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Study on endophytic symbiosis on morphological and biochemical traits on fescue grass species under drought stress

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Abstract

Background and Objectives: Tall fescue (*Festuca arundinacea schreb*) is one of the most extensive genus in the Gramineae family and herbaceous endophytes are fungi of the Clavicipitaceae family and Neotyphodium genus that infect systematically the Poaceae grasses and discover the symbiotic relationship between festuca and endophytic fungi has encouraged plant breeding experts to use this relationship to create plants that have optimal performance and more effective growth habits in stress conditions. In this study, the effect of drought stress (14 days drought and control) and endophyte fungi and plant genotype (parent and offspring) on physiological and morphological changes such as proline, chlorophyll, carotenoids, fresh and dry weight and the comparison of length of plant growth have been investigated.

Materials and Methods: Seedlings of tall-fescue genotypes were prepared from the collection of Research Institute of Agricultural Biotechnology in the North West and West of the country. In order to match the samples, an E+ seedling was reproduced for 2 months by using the paw division method and for preparing E- seedlings, a number of E+ samples were propagated twice in 10 days intervals by propiconazole fungicide with 2 g/L of active ingredient concentrations. After testing the presence or absence of endophytic fungi, by using Rosebangal staining, water treatments including (control) 100% field capacity), drought stress for 14 days (25% field capacity) and 14 days recharge after retrieval for two genotypes of parent and offspring, after 20 days of settling in pots, in two replications in the form of a completely randomized design was applied. Then the traits mentioned were measured and analyzed by SAS statistical software. Duncan's test was used to compare the means.

Results: The results showed that proline content for water stress and species type was significant at 0.01% probability level and the highest amount of proline (2.96 mg/g fresh weight) was obtained under stress and for offspring and the effect of endophyte fungi was not significant. On the other hand, chlorophyll, carotenoids content and vegetative growth of the plant before the stress about the effects of the trial were not significant. In terms of fresh and dry weight of the plant, the effects of water stress, endophytic fungus, plant genotype and interaction of these three effects were significant ($P<0.01$) and the highest fresh weight (1.167 g) and dry weight (0.184 g) were related to offspring genotype and parent genotype without endophyte and under control conditions. The lowest dry weight (0.225 g) was in endophytic offspring and under stress conditions. For growth of shoot, two weeks after stress, the effect of water stress and interactions between stress and plant genotype was significant at 0.01% level and the highest height (31.25 cm) was observed in the offspring under control conditions.

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Conclusion: In order to manage this stress, it is better to use the parent species, which had higher dry weight under stress conditions and better growth after two weeks. On the other hand, about the role of endophyte in this study, as seen, no significant effect has been observed.

Keywords: Carotenoid, Chlorophyll, Drought Stress, Endophytic fungi, Proline

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Evaluation and selection of rice mutant lines based on drought tolerance indices

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Abstract

Background and Objectives: Rice is one of the most important crops in Iran and all over the world and drought stress is a significant limiting factor in producing this crop. Breeding for drought tolerance can be an effective method to improve and sustain yield in drought-prone regions. Inducing mutation is a suitable method for increasing the genetic variation of crops. The current research aimed was carried out to identify and classify tolerant and sensitive mutant lines of rice to drought stress.

Materials and Methods: Parent lines of the ninth generation resulting from a cross of Ahlemi-Tarom (relatively drought tolerance) and Sepidroud (relatively drought sensitive) were obtained. In 2015, to improve genetic diversity in drought tolerance, an irradiation with gamma-ray (250 grays) was conducted on 300 ninth generation lines at Nuclear Science and Technology Research Institute in Karaj. Using a primary screening in M_1 based on important agronomic and breeding traits, ninety-six mutant lines were selected. The present experiment was conducted on 96 mutant lines of rice (M_2) in two environments, i.e. non-stress (flooding) and drought stress conditions, on the research farm of Gonbad Kavous University in 2016 using a randomized complete blocks design with three replications. Through applying yield for each genotype and yield mean for all genotypes under stress and non-stress conditions, seventeen drought tolerance indexes were calculated. The indexes under study included TOL, MP, GMP, HM, YSI, YI, SSI, STI, ATI, DI, K_1STI, K_2STI, RDI, RDY, SSPI, SPI and SNPI. To determine the best indicators for identifying high yielding genotypes under different moisture conditions, correlations of indices with yield in stress and non-stress conditions were employed. To identify the relationship between the indices, multivariate analyses including a principal component analysis, a cluster analysis and a discriminant function analysis were used. The discriminant function analysis was used to determine the number of significant groups in cluster analysis and dendrogram cutting points. In order to select the best genotypes and indicators for determination of tolerant and sensitive genotypes to drought stress, a biplot was drawn.

