



Evaluation and selection of drought- tolerant rice genotypes by fluorometric methods

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Abstract

Background and Objectives: Water deficit in soil and atmosphere is the most important limiting factor for photosynthesis and plants growth especially rice and adversely affect on photosynthesis through reduction the carbon assimilation due to stomatal and metabolic constraints. Since the capacity for photo-protection is limited, drought can lead to loss of active PSII reaction centers. Therefore, non-destructive measurements of photosynthesis by chlorophyll a fluorometry may potentially provide information about plant viability and performance in response to drought. Rice was sensitive to drought increase when drought happens during the vegetative and flowering period. Plants response to drought stress can be assess by identification of character involve an important role in drought tolerance in morphological, cellular, biochemical and molecular levels. This experiment was conducted to evaluate the rice genotypes by measuring the traits associated with photosynthetic pigments and chlorophyll fluorescence components in order to select appropriate criteria for screening and drought stress tolerant in rice genotypes.

Materials and Methods: This experiment was arranged in randomized complete blocks design in Iran Rice Research Institute (Amol) in 2014. It was carried out in two conditions of well watered and drought stress during seedling stage in 56 rice genotypes from different provinces of Iran and the International Rice Research Institute (IRRI). After seeding, the seedlings daily irrigated until two to three leaf seedling stages. After 15 days, in normal irrigated conditions, irrigation continued-to the end of the growth period while completely cut off for drought stress treatments. When soil moisture reached to 20% (about 10 days after irrigation stop), the photosynthetic pigments related traits such as chlorophyll a, b and carotenoids and chlorophyll fluorescence attributes such as Fv/Fm, Φ PSII, qN, ETR and PAR were measured using the scientific methods.

Result and Discussion: The results showed that the amount of chlorophyll a and b, increased, 2.3 and 21.4 percent respectively and carotenoids content, decreased by 3.8 percent in drought stress. Chlorophyll fluorescence parameters were significantly different in the two environments except for Fv/Fm. Φ PSII, qN, ETR and PAR parameters which reduced in stress conditions by 7.3, 13, 35.5 and 28.8%, respectively. Correlation results showed that chlorophyll a with b and carotenoids had a significant and positive correlation with

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chlorophyll a and b. Also correlation between Φ PSII with Fv/Fm ($r=0.29$; $P<0.05$) and qN ($r=-0.91$; $P<001$) was negative and significant.

Conclusions: The results showed that chlorophyll pigments and chlorophyll fluorescence parameters, especially Φ PSII and ETR can be using as an evaluation criteria for the selection and screening of tolerant rice genotypes under drought stress conditions.

Keywords: Chlorophyll fluorescence, Photosystem II, Quantum yield, Rice, Screening



Identification and comparison silymarin inendophytic fungi isolated from seed of *Silybum marianum* (L) Gaert.)

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Abstract

Background and Objectives: *Silybum marianum* (L.) Gaert.) is a member of Asteraceae family, and silymarin is known as a value effective substance in the plant, which is used to treat a number of diseases, such as liver disease. Chalcone synthase is one of the key enzymes in the production of silymarin. The fungal endophytes have a beneficial effect on the production of secondary metabolites of plants. Recently, several endophytic fungi from plants have been isolated and studies were the chemical and molecular on its fungus has been considered. Therefore, this study aimed to isolate endophytic fungi from the seeds of milk thistle plant, and comparing the production of fungi and plant silymarin.

Materials and Methods: This research was carried out to isolate endophytic fungi from the seeds of milk thistle plant, and to compare the production of fungal and plant silymarin. For this purpose, milk thistle seeds were collected from the area of Sari Agricultural and Natural Resources University and after disinfection. They sterilized in conditions of cultivated on Murashige and Skoog medium. After appearance of fungi in the culture medium, the fungi were transferred to the PDA medium under sterile condition for purification to Water agar medium. Fungal growth isolates were transferred to PDB medium and after 10 days of silymarin extraction molecular identification of endophyte fungi isolates was performed by amplification of ribosomal areas, then the alignment of the obtained sequence with the sequences on the NCBI site was compared with BLAST online software and identified with phylogeny tree of endophytic fungus. In order to investigation of bioinformatics of Chalcone synthase in milk thistle and several other fungi species, the NCBI database was used and it was obtained by comparing domains and similar positions of Chalcone synthase. It was investigating with the Clustalo Uniprot database. Then it was analyzed with CLC Genomics Workbench ver. 5.5.2 software and their specifications table was drawn up. The phylogeny tree of these sequences was drawn using the Mega ver.7 software, using the Neighbor- joining.

