight was significantly correlated to stem dry weight (0.93**), flower dry weight (0.96**) and total dry weight (0.96**). Stem dry weight was significantly correlated to flower dry weight

(0.99**) and total dry weight (0.99**). Finally, flower dry weight was significantly correlated to total dry weight (0.99**).

Results of principal component analysis (Table 2) indicated that four firs prins explained more than 97% of the variations. In the first prin, about 80% of the variations were related to traits such as plant height, stem dry weight, leaf yield, flower yield and total biomass yield. In the second prin, internode length was the most effective trait. In the third prin, leaf width and internode length had the highest effect. In the forth prin, stem diameter, internode length and inflorescence length were the most effective traits on variations.

Table 2. Principal component analysis for the measured traits

Traits	Prin 1	Prin 2	Prin 3	Prin 4
Plant height	0.317	0.05	-0.068	-0.195
Leaf length	0.29	0.072	-0.413	0.056
Leaf width	0.166	-0.534	0.725	0.129
Petiole length	0.306	-0.161	-0.048	0.322
Stem diameter	0.306	-0.107	-0.191	0.357
Internode length	0.069	0.799	0.458	0.345
Inflorescence length	0.304	-0.072	-0.066	0.433
Leaf dry weight	0.305	0.067	0.188	-0.544
Stem dry weight	0.32	0.032	-0.05	0.004
Petiole dry weight	0.314	0.109	0.068	-0.226
Flower dry weight	0.32	0.05	0.045	-0.181
Total dry weight	0.321	0.05	0.019	-0.144
Special values	9.569	1.216	0.704	0.214
Relative variance	0.797	0.101	0.058	0.017
Cumulative variance	0.797	0.898	0.957	0.975

Underlined numbers have more value in principal components.

Results of stepwise regression of the traits which were effective on total biomass yield (as the variable factor) showed that flower dry weight, stem dry weight, leaf dry weight and petiole dry weight entered the model, respectively (Table3). The model is below:

$$Y = 0.03160 + 0.99985X + 1.00005X_2 + 1.00016X_3 + 1.00004X_4$$

In this equation:
Y = total dry biomass,
X = flower dry yield,
X_2 = stem dry yield,
X_3 = leaf dry yield,
X_4 = petiole dry yield.

In the above model, R-square was 0.99977; indicating that the traits explained 99% of the variations of the total dry biomass. Flower dry weight was the first trait entering the model and had the highest correlation coefficient (r = 0.99903) with the total biomass. The second trait was stem dry weight which had positive significant correlation with the total biomass yield (r = 0.99413). The third trait was leaf dry yield which was significantly correlated to total biomass yield (r = 0.96363). Finally, the forth trait was petiole dry yield which was significantly correlated to total biomass yield (r = 0.97680). Although these traits explained more than 99% of the variations together, however, the second, third and forth traits had the partial R-square of 0.0013, 0.0003 and 0.0004, respectively.

Table 3. Steps of stepwise regression analysis for the measured traits

Traits entered to the model	Steps of stepwise regression analysis			
	Step 1	Step 2	Step 3	Step 4
The fixed number	-1354.06728	-631.64175	-493.30798	0.031160
Flower dry yield	3.36799	2.51633	1.80664	0.99985
Stem dry yield	-	-	0.77857	1.00005
Leaf dry yield	-	-	0.75685	1.00016
Petiole dry yield	-	-	-	1.00004
Partial R-square	0.9980	0.0012	0.0003	0.0004
Model R-square	0.9980	0.9992	0.9995	0.9999

Results of path analysis (Table 4) indicated that although flower dry weigh was the first trait which entered to the model of stepwise regression, however, it was the second most effective trait based on its direct positive coefficient (0.294). Stem dry weight was the first trait here with the direct positive R-square of 0.482. Leaf dry yield and petiole dry yield were the third and forth traits with the highest direct effect on total biomass yield. In the second step, flower dry weight had the highest indirect positive effect on total biomass yield (0.291). Leaf yield was the third most effective trait (0.125) with indirect effect on total yield. However, its indirect effect through flower dry yield (0.285) and stem dry yield (0.45) was more important than its direct effect. Petiole dry yield was the fourth trait entering the model; the direct effect of this trait (0.106) was lower than its indirect effect through flower yield (0.288), stem yield (0.461) and leaf yield (0.119). Finally, it can be concluded that stem yield, flower yield, leaf yield and petiole yield were the most effective traits on total biomass yield.