Results: Results of the correlation analysis between drought tolerance indices and grain yield showed that GMP, HM, STI, MP and RDY were the best indices for identifying high yield of genotypes under flooding and drought stress conditions. By examining the correlations of

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indices with grain yield (stress and non-stress conditions) and their coefficient of variations, it was determined that the STI index, due to its significant correlation in both environments and its high coefficient of variation, can be introduced as an index which justifies the greatest variation under different moisture conditions. The principal component analysis showed that three principal and independent factors explained 99.93 percent of total variance in all data. The first, second and third factors with 84.47, 14.12 and 1.33 percent of the variance respectively were named as drought sensitive, drought tolerance and yield potential. The cluster analysis using the WARD method and Euclidean distance led to grouping mutant lines of rice. The discriminant function analysis showed that there were four significant groups in the cluster analysis. The first to fourth groups had 7, 25, 17 and 47 genotypes, respectively. The first and third cluster genotypes were identified as tolerant and sensitive to drought stress, respectively.

Conclusion: Genotypes No. 94 was selected as the best mutant line in terms of yield and tolerance to drought stress among plant sources in the present study. The biplot drawn based on the first two components introduced SNPI and SSPI indices as indexes for identifying tolerant and sensitive drought stress genotypes, respectively.

Keywords: Cluster analysis, Discriminant function analysis, Drought stress, Genetic diversity, Rice

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Effects of foliar spray some of commercial fertilizers on yield and fruit characteristics apple 'Fuji' and 'Delbar Estival' cultivars

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Abstract

Background and Objectives: Apple (*Malus Domestica*) is one of the most important horticultural crops that each year contributes a lot of the global trade in agricultural productions. Today, the role of different nutrition elements has been identified in increasing the yield and improving the quality of the fruits. Hence, the addition of balanced chemical fertilizers is more effective than other inputs in increasing agricultural production. This research was carried out with the aim of investigation effects of some organic and micro-macro nutrition elements on yield and fruit characteristics in apple 'Fuji' and Delbar Estival' cultivars.

Materials and Methods: This study was investigated in two separate experiments in randomized complete blocks design with three replicates per block for each cultivar in 2013-2014. Nutrition treatments included (Thiopher, Takamin Max, Oligogrine, Takamin Max + Oligogrine, Boron + Zinc, Oligogrine +Thiopher, Takamin Max + Boron + Zinc, Thiopher + Boron + Zinc and Control (without fertilizer)). At the end of the experiment was evaluated fruit qualitative and quantitative characteristics and economic evaluations were carried out for each cultivar separately.

Results: The results showed that all treatments except Thiopher were increased initial fruit set, final fruit set, average fruit weight, average yield per tree and average yield per hectare in both 'Fuji' and Delbar Estival' cultivars significantly compare to the control trees. Fruits tissue firmness was increased only in treatment (Takamin Max + Boron + Zinc), significantly compare to control trees (8.59 and 7.56 kg/cm^2 respectively). In general, the highest yield per hectare in both 'Fuji' and Delbar Estival' cultivars (31525 and 12715 kg) and (30525 and 157.5 kg) was observed in treated trees with (Takamin Max + Boron + Zinc). Fruits quality as well as fruits quantity were increased in this treatment significantly compare to control trees. The highest percentage of TSS and highest rate of fruit tissue firmness and the lowest percentage of acidity (TA) in the both cultivars were observed in treatment (Takamin Max + Boron + Zinc).