Results: The results of high performance liquid chromatography confirmed that the silymarin produced by of fungi. The amount of silymarin for leaf samples of intact plant was 3.3079 mgr/gr FW, for the in vitro grown plant was 1.7183 mgr/grFW and for the endophyte fungus was obtained 0.729 mgr/grFW. Using ITS, molecular identification of isolates was carried out and its species was identified as *Alternaria alternata*. Also, analysis phylogenic relationship of chalcone synthase, as a key enzyme for production of silymarin, between milk thistle and a few fungi showed its closest proximity to *Alternaria* sp.

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Conclusion: The study determined the role of endophytic fungi in the production of silymarin in fungi isolated from the seeds of milk thistle and in vitro and in vivo plants, along with the bioinformatics study of the pathway of production of Chalcone synthase enzyme. The fungal isolate was also able to produce silymarin in laboratory conditions.

Keywords: Alternaria, Endophyte, HPLC, Milk thistle, Silymarin



Effect of organic fertilizer application on quantitative and qualitative performance of pumpkin skin (*Cucurbita pepo* Var. *Styriaca*)

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Abstract

Background and Objectives: The increasing use of medicinal plants have required mass production of these plants by using the minimum chemical inputs. In recent years, the study and evaluation of the response of medicinal plants to the use of organic and biological fertilizers have a special place in the research. Pumpkin skin (*Cucurbita pepo* Var. *styriaca*) is one of the most important medicinal plants that, due to its high quality oil, has a therapeutic aspect in addition to oral intake. Therefore, this research was carried out with the aim of evaluating quantitative and qualitative performances of pumpkin skin under biofertilizer treatments.

Materials and Methods: This experiment was conducted as a randomized complete blocks design in a research farm of Gorgan University of Agricultural Sciences and Natural Resources with four replications in 2017. Treatments included: fulvic acid (2, 4 milliliters), compost tea (2 levels 20, 10 ml), lignin (at 2 levels 0.2, 0.4 g) and control treatment (no fertilizer application). In this experiment, traits such as total phenol, total flavonoid, total antioxidant, oil percentage, free fatty acid, linoleic acid, oleic acid, protein, 1000 seed weight, grain yield and biological yield were measured in pumpkin skin. Analysis of variance of data was done using SAS software. Mean comparison of data was done by LSD test.

Results: The results of analysis of variance showed that the effect of experimental treatments on phenol total, total flavonoid, total antioxidant, oil percentage, free fatty acid, linoleic acid, oleic acid, protein and quantitative traits of gingiva was significant at 1% probability level. Based on the results of this experiment, the control treatments and the application of lignin had a higher total of phenol and flavonoid than compost tea and fulvic acid, which had antioxidants, phenols and flavonoids. Also, unlike phenol and flavonoid, the highest amount was obtained for oil percent, oleic acid and linoleic acid in foil and tea compost treatments. The percentage of oil in control treatments (35.1%), lignin 0.4 g (36.8%), lignin 0.2 g (37.9%), tea compost 10 ml (36.3%), fulvic acid were 2 ml (39.7%), 4 ml folic acid (44.6%) and tea compost 20 ml (42.7%). According to the results of this study, the highest amount of grain yield was observed in folivic acid and compost tea treatments, which was significantly higher in lignin and control treatments. the highest of grain yield was observed in treatments in 2 ml folivic acid treatments, 4 ml folivic acid, 10 ml of compost tea, 20 ml of compost tea, 0.2 gram of lignin, 0.4 grams of lignin and control was as 1144, 1044, 909, 997/7, 820.0, 862.7 and 780.7 kg / ha, respectively.

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Conclusion: In general, the results of this experiment showed that for the quantitative and qualitative improvement of pumpkin seeds, as much as possible, fulvic acid 4 ml and 20 ml of compost tea should be used. In addition they can improve the quality traits with increasing the grain and oil yield of pumpkin skin.

Keywords: Compost tea, Folivic acid, Grain yield, Lignin, Oil percentage, Pumpkin



Effect of silicone spraying on assimilate remobilization and yield of two bread and durum wheat under late season water stress

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Abstract

Background and Objectives: Wheat is one of the major plants cultivated in arid and semi-arid regions and is number one with respect to planting area and production in the world. Sensitivity of wheat to water stress is not equal in all of the growth stages and flowering stage is very sensitive to water stress, which silicon application could be able to increase the tolerance of wheat to water stress. This research was conducted to investigate the effect of silicon spraying on assimilate remobilization and grain yield of wheat under late season water stress condition.