Table 4. Path analysis and the direct and indirect effect of traits entered to the stepwise regression analysis model

Traits entered to the model	Flower dry yield	Stem dry yield	Leaf dry yield	Petiole dry yield
Flower dry yield	0.294	0.291	0.285	0.288
Stem dry yield	0.478	0.482	0.45	0.461
Leaf dry yield	0.121	0.117	0.125	0.119
Petiole dry yield	0.104	0.102	0.101	0.106
Total	0.999	0.994	0.963	0.976
Residual effect	-	0.001	-	-

Underlined numbers are the direct effects

DISCUSSION

In this experiment, path analysis was conducted to find the direct and indirect effect of traits entered to the model on total biomass yield. This is important because the relation between traits plays vital role in breeding programs and selection of varieties, ecotypes and accessions. In fact, selection for agronomic traits without considering the effect of other traits will not result in a suitable selection. So path analysis is required to determine the correlation, direct and indirect effect of traits, and select the superior varieties and ecotypes in breeding programs [14].

Path analysis proved the role of stem yield and flower yield in the improvement of total shoot yield. High positive significant correlation between dry yield with stem yield and flower yield was predicted because improvement of these two traits will increase shoot yield. Moreover, although leaf weight was the third trait with high effect on total yield, however, it is a very important trait because it is the photosynthetic organ which supports growth of other organs. Results indicated that plant height was another effective trait on total yield; this trait can be a suitable one for selection of varieties. Petiole weight and stem diameter were other effective traits on yield which had positive significant correlation; petiole weight was one of the traits which entered the stepwise regression analysis model. Path analysis showed that petiole weight had higher indirect effect on total yield through stem (0.461), flower (0.288) and leaf (0.119), compared with the direct effect (0.106). Abbaszadeh et al. (2011) reported that leaves and stems were more effective on *Mentha longifolia* var. amphilema shoot yield than other traits [4].

Finally, the varieties tested in this experiment are high yield forage plants in addition to being a medicinal plant, so it seems this plant can be used for different purposes.

REFERENCES

[1] A Farshadfar, Application of Quantitative Genetics in Plant Breeding, vol. 1, Razi University Publications, Iran, **1998**; pp. 396. (In Farsi).
[2] A Haji Sharifi, Secrets of Medicinal Plants: Manual to Identify and Use Medicinal Plants and Cure different Diseases, Hafez Novin Publications, Iran, **2005**; pp. 1142. (In Farsi).
[3] AK Kukreja, PS Dhawan, PS Ahuja, S Sharma and AK Mathur, *Journal of Essential Oil Research*, **1992**, 4, 623-629.
[4] B Abbaszadeh, MB Rezaei and F Paknejad, *Iranian Journal of Medicinal and Aromatic Plants*, **2001**, 27 (1), 46-55. (In Farsi).
[5] G Stalknecht and J Schula-Schaeffer, Amaranth Rediscovered, in: J Janick and J Simon (eds), New Crops, pp. 211-218, Wiley Publications, USA, **1993**.
[6] H karimi, Weeds of Iran, University Publications, Iran, **2001**; pp. 419. (In Farsi).
[7] H Karimi, Encyclopedia of Iranian Vegetatives, vol 3, Parcham Publications, Iran, **2002**; pp. 404. (In Farsi).
[8] H Mirzaie-Nodoushan, MB Rezaie and K Jaimand, *Flavor and Fragrance Journal*, **2001**, 16, 340-343.
[9] H Mirzaie-Nodoushan, Sh Mehr Pour and F Sefidkon, *Iranian Journal of Research and Development*, **2006**, 71 (1), 88-94. (In Farsi).
[10] H Samsam Shariat, Selected Medicinal Plants, Mani Publications, Iran, **2004**; pp. 1040. (In Farsi).
[11] J Lauer, P Carter, T Wood, G Diezel and M Lynarek, *Agron J*, **1999**, 91, 834-839.
[12] MH Rashed Mohassel and K Vafabakhsh, Scientific Weed Management, Mashhad Jahad Daneshgahi Publications, Iran, **1999**; pp. 175. (In Farsi).
[13] ML Rashed Mohassel, H Najafi and M Akbarzadeh, Weed Biology and management. Ferdousi University Publications, Iran, **2001**; pp 350. (In Farsi).
[14] M Sabokdast and F Khialparast, *Iranian Journal of Sciences and Technology of Agriculture and Natural Resources*, **2007**, 11 (42), 123-134. (In Farsi).
[15] MR Ghannadha and M Naghavi, Applicative Quantitative Genetics, Tehran University Publications, Iran, **2002**; pp. 171. (In Farsi).
[16] WM Ayethan, MM Sein and M Maybwin, The Effects of Some Medicinal Plants on Smoot Muscle, **1996**, AB Abstract 1970/1979.