Conclusion: Totally, treatments (Takamin Max + Boron + Zinc) and (boron + zinc) were increased the quantity and quality of fruits significantly in compare to control, respectively. On the other hand, the results of economic calculations showed that although the highest gross income per product total sale (39406250 and 39406250 Toman) and gross income per yield increased (14643750 and 15893750 Toman) ratio to control in both cultivars were observed in treatment (Takamin Max + Boron + Zinc), But the most of proportion total income to the

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per-unit cost (157.5 and 163.12) and income obtained from yield increased ratio to per-unit cost (50.62 and 56.25) were observed in treatment (boron + zinc). These results indicated that, although in treatment (Takamin Max + Boron + Zinc), gross and net income was increased significantly in compare to treatment (Boron + Zinc), but ratio of income increase per unit of the cost was decreased significantly in compare to treatment (boron + zinc). Considering that farmers in Iran aren't often willing to pay a great deal of cost at one time, even though their gross and net income increases. Therefore, it can be suggested that they be used treatment of (boron with a concentration of 2/1000 +zinc at a concentration 1/1000) in the balloon stage of flowers for Fuji and Delbar Estival cultivars.

Keywords: Apples, Fruit set percentage, Nutrition, Qualitative traits, Yield per hectare

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Evaluation of biotic elicitors foliar application on functional changes, physiological and biochemical parameters of fennel (*Foeniculum vulgare*)

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Abstract

Background and Objectives: Fennel or green badian is one the oldest medicinal plants of Iran, with its different parts are used in drugs, cosmetic and traditional medicine industries. Elicitors' application increases the yield and secondary metabolites production in medicinal plants. Considering the increasing demand and the economic importance of plant metabolites types, the use of biotic elicitors in sustainable agricultural systems is necessary in order to quality improve and the maximum yield and essential oil yield of native medicinal plants of Iran. This study was carried out with the aim of evaluation of biotic elicitors foliar application on functional changes, physiological and biochemical parameters of fennel (*Foeniculum vulgare*).

Materials and Methods: This research was concluted at the agricultural research farm of Zabol University in a completely randomized blocks design with three replications and 16 treatments in 2016. In this study, foliar spray of salicylic acid and chitosan were in three stages of vegetative, flowering and reproductive with different combination by sprays. Characteristics of height plant, number of umbrella per plant, number of umbellate per plant, thousand-seed weight, seed yield, biological yield, harvest index, essential oil percentage, essential oil yield, chlorophyll a, chlorophyll b, carotenoid, anthocyanin, flavonoid, phenol, peroxidase and polyphenol oxidase were evaluated.

Results: According to the results, increasing chitosan and salicylic acid concentrations increased the number of umbellate and umbrella per plant. The results showed that the highest number of umbrella per plant was obtained from chitosan= 200 $mg.l^{-1}$, salicylic acid= 1.5 mM (A_{15}) and the lowest value from chitosan= 0 $mg.l^{-1}$, salicylic acid= 0 mM (A_0) treatment. The chitosan and salicylic acid foliar application had a significant effect on thousand – seed weight, so that the treatment chitosan= 150 $mg.l^{-1}$, salicylic acid= 1.5 mM (A_{14}), increased the thousand – seed weight by 41.1% compared to the control. The highest seed yield was obtained from A_{15} treatment with the mean of 1551 $kg.ha^{-1}$ and lowest in control treatment with the mean of 11.22 $kg.ha^{-1}$, which showed a decrease of 27.7% (480.4 kg) compared to the control. Also, with increasing levels of chitosan and salicylic acid, biological yield and harvest index increased significantly compared to control. The highest percentage (2.86%) and essential oil yield (14.2 kg ha^{-1}) were observed in A_{14} treatment. Without elicitors application significantly decreased amount of chlorophylls, carotenoids, anthocyanins and flavonoids. The 200 $mg.l^{-1}$ chitosan and 1.5 mM salicylic acid application the phenol, peroxidase and polyphenol oxidase enzym activity increased to 76.3, 71.4 and 55.7% respectively, in comparison with the control. The results showed that the chitosan and salicylic acid spraying by enhancing photosynthesis

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pigments and soluble osmolites, also protection against the damage of electrolyte leakage, improved the ability plant and increased seed yield of fennel.

Conclusion: With regard to this fact that the drought is characteristic feature of the Sistan region, it seems that the integrated application of biotic elicitors at 1.5 mM salicylic acid and 200 $mg.l^{-1}$ of chitosan increased yield, yield components and secondary metabolites of fennel. Therefore, salisilic acid and chitosan are recommended spraying application for planting and development of fennel and alternative for chemicla fertilizers.