Materials and Methods: In order to investigate the effect of silicon on remobilization and yield of two bread and durum wheat cultivars, under late season water stress, a field experiment was conducted as split factorial experiment in a completely randomized blocks design with three replications at Faculty of Agriculture and Natural Resources of Darab, Shiraz University, Darab, Shiraz University, during 2017-2018 growing season. Experimental treatments consisted of water stress in two levels included normal irrigation and water stress at the end of flowering, silicon (Si) spraying at 0, 1, 2, and 3 mM and two wheat cultivars (Chamran and Shabrang). In this research, dry matter remobilization, remobilization contribution and remobilization efficiency were determined.

Results: The results showed that the main effects of water stress, cultivars and silicon had significant effects on dry matter remobilization, contribution efficiency, remobilization efficiency, number of seeds per spike, 1000-grain weight, harvest index, biological yield and grain yield. Foliar application of 3 mM Si increased 12.7%, 25.3% and 16% of dry matter remobilization, contribution efficiency, and remobilization efficiency of wheat compared to no Si application, respectively. Also, in the 3 mM silicone under water stress, the number of seeds per spike and 1000-grain weight increased 43 and 13%, respectively. In normal irrigation condition, grain yield had a positive and significant correlation with 1000-grain weight ($r = 0.545^{**}$), while in water stress conditions, grain yield was had a positive and significant correlation with 1000-kernel weight (0.520^{**}), harvest index (0.404^{*}), biological yield (0.810^{**}) and contribution efficiency (0.459^{**}).

Conclusion: The foliar application of 3mM Si improved dry matter remobilization and remobilization efficiency by 67.2 and 38.7% in Chamran cultivar, respectively, which resulted in 19.7% increase in grain yield of Chamran cultivar compared to Shabrang when plant exposed to water stress. Overall, foliar application of 3 mM silicon could be a suitable approach in improve and increase the wheat grain yield under late season water stress in semi-arid areas.

Keywords: 1000-grain weight, Chamran cultivar, Contribution efficiency, Remobilization efficiency

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Evaluation of sugar beet S₁ pollinator lines using drought tolerance indices

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Abstract

Background and Objectives: Plants are encountered with biological and non-biological stress at different stages of their development. Drought stress is a serious threat to producing successful crops around the world, including Iran. One of the ways to select drought tolerant cultivars is to evaluate and determine their compatibility in two stressed and non-stressed environments. Tolerant genotypes can be selected using selectable indices. The aim of this study was to evaluate of sugar beet S₁ pollinator lines under non-stress and drought stress conditions in order to select promising and drought tolerant lines.

Materials and Methods: This experiment was conducted to evaluate the drought tolerance indices of 30 sugar beet genotypes (29 S₁ pollinator lines with origin population) and their relationship with sugar yield in Khorasan Razavi Agricultural and Natural Resources Research and Education Center in two separate experiments under field condition with randomized complete blocks design with three replications in 2016. Irrigation was done routinely up to the thinning. Subsequent irrigations were done after 90 mm and 200 mm evaporation from the class A evaporation pan in non-stress and drought stress conditions, respectively. Stress Tolerance (TOL), Mean Productivity (MP), Stress Susceptibility Index (SSI), Stress Tolerance Index (STI), and Beet Tolerance Index (BTI) indices were used to evaluate susceptibility and tolerance of the genotypes.

Results: Combined analysis of variance showed that there was a significant difference ($P \leq 0.01$) among studied genotypes and different irrigation regimes for sugar yield. The highest yield of sugar in non-stress and drought stress conditions were observed in S₁-45 (8.98 ton/ha) and S₁-3 (5.15 ton/ha), respectively. S₁-80, S₁-95, S₁-45, S₁-3, S₁-13, S₁-8 lines and origin population had sugar yield above average under both conditions of irrigation and they were in group A (high yield under non-stress and stress conditions) based on Fernandez' instructions. The study of correlation coefficients between sugar yield and tolerance indices in non-stress and drought stress conditions indicated the superiority of MP, STI and BTI indices.

Conclusion: In general, the results showed that S₁-3 line, both in terms of MP, STI, and sugar yield indicators under stress condition can be identified as the most susceptible genotype to drought stress.

