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Original article

Evaluation of genotype × environment interaction for essential oil yield of coriander genotypes under different irrigation conditions using GGE biplot method

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Extended abstract

Introduction

Coriander is an annual herb of the umbel family and is belonged from North Africa to south-western of Asia. Coriander is one of the important medicinal plant that used in the pharmaceutical industry and it mainly cultivated and widely distributed for the fruits. The dried fruits are widely employed as a condiment, especially for flavoring of sauces, meat products and bakery and confectionery items. Also, coriander fruits are as a source of essential oils and fatty oil. Water deficit stress is one of the most important factors limiting the growth and survival of plants in arid and semi-arid regions of the world. Water is a major component of the fresh produce and significantly effects on weight and quality of plants. Also, water deficit may cause significant changes in the yield and composition of essential oils in aromatic and medicine plants. So that, was reported that water deficit increased essential oil percentage in coriander but decreased essential oil yield. Iran with an average annual rainfall of 240 mm is included among arid and semi-arid regions of the world. Of the million hectares of cultivated region, only five millions are under irrigation because of intense water limitations. However, Iran is one of the world's commercial coriander producers. Coriander has been cultivated for many years in different parts of Iran. Therefore, development of drought-tolerant cultivars with high essential oil yield is important in coriander. This research was conducted in order to evaluate the effect of drought stress on morphological, physiological and phytochemical characteristics of endemic coriander genotypes.

Materials and methods

F_2 generations derived from half-diallel crosses of six endemic coriander genotypes including Isfahan, Hamedan, Bushehr, Mazandaran, Markazi and Alborz, together with their parents were evaluated in randomized complete block design with three replications in each experiment during growing season of 2016 in the research field of Tarbiat Modares University. Plants were treated with different levels of water treatment: well watered (WW), moderate water stress (MWS) and severe water stress (SWS). Data were collected on fruit yield, essential oil content and essential oil yield. GGE biplot statistical method (genotype effect + genotype × environment interaction) was used to study stability of genotypes in the studied environments.

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Results and discussion
Results of Combined analysis of variance indicated that the effects of environments, genotypes and genotype × environment interaction were significant, suggesting that the genotypes responded differently in the studied environment conditions. So, there was the possibility of stability analysis. Results of stability analysis using GGE biplot method indicated that the two first and second principal components of the GGE biplot explained 96.4% of the total essential oil yield variation. Based on a hypothetical ideal genotype biplot, the genotype G17 was better than the other genotypes across environments for essential oil yield and stability and had the high general adaptation in all environments. . Furthermore, the genotype G9 at E1 environment and genotype G18 in E2 and E3 environments were superior genotypes with the high specific adaptation. Too, the results showed that all environments had high discriminating ability so that could able to show differences between genotypes. The moderate stress environment was the nearest environment to ideal environment that had the highest discriminating ability and representativeness.

Conclusions
Generally, the results indicated that all environments had high discriminating ability so that could able to show differences between genotypes. Also, the genotype as stable and drought tolerant genotype can be considered as donor parent which contains drought tolerance genes and could be used to improve coriander high essential oil yield in drought condition.

***Keywords*:** Coriander, Essential oil yield, Ideal genotype, Stability

Table 1. The studied genotypes in this research

Code	Genotype	Code	Genotype
G1	Alborz	G12	Isfahan
G2	Alborz × Markazi	G13	Isfahan × Mazandaran
G3	Alborz × Isfahan	G14	Isfahan × Hamadan
G4	Alborz × Mazandaran	G15	Isfahan × Bushehr
G5	Alborz × Hamadan	G16	Mazandaran
G6	Alborz × Bushehr	G17	Mazandaran × Hamadan
G7	Markazi	G18	Mazandaran × Bushehr
G8	Markazi × Isfahan	G19	Hamadan
G9	Markazi × Mazandaran	G20	Hamadan × Bushehr
G10	Markazi × Hamadan	G21	Bushehr
G11	Markazi × Bushehr		

Table 2. Combined analysis of variance for essential oil yield of coriander genotypes in different environments.

Source of variations	df	Mean square	Present of total variation
Environment (E)	**65.0**	0.003634**	2
Replication / E		0.000264	6
Genotype (G)	**25.5**	0.001428**	5
G × E	**4.2**	0.000235**	10

** Non-significant at the 0.01 probability level.

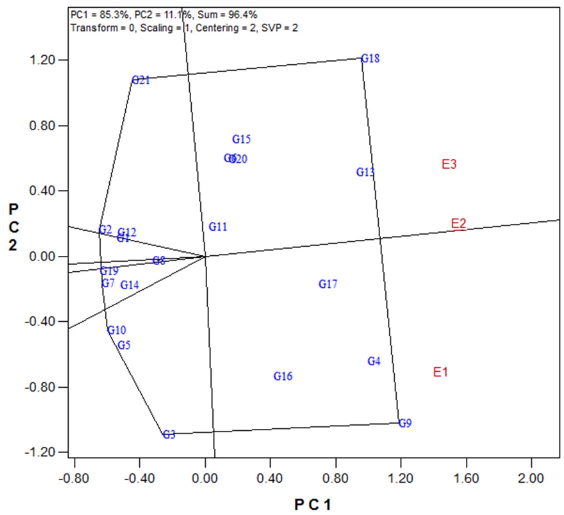

Fig. 1. Biplot polygon view for grouping the genotypes and environments in coriander