Keywords: Chitosan, Chlorophyll, Phenol, Polyphenol oxidase, Salicylic acid

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Effect of fertilizer sources on biochemical traits and yield of rosemary (*Rosmarinus officinalis* L.) in competition and non- competition with weeds

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Abstract

Background and Objectives: Plant nutrition is an important factor in the growth and chemical composition of plants. The application of natural fertilizers can enhance the performance and pharmacological properties of plants. Rosemary (*Rosmarinus officinalis* L.) belonged to Lamiaceae family. Application of chemical fertilizers causes environmental pollution and ecological damage. One of the solutions to these problems is the use of sustainable agriculture principles in agroecosystems, including the use of organic fertilizers such as vermicompost and manure fertilizer. Considering the mentioned issues and taking into account the importance of rosemary herb and the management of weeds in agricultural landscapes, which is one of the biggest problems faced by farmers, this experiment was carried out with the aim of investigating the effect of fertilizer sources on biochemical characteristics and yield of rosemary in competition and non- competition with weeds conditions.

Materials and Methods: This experiment was conducted as a split plot in a randomized complete blocks design in three replications at Sari Agricultural Sciences and Natural Resources University in 2016. The treatments consisted of competition between plants and weeds (weedy and weed free) as a main factor and sub factor was fertilizer sources include sheep manure (20 ton ha^{-1}), vermicompost (10 ton ha^{-1}), sheep manure (10 ton ha^{-1}) + vermicompost (5 ton ha^{-1}), NPK fertilizer, NPK nanofertilizer and control (no fertilizer). The studied traits included: photosynthetic pigments (chlorophyll a, b, total and carotenoid), total phenol, total flavonoids, antioxidant activity, nutrient content (NPK), yield of rosemary and weeds biomass.

Results: The results showed that treatments had a significant effect on all traits. highest levels of chlorophyll a (7.24 µg ml^{-1}), chlorophyll b (2.66 µg ml^{-1}), total chlorophyll (10.08 µg ml^{-1}) and carotenoid (2.19 µg ml^{-1}) was observed in vermicompost treatment, which was happen in weed free condition too. Maximum amount of total phenol (70.85 mg g^{-1} leaf dry weight), total flavonoid (46.43 µg ml^{-1} leaf dry weight) and antioxidant activity (91%) were observed in sheep manure with weed interference, sheep manure with weed interference and vermicompost without weeding, respectively. While, maximum amounts of nitrogen (1.65%) and potassium (1.90%) were seen in vermicompost in weed free condition and for phosphorus (1.26%) in sheep manure with weed free, respectively. The highest weeds biomass was observed in chemical fertilizer treatment in all three sampling.

Conclusion: The results of the experiment indicated the superiority of organic fertilizers to chemical fertilizers, as well as the positive response of rosemary to fertilizer application.

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Non-use of chemical inputs in the production of medicinal plants and their products is a prerequisite for their health and naturalness. Therefore, considering the positive response of rosemary herb to the use of organic fertilizers, seems that the application of these fertilizers, reduced the use of chemical fertilizers and have no environmental consequences, decrease weeds biomass and reduces weed damage, as well as reducing herbicide use; therefore it is a good way to produce healthy and sustainable products of these species.

Keywords: Medicinal plants, Organic fertilizer, Photosynthetic pigments, Weed

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Effect of chemical and biological fertilizers on phytohormone changes and absorption of nutrients in sorghum under different irrigation periods

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Abstract
Background and Objectives: Despite the fact, that forage plants are trapped in a trap, in our country, less attention has been paid to this group of plants compared with other crops, which has led to a shortage of animal proteins with a shortage in their quality. Today, drought stress is considered as one of the most important factors in reducing food production. Increasing population and decreasing production due to drought stress has made study in this field always considered as one of the important issues in the research. Regarding the resistance of sorghum to drought stress, this plant can be considered as an essential tool for solving the problem of forage deficiency in addition to the production of grain, fresh fodder and dry fodder, it is also widely used. This experiment was carried out with the aim of investigating the effect of chemical and biological fertilizers on phytohormone changes and absorption of nutrients in sorghum under different irrigation periods.

Materials and Methods: In order to evaluation combined application of biological and chemical fertilizers with different irrigation periods on qualitative characteristics of sorghum (cv. Speed feed), an experiment was conducted as split plot based on randomized complete blocks design with three replications and 15 treatments at agriculture research station of Naghade. The main factor included irrigation at three levels (irrigation after 60 mm evaporation from the surface of the class A pan, irrigation after 100 mm evaporation from the surface of the class A pan, irrigation after 140 mm evaporation from the surface of the evaporation pan of class A) and the sub factor includes fertilizer treatments in five levels (bio fertilizer, 100% fertilizer, bio fertilizer + 75% recommended fertilizer, bio fertilizer + 50% recommended fertilizer, bio fertilizer + 25% recommended chemical fertilizer.