Keywords: Drought stress, Genotype, Sugar yield

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Yield stability assessment of winter oilseed rape lines in cold regions of Iran using AMMI model

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Abstract

Background and Objectives: Oilseed rape is one of the most important edible and industrial oilseed crop in the world. In most breeding programs especially multi-environment yield trials, genotype×environment interaction causes variable performances of cultivars. For this reason, it is difficult to recommend and introduce superior cultivars in vast environments. Thus, for the purpose of concise evaluation of adoptability of genotypes, selection is done based on assessment in several locations during several years. In this study, AMMI procedure is used for determination of yield stability, selection high-yielding cultivars and estimation of genotype×environment interaction of for 25 winter oilseed rape lines in cold and moderately cold regions of Iran.

Materials and Methods: The compatibility and yield potential of 20 winter rapeseed lines with two promising lines and three cultivars namely Okapi, Ahmadi and Modena in cold and moderately cold regions of Iran was studied in randomized complete block designs with three replications in five locations (Karaj, Hamedan, Kermanshah, Tabriz and Arak) during two agronomic seasons. The AMMI (additive main effects and multiplicative interaction) method was used to investigate the effects of genotype×environment interaction and reaction of the lines under study. Uniformity of error variances let to do combined analysis of variances.

Results: Simple effects of location, genotype and genotype×location and genotype×location ×year interactions were significant. AMMI analysis showed environmental portion of genotype×environment interaction had highest effect on seed yield. Based on this analysis, the four principle components were significant and accounted for 26.8%, 21.23%, 13.58% and 10.99% of interaction sum of squares, respectively. SW101, and after that HW112 and L120 lines showed lower ASV and stable high yield compared to total average yield of the genotypes.

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Conclusion: Sustainability evaluation using ASV index showed that SW101 line has the highest stability. This line was considered as a genotype with good general stability with the lowest ASV and higher performance than the total average.

Keywords: AMMI, Biplot, Compatibility, Genotype \times Environment interaction



The effects of glycine betaine on some morphological and physiological characteristics of *Salsola imbricata* L. under salinity stress

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Abstract

Background and Objectives: After drought, salinity is the second most common environmental limiting factor for agricultural production. *Salsola imbricata* L. from Chenopodiaceae is a small shrub plant. Glycine betaine is one of the most commonly compatible solutes and is the most abundant compound among the many known quaternary ammonium compounds in response to stress. This study was conducted to evaluate and compare the some growth and enzymatic properties of *Salsola imbricata* L. using glycine betaine in response to the different salt stress levels.

Materials and Methods: This study was conducted as factorial based on a completely randomized design with 3 replications at Research Greenhouse of National Salinity Research Center, during 2017-18 growth season. The treatments were four levels of salinity: 3 (control), 10, 30 and 60 dS M⁻¹ (saline water resource) and two levels of GB consisted of without application and spraying with 50 mM concentration. Throughout the experiment, stem length, root length, root-shoot length ratio, shoot dry weight, root dry weight, root volume, chlorophyll content, soluble sugars, proline and protein were evaluated.

Results: The results indicated that increasing in salinity levels significantly decreased stem length in both with and without glycine betaine (GB) treatments. The highest and lowest stem length was obtained in 3 dS m⁻¹ using GB and 60 dS m⁻¹ without GB application, respectively. Regarding root length, increasing salinity levels from 3 to 60 dS m⁻¹ caused a significant decrease in root length. The use of GB did not cause a significant difference in root length than no GB except in 3 dS m⁻¹ treatments. The results showed that treated GB plants had a lower root to shoot length ratio, so that the GB application reduced root to shoot length ratio by 19.23%. Increasing levels of salinity significantly reduced shoot dry weight, so that with increasing salinity from 3 to 60 dS m⁻¹, a 40.8% reduction was observed in shoot dry weight. The results indicated a significant effect of GB application on increasing shoot dry weight, as GB increased the shoot dry weight by 4.46 g plant⁻¹. Increasing salinity levels up to 30 dS m⁻¹ did not affect the amount of soluble sugar, however increasing salinity level to 60 dS m⁻¹ resulted in significant increasing 31.97% soluble sugar by 31.97% compared to 3 dS m⁻¹. The results revealed that proline content was decreased when GB was applied than no-GB treatments at all salt stress levels, however this reduction was only significant at 30 and 60 dS m⁻¹ salinity levels.