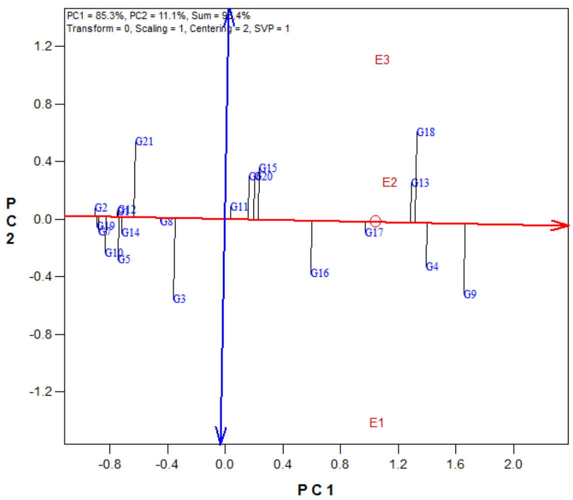

Fig. 2. Biplot view for simultaneous selection of yield and stability in coriander genotypes

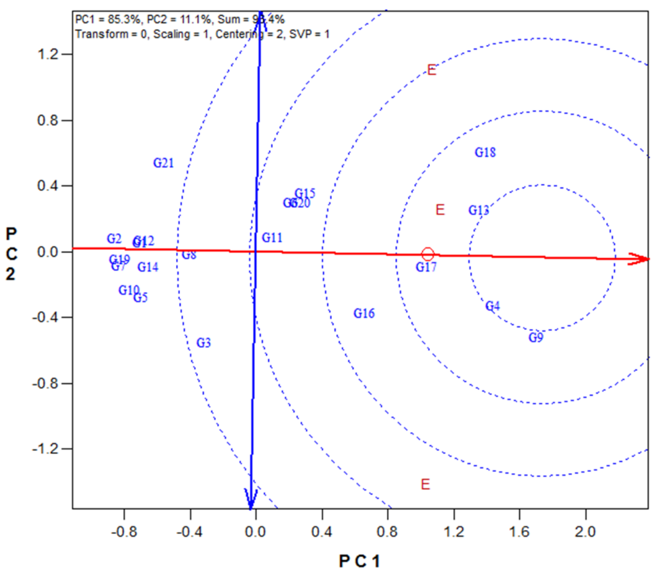

Fig. 3. Biplot view to compare the studied genotypes with the ideal genotype in coriander

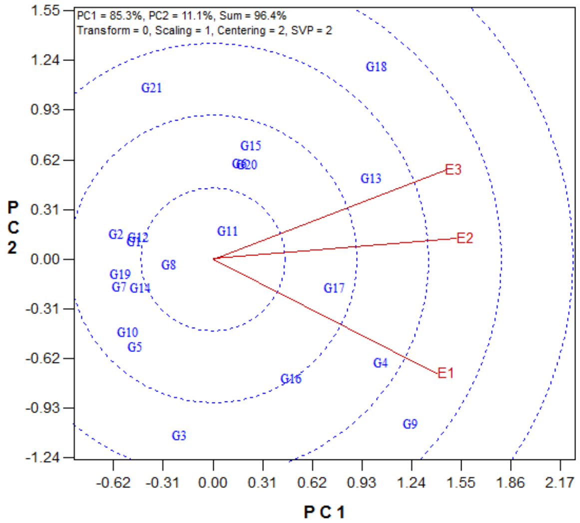

Fig. 4. Biplot view for displaying the relationships among the studied environments in coriander

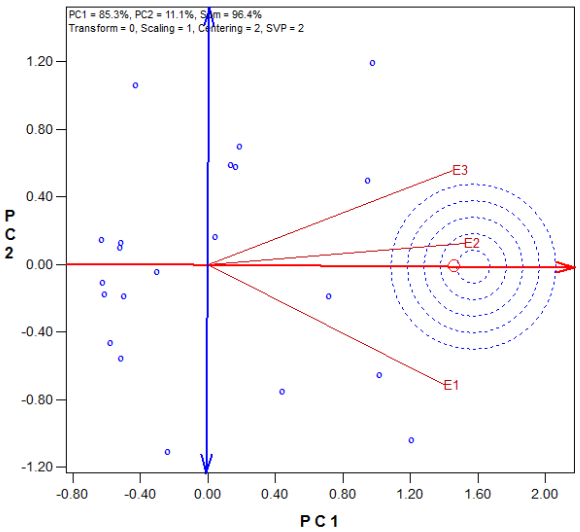

Fig. 5. Biplot view to compare the studied environments with the ideal environment in coriander