Results: The results of analysis of variance exhibited that effect of treatments on macro and micro nutrient uptake and phytohormones amounts was significant in 1% level. Among the elements, the highest amount of nitrogen was observed in normal irrigation and biological fertilizer + 75% chemical fertilizer. The highest amount of Indole-3-acetic acid hormone was observed in normal level irrigation treatments for all fertilizer levels except 100% chemical fertilizer treatment and the lowest levels of this hormone were recorded in severe stress treatments for all fertilizer levels. In terms of gibberellin hormone, superiority was observed in fertilizer and irrigation treatments. During the first irrigation interval, the highest amount of gibberellin was associated with bio fertilizer treatment + 25% chemical fertilizer and the

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lowest amount was for the treatment of 100% chemical fertilizer. In the following, bio fertilizer treatment, bio fertilizer + 75% chemical treatment and bio fertilizer + 50% chemical was ranked in one group. The highest amount of abscisic acid hormones was related to 100% fertilizer application and the lowest amount of this hormone was related to normal irrigation conditions in all treatments. The inoculation of seed with growth stimulating bacteria (Azotobacter, Phosphate barvar 2 and Bio-super) had a positive effect on the absorption of nutrients and hormones.

Conclusion: As the final result, it can be stated that due to the dry climate of Iran and positive effects of growth stimulating bacteria and the importance of sorghum forage production, the integrated chemical and bio-fertilizer can be used as an alternative method to reducing the use of chemical fertilizers and reduce environmental pollution caused by them.

Keywords: Azotobacter, Biosuper, Gibberellin, Indole acetic acid, Nitrogen, Phosphate

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Changes of yield and yield components of tomato (*Solanum lycopersicum* L.) under the effects of ultraviolet radiation and abscisic acid application in water deficit stress conditions

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Abstract
Background and Objectives: The use of low doses of ultraviolet radiation (< 50 kJ m^{-2} day^{-1}), is one way to stimulate plant defense system that can increase cell metabolism, improve physiological processes and increase plant resistance to various environmental stresses. Accordingly, an experiment was conducted to investigate the effect of ultraviolet radiation (UV-AB, UV-C and natural light) and spraying of the abscisic acid hormone on the changes of agronomic traits and fruit yield of tomato plants under water deficit stress conditions during vegetative and reproductive stages.

Materials and Methods: In this two-years experiment was conducted out in the form of a compound factor analysis in a factorial using based on a randomized complete blocks design with four replications in 2014-15 and 2015-16 crop years. Experimental treatments include: (1) mild spectra of ultraviolet radiation (non-radiation (control), UV-AB and UV-C), (2) application of abscisic acid (non-application and application of abscisic acid hormone) and (3) irrigation factor (full irrigation during the whole growth period (control or non-water deficit stress), water deficit stress during vegetative stage and water deficit stress at reproductive stage).

Results: The results of analysis of variance showed that the effects of mild ultraviolet radiation, abscisic acid hormone and irrigation factor on fruit yield of tomato and fresh weight of fruit were significant at 1% level, but the effect of the abscisic acid hormone was not significant on the number of fruit per plant and dry weight of fruit. Also, the results indicated that during the first year ultraviolet radiation of UV-AB and UV-C reduced by 15.8 and 16.3% of the number of fruits per plant. But in the second year, there were notable changes, so that UV-AB radiation increased by 6.2% and UV-C radiation decreased by14.1% of the number of fruits per plant. The results showed that in full irrigation conditions, dry weight of fruit was generally higher than water deficit stress at vegetative and reproductive stages, however, the use of UV-AB and UV-C rays in the full irrigation and water deficit stress conditions, the dry weight of fruit is relatively less than the non-use of UV rays. The results of interaction of irrigation factor × application of abscisic acid showed that in all irrigation treatments including full irrigation,

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water deficit stress at vegetative and reproductive stages application of abscisic acid increased fruit yield per plant, 18.1, 11.5 and 7.8%, respectively. The results obtained for dry weight of fruit for the index of dry weight of fruit to fresh weight were also true. Thus, at all levels of water deficit and control, the index of dry weight of fruit to fresh weight in plants exposed to mild radiation of UV-AB was less than non-ultraviolet irradiation and mild radiation of UV-C. The results showed that the under full irrigation conditions, application of abscisic acid reduced the index of dry weight of fruit to fresh weight, while its application in water deficit stress at vegetative and reproductive stages increased by 5.1 and 6.5% of the above attributes, respectively.