Conclusions: Increasing salt stress from 3 to 60 dS m⁻¹ significantly reduced stem and root length, root to shoot length ratio, shoot and root weight, and root volume. Application of

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GB increased stem and root length, shoot and root dry weight and root volume. Increasing salinity levels enhanced soluble sugar and proline content. The amount of proline in GB application treatment was higher than no-GB at all salinity levels. It seems that in this study the use of GB increased plant ability against salt stress by improving the plant growth characteristics.

Keywords: Chlorophyll, Compatible solutes, Foliar application, Proline, Soluble sugars



Effect of salicylic acid and abscisic acid on yield and yield components of common purslane (*Portulaca oleracea*) under water deficit

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Abstract

Background and Objectives: Purslane (*Portulaca oleracea* L.) is one of the most valuable herbs of the Portulacaceae family. Water deficit is one of the major abiotic stresses that have adverse effects on plant growth and yield. The application of growth regulators such as salicylic acid and abscisic acid increases the resistance of plants to stresses and is a strategy to prevent the destructive effects of environmental stresses. Due to the low water resources in the country and the widespread use of purslane in the different industries, this study was conducted to investigate the effects of salicylic acid and abscisic acid on yield, yield components and some quantitative and qualitative traits of purslane forage under water deficit stress.

Materials and methods: Field experiment was carried out as split-plot based on randomized complete blocks design with three replications in 2018. Treatments were four levels of water supply (irrigation after 70, 100, 130 and 160 mm evaporation from class A pan) and three levels of foliar application (control (foliar application of water), foliar application of salicylic acid (1 μ molar) and foliar application of abscisic acid (50 μ molar). Irrigation and foliar application treatments were allocated to main and sub plots, respectively. In this study, yield and yield components, forage yield and crude protein of forage and water use efficiency of purslane were evaluated.

Results: Decreasing water supply led to reduction in number of capsules per plant, number of grains per capsule, number of grain per plant, biological and grain yield. Foliar application of salicylic acid and abscisic acid caused significant increase in number of capsules per plant (13.2 and 10.9% respectively), biological (15.2 and 13.1% respectively) and grain (16.1 and 13.3% respectively) yield. Also, forage yield and crude protein percentage and yield decreased 65.7, 35.4 and 80.8% respectively as a result of water deficit. Forage yield and crude protein yield significantly enhanced by foliar application of salicylic acid and abscisic acid. The application of growth regulators at all irrigation levels increased the water use efficiency of purslane. The highest water use efficiency (4.61 kg/m³) was obtained from salicylic acid foliar application under irrigation after 100 mm evaporation from the class A pan.

Conclusion: There was no significant difference between salicylic acid and abscisic acid foliar application. Therefore, regarding to beneficial effects of salicylic acid and abscisic acid on grain and forage yield of purslane, foliar application of salicylic acid and abscisic acid recommended. This would become more important under conditions where water availability is limited.

Keywords: Drought stress, Forage crude protein, Growth regulators, Purslane

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Genetic differences and heritability using morphological and phytochemical traits of some Iranian apples

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Abstract

Background and Objectives: In Iran considerable genetic resources of apple can be found in center, north and north east of the country and alongside the Caspian Sea. These genotypes have different phenotypes. In order to examine the levels of anthocyanin, phytochemicals, physical and chemical traits, the current experiment was designed and performed. Variations in size, skin and pulp color of the samples were found. The presence of genetic diversity led to more adaptation of plants to different environments and these enable researchers to select superior genotypes. Since diversity in germplasm is backbone of breeding programs, the present research work was undertaken to evaluate different apple varieties using morphological and phytochemical characteristics by multivariate statistical methods. The experiment was conducted in 2016 as a completely randomized design with 12 native genotypes and 3 introduced ones with 3 replications.

Materials and Methods: The fruits were collected from Kamal Shahr Horticulture Station of Karaj, affiliated to the Seed and Plant Improvement Institute. A total of 11 traits including weight, volume, density, firmness, acidity, total soluble solids and other characteristics were evaluated. The obtained data were subjected to analysis of variance using SAS (9.1) software and Duncan's test was performed to mean comparisons.

Results: Analysis of variance showed a meaningful difference among genotypes for all measured traits. According to the results, fruit weight varied from 161.9 g in Fuji cultivar to 4.25 g for Gol-ghermez cultivar. Acidity varied from 0.88% for Gol-sefid to 0.16% for Shahrood-10 genotype. The percentage of TSS varied from 19.5% for Red delicious cultivar to 11.5% for GH2 genotype and Golab-Kohanz cultivars. The highest positive correlation (0.95) was observed between fruit weight and fruit volume. Based on the results of PCA, the cultivars were divided into three distinct groups, which were similar to our cluster analysis results.