Conclusion: Results showed that the treatment combination of application of abscisic acid × full irrigation × UV-AB was the best in terms of fruit yield per plant, number of fruit per plant, and fruit dry weight. Overall, it could be stated that the use of low doses of UV-AB radiation with application of abscisic acid can have a positive effect on fruit yield and yield components of tomato.

Keywords: Abscisic acid, Fruit dry weight, Moisture stress, Tomato, Ultraviolet radiation

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Effect of biological and chemical phosphorus fertilizers application on flower yield, essential oil percentage and osmatic adjustments of chamomile (*Matricaria chamomilla* L.) in response to water deficit

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Abstract

Background and Objectives: Application of chemical fertilizers besides contaminating the water and soil resources and reducing the quality of agricultural and medicinal products has created serious environmental issues. Thus, to improve the soil fertility and for sustainable production, application of bio-fertilizers as an alternative to the chemical fertilizers have been widely promoted. Drought stress is an important environmental stress that reduces the growth and dry matter production of the medicinal plants, although increasing the effective ingredients production. This experiment was conducted to determine the most suitable amount of biological and chemical phosphorus fertilizers on dry flower yield, essential oil percentage and osmotic adjustments of chamomile in response to water-deficit.

Materials and Methods: The study was conducted at agricultural research institute of University of Zabol in 2016. The experiment was designed as a split plot using randomized complete blocks with three replicates. The main plots were different levels of water stress regulated by irrigation at 90, 70 and 50% of the field capacity (FC). The subplots were four levels of phosphorus fertilizers application including 100% chemical phosphorus fertilizer, 50% phosphate fertilizer and 50% bio-fertilizers, 100% bio-fertilizer and the control plot without any fertilizer application. Properties such as flower yield, total leaf chlorophyll, soluble carbohydrate, essential oil percentage, proline, carotenoid, phosphorus (P) and potassium (K) were evaluated. After the data collection, SAS program was used for statistical analysis and means were separated according to the least significant difference (DMRT) at 0.05 level of probability.

Results: Results showed that K and soluble carbohydrate were affected by the water stress and phosphorus fertilizer application. Increasing the water stress intensity from 90% of FC (control) to 50% of FC reduced the K uptake and increased the soluble carbohydrate content. The combined application of chemical and biological fertilizers showed the most positive effects. Interaction of the water stress and phosphorus fertilizer application showed significant impacts on dry flower yield, essential oil percentage, proline, total leaf chlorophyll, carotenoids and P content. The highest dry flower yield, total leaf chlorophyll and P were obtained from the control plot and the treatment with integrated application of chemical and biological phosphorus fertilizers. The highest essential oil percentage, proline and carotenoids were obtained from the treatments with severe water stress and with combined application of chemical and biological phosphorus fertilizers. Results showed that the highest dry flower yield (420 $kg.ha^{-1}$) was related to irrigation after 90% of FC along with the integrated application of chemical and

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biological phosphorus fertilizers and the highest essential oil percentage (0.846%) and proline (13.95 mg.g^{-1}FW) was belong to irrigation after 50% of FC along with integrated application of chemical and biological phosphorous fertilizer.

Conclusion: According to these results, to improve the qualitative charactertics of chamomile medicinal plant, integrated application of chemical and biological fertilizer along with water stress would be appropriate.

Keywords: Essential oil percentage, Flower production, Proline, Phosphate, Pigment

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Evaluation of some bioactive compounds and antioxidant activity of leaf methanolic extract and flower essential oil content from different cultivars of *Chrysanthemum morifolium*

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Abstract

Background and Objectives: *Chrysanthemum morifolium* is an important ornamental and medicinal herb in the world. Available reports revealed the presence of different organic and antioxidant compounds in different *chrysanthemum* cultivars. Also many biological characteristics such as antioxidant, anti-inflammatory, anti-bacterial and anti-virus are known for this plant. In this study, thirteen cultivars of *C. morifolium* were compared in terms of leaves total phenolic, flavonoid and antioxidant activity and also for their flower essential oil content.