Conclusion: The results revealed that native Iranian apple varieties and genotypes are rich in genetic diversity and can play an important role in future apple breeding programs.

Keywords: Cluster analysis, Genetic diversity, Morphological and phytochemical traits, Principal component analysis

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Some physiological characteristics of the medicinal plant *Lavandula angustifolia* in response to drought stress, compost and vermicompost

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Abstract

Background and Objectives: Lavender (*Lavandula angustifolia*) is an herbaceous medicinal plant that has a long history of treating low levels of jaw, jaundice, asthma, liver and spleen disorders, nausea, asthma, and neurological disorders. In this study, the effect of different amounts of compost fertilizers obtained from solid municipal waste and vermicompost from fruit and vegetable field remnants on qualitative and quantitative characteristics of lavender plant under drought stress was investigated

Materials and Methods: This research was arranged in factorial based on randomized block design in greenhouse of Shiraz University in 2017. Treatments were included drought stress at three levels of 0, 5 and 9 days, and compost and vermicompost fertilizers each one in three levels of 0, 10 and 30% of the volume of soil pots. The effects of compost and vermicompost fertilizers on growth, physiological characters such as antioxidants property, phenol content, proline and secondary metabolites in essential oil at different salinity stress were measurement. The compost prepared from municipal waste under aerobic conditions and by the activity of microorganisms. The vermicompost was prepared from agricultural waste and fruit by processes using special worms. The data was analyzed using SPSS 16.0 software. Mean comparisons were made by LSD test at 0.05 ($P \leq 0.05$).

Results: The results showed that the effect of drought stress on all traits was significant, 10% vermicompost increased root growth. In compost and vermicompost treatments and drought stress, fresh weight of shoot had the highest growth rate in the control plant. The highest amount of proline (10.81 $\mu\text{mol/g}$ FW) was observed in 9-day drought stress treatment with compost and vermicompost 30% and lowest (2.9 $\mu\text{mol/g}$ FW) in control treatment. The antioxidant level of the plant leaves increased compared to the same treatment without stress. The highest antioxidant activity (7.15 $\mu\text{mol/g}$ DW) was observed in drought stress treatment. The highest amount of phenolic content (10.64 $\mu\text{mol/g}$ DW) was observed in plants treated with 10% vermicompost and nine days of drought stress and the lowest amount (5.96 $\mu\text{mol/g}$ DW) was observed in 30% compost treatment and 10% vermicompost treatment without drought stress.

Conclusion: The results indicate that using vermicompost fertilizer in low concentrations can improve the quantitative and qualitative properties of lavender plant under drought stress condition and the use of compost from solid municipal waste reduces the effective content of lavender plant. It is recommended that agricultural waste can be used in the preparation of compost and that urban wastage can be consumed as little as possible

Keywords: Antioxidant, Biological fertilizer, Drought stress, Essential oil, Lavender

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Evaluation of seed and oil production of sesame cultivars affected by row spacing and plant density

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Abstract

Background and Objectives: Yield of crops such as sesame is affected by environmental conditions, genetic characteristics and field management. Increasing plant density is one way to improve crop yield per unit area and determining the best planting arrangement for optimal use of resources, climatic conditions and genetic capacity of cultivars is essential. Therefore, this experiment was conducted to investigate the planting pattern on sesame varieties yield by changing the distance between row and plant density.

Materials and Methods: The experiment was carried out as a factorial split plot as based randomized complete blocks design with three replications in two spring seasons during 2015-16 at Zakak Agricultural and Natural Resources Research Station, Sistan and Baluchestan province. Row intervals at three levels including 30.40 and 50 cm were considered as main factors and plant density (20, 30 and 40 plants per m²) and genotype (Darab 1, Shovine in and Sistan local) as sub-factors. In this study, yield characteristics and components of grain yield, phenological characteristics, oil percentage and yield were investigated. Statistical analysis was performed using MSTAT-c software and the means were compared at 5% level using Duncan's multiple range test. Excel software was used to draw charts.

Results: The results of combined analysis of variance showed that the effect of year on grain yield, day to flowering and day to physiological maturity was significant. The effect of row and cultivar distance on yield components and grain yield showed significant differences. The effect of plant density except number of seeds per capsule on yield and yield components was significant. Triple interaction effects of studied factors on grain yield were significant. The highest grain yield was obtained in the first year with an average of 937 kg / ha. Among the row intervals, the highest grain yield belonged to the 40 cm row spacing with an average of 898 kg / ha, which was 27% and 14% higher than the 30 and 50 cm row spacing, respectively. Among the plant densities, the highest grain yield belonged to 30 plants / m² with an average of 809 kg / ha, which was 7.8% and 5%, respectively. Among the studied cultivars, Darab 1 had the highest yield of 902 kg than other cultivars. Also local cultivar and Darab 1 had the highest oil content and oil yield. The interaction of triple row spacing × plant density × cultivar showed the highest grain yield with average of 1149 kg.ha⁻¹ at 40 cm row spacing and 30 plant density for Darab 1 cultivar.

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Conclusion: Based on the results of this experiment, it can be concluded that in order to achieve maximum grain and oil yield in sesame for multiple branch cultivars such as Darab 1 and local Sistan cultivar, observing 40 cm row spacing and 30 plants per m² and for single branched cultivars such as Shovine observing 40 cm row spacing and 40 plants per m² are recommended in Sistan region conditions.

Keywords: Oil, Planting pattern, Row spacing, Yield component



Investigation of photosynthetic properties, gas exchange, leaf elements and compositions of some olive cultivars

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Abstract

Background and Objectives: The quality and quantity of oil and table olive fruits derived from olive fruit are influenced by many factors. These factors affect the final product by affecting photosynthesis, transpiration, stomatal conductance, mesophilic conduction, photosynthesis active radiation, total phenol, proline, and leaf elements. One of the most important factors affecting these traits is the existence of differences between the cultivars in terms of these variables. Therefore, the present study was conducted to investigate the photosynthetic properties, gas exchange, elements and leaf compositions of Mastoidis, Manzanilla, Jolat and Mari olive planned and implemented.

Materials and Methods: This research was conducted in year 2016 in a completely randomized design with four levels (Mastoidis, Manzanilla, Jolat and Mari) and three replications at Tarom olive station in Zanjan province. The measured traits were: photosynthesis, leaf temperature, transpiration, water use efficiency, photosynthetic active radiation, difference in atmospheric CO₂ concentration with the stomatal chamber, carbon dioxide under the stomata, difference in atmospheric H₂O conductance with the stomatal chamber, stomatal conductance, mesophyll conductance, chlorophyll index, total phenol, proline, nitrogen, phosphorus and potassium leaves of olive trees.

Results: It was found that Mari cultivar had significantly higher photosynthesis than other cultivars. Also, this cultivar showed the highest amount of transpiration, and at the opposite point, the Mastoidis cultivar had the lowest transpiration rate. Mastoids and Jolat cultivars significantly improved the water use efficiency of the two other cultivars. Mari cultivar had the highest stomatal conductance, and Jolat cultivar showed the most mesophilic conductance. Mari cultivars had the highest total phenol content in their leaves, and the Mastoidis cultivar showed the lowest total phenol content in leaves. The Mastoidis, Manzanilla and Mari cultivars had the highest proline content. Mastoidis, Manzanilla and Jolat had more phosphorus content in their leaves. Jolat had the highest amount of potassium in its leaves.

Conclusion: These results showed that Mari cultivar had a high amount of photosynthesis (10.14 $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$), transpiration (2.53 $\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$), stomatal conductance (0.15 $\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$), total phenol (18.33 mg/g FW) and proline (1/02 $\mu\text{mol/g FW}$), and it was suitable for these traits. Also, Jolat cultivar with high water use efficiency (137.56 $\text{mol CO}_2 \text{ mol H}_2\text{O}^{-1}$), mesophilic conductivity (0.05 $\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$) and macro elements (Phosphorus 0.09% and Potassium 1.16%) was also suitable for planting, especially in areas suffering from water scarcity.

Keywords: Mesophilic conduction, Phenol and Proline, Stomatal conductance, Water use efficiency

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Effect of salicylic acid on some morphological properties, growth and yield of tomato (*Solanum lycopersicum* L.) under shading conditions

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Abstract

Background and Objectives: Environmental stresses such as high and low light intensity are important limiting factors in the growth and development of plants. In the natural environment, all plants are shaded to some degree by surrounding plants or themselves during their lifecycle. Salicylic acid, as one growth regulator, can increase plants resistance to high light intensity and shading. The objective of this experiment, was to evaluate the application of salicylic acid on some morphological and yield and its effect on reducing tomato damage in low and high light intensity conditions, which the plant growth is possible under shading conditions and excess light.