Materials and Methods: This research was carried out in a randomized complete blocks design with three replications at the research farm of Isfahan University of Technology in 2015. For this purpose, methanol extracts were prepared from the dried leaves of different cultivars. Total phenolic and flavonoid was measured using spectrophotometry method and measurement of antioxidant activity was done using two model systems, DPPH and ferric reducing power. Essential oil extraction from ground dried flowers was carried out using a Clevenger-type apparatus and essential oil percentage was calculated.

Results: The results of analysis of variance showed that *Chrysanthemum* cultivars were significantly different for all studied phytochemical traits. According to the obtained results, total phenol and flavonoid contents and IC_{50} values in different cultivars were ranged from 17.63-33.20 mg/g DW, 12.62-53.17 mg quercetin/g and 54-228 µg/ml respectively. The highest phenolic content was in cultivar "Poya3" (33.20 mg/g DW), whereas the cultivar "Sahand2" (17.63 mg/g DW) contained the lowest value. Also, in terms of total flavonoid content, cultivars "Marmar" and "Sahand 2" had the highest and the lowest flavonoids with 53.17 and 12.62 mg quercetin per gram, respectively. Regarding FTC model system the absorbance rate of different cultivars was variable between 1.30-2.03. Cluster analysis divided all studied cultivars into five groups. The essential oil content ranged from 0.07 to 0.53% (w/w) among the different cultivars. Also, investigated cultivars showed high variation for their essential oil contents.

Conclusion: In overall, the results revealed high antioxidant activity in most of the studied cultivars. So, the extract of *Chrysanthemum* leaves can be introduced as a suitable source of natural antioxidants. Also, in this study, the cultivars Marmar, Atash2 and Erica in terms of phytochemical traits and the cultivar Dorna2 for higher content of essential oil were superior than the others. Therefore, it can be expected that the cross between cultivars "Marmar", "Atash2" and "Erica" with cultivars in Group V (Derna 2 and Sahand 2) can improve the varieties in this group in terms of biological and antioxidant compounds.

Keywords: Antioxidant activity, *Chrysanthemum*, Essential oil, Flavonoid, Phenol

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Effect of winter irrigation on flowering and fruit set of *Olea europaea* L. cvs 'Zard' and 'Manzanilla' in Loushan region

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Abstract
Background and Objectives: Flowers number and quality are the main determining factor which influence on fruit and oil yield of olive trees. So that, water deficiency during flowers differentiation and development in winter season by increasing incomplete flowers reduce fruit yield. Therefore, one of the most important times for irrigation where there is not enough rainfall in the late winter is one month before flowering.

Materials and Methods: Therefore, in this study, the effect of winter irrigation with three, six and nine days intervals on flowering, fruit set and fruit and oil yield of two olive cultivars, Zard and Manzanilla was investigated. The control was rainfed or common irrigation schedules in the orchard, irrigation with seven days. Irrigation of trees was started from January to mid-April for three and a half months. The characteristics such as inflorescence number and inflorescence length were measured from four main branches in each tree. Thereafter, total flowers number, complete flowers and final fruit set after natural flowers abscission were determined form six secondary shoots in each main branch. Fruit yield per tree in each treatment was calculated after fruit maturation. Furthermore, oil yield was determined after oil extraction from each treatment.

Results: The results showed that there was a significant difference between different irrigation treatments for inflorescences number, total flowers number, complete flowers, final fruit set, fruit and oil yield but no significant difference was found for fruit weight. The best winter irrigation interval was dependent to olive cultivars. So that the lowest inflorescence number, total flowers numbers, complete flowers percent and final fruits set were found in rain fed olive tree but the highest values was found six days interval for cv Zard and nine days interval for cv Manzanilla. No significant difference was found for fruit yield between winter irrigation treatments, but there was a significant between winter irrigated treatments and rain fed tree. The highest fruit yield was found in winter irrigation with six days interval. Winter irrigation increased fruit yield to 35 percent and increased oil yield to 50 percent as compared to rain fed control. The highest oil yield was found in winter irrigation with nine days interval.

Conclusion: Overall, winter irrigation could increase fruit and oil yield by increasing complete flowers number and final fruit set percentage in olive cultivars Zard and Manzanilla.

Keywords: Complete flower, Final fruit, Irrigation interval, Oil yield, *Olea europaea* L.

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