Materials and Methods: In order to evaluate the effect of different levels of shading, salicylic acid and cultivar on growth, yield and quality of tomato (*Solanum lycopersicum* L.), an experiment was carried out as factorial split plot based on randomized complete blocks design with three replications at research field of Moghan Pars Abad located to Ardabil province, in 2015. Shading treatment (0, 25 and 50% shading) was considered as main plot and salicylic acid (0 and 2 mM) and cultivar (Super beta and Super 6108) treatments as subplot. In this experiment stem length, internode length, leaf number, leaf area, stem and leaf dry and fresh weight, chlorophyll content, stomatal conductance and yield were measured.

Results: The results showed that the total length of the plant, leaf number, leaf area and fresh and dry weight of leaf and stem, chlorophyll index and yield were higher in super beta cultivar treated with full light intensity and 2 mM salicylic acid, while the internode length and stomatal conductance increased with increasing shading intensity. The plant height, stem dry weight, fruit yield were higher in no shading conditions and foliar spraying of 2 mM salicylic acid than tomatoes treated with 50% shading and control salicylic acid. The maximum plant length, leaf number, fresh and dry weight of plant and yield were observed in full light conditions and in super beta cultivar, but their minimum value were observed in 50% shading and in super 6108 cultivar. The highest yield (3383 g per plant) was obtained in plants exposed to full light and treated with salicylic acid, but the lowest yield (1563 g per plant) was achieved in plants grown at 50% shading and without salicylic acid treatment.

Conclusion: In general, it is concluded that tomatoes grown in no shading treatment had better growth and yield. Salicylic acid application could improve the morphological properties and yield of tomato in shading conditions.

Keywords: Light intensity, Stress modulation, Tomato, Vegetative traits

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Physiological and morphological responses of two barley varieties and their progenies to toxic effects of lead

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Abstract

Background and Objectives: Heavy metal contamination in soil caused by human activities, such as mining and industrial activities and it is a serious problem all over the world. Lead (Pb) is one of the major heavy metals that tend to accumulate in the surface ground layer and its concentration decreases with soil depth. Soils contaminated with Pb cause sharp decreases in crop productivity thereby posing a serious problem for agriculture. Toxic effects of lead on plants can be attributed chlorosis, reduced growth, blackening of root system, upsets mineral nutrition and water balance, changes in hormone status and effects on the structure and permeability of the membrane. This study was conducted to evaluate several morphological and physiological traits of barely genotypes under lead contamination stress.

Materials and Methods: In this research, morphological effects of three different densities of lead nitrate (1000, 1500, 2000 ppm) and a control sample on two barley genotypes (Rec and Dom) were investigated in a completely randomized design with five replications. Traits of stem length, root length, leaf number and number of yellow leaves shoot fresh weight, root fresh weight, stem dry weight, root dry weight and ultimately the dry and fresh biological performances for the control and different treatments were measured. After observing the difference between the two parents in response to lead poisoning, on October 16, 2017, 94 inbred lines from Dom and Rec were planted in a completely randomized design with three replications in pots with 20 cm diameter. Then at 2- to 3-leaf stage, seedlings were treated by 0-2000 ppm density lead nitrate.

Results: The results showed that there was a significant difference between Rec and Dom genotype in 2000 ppm density respecting the lead resistance, and Dom showed a higher resistance compared to another parent. Stem length, leaf number, number of yellow leaves, stem dry weight; dry and fresh biological performances were affected by lead more than the other traits. The results of the experiment showed that in all morphological and physiological traits, there was a significant difference between the lines in the probability level of 1%. Based on genotypic correlation, there was a positive and significant correlation between photosynthesis and transpiration traits, stomatal conduction, CO₂ concentration, and plant greenness. In addition, there was a positive and significant correlation between fresh and dry biological performance and stem height, root length, shoot fresh weight, root fresh weight, root dry weight, and the number of green leaves. Based on the studied traits and by using cluster analysis, barley inbred lines were divided into 3 and 4 clusters under normal and stress conditions, respectively.

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The lines 24, 40, 41, 44, 48, 78, 80 with the highest mean of morphological and physiological traits, were placed in cluster 3 under stress condition. These genotype were the lead resistant. The lines 1, 7, 8, 15, 21, 25, 50, with the lowest mean of morphological and physiological traits, were put in cluster 2 under stress condition and were considered as the genotypes sensitive to lead.

Conclusion: Since tension with heavy metals causes' significant disruption to plants, so it is essential to understand the traits that are affected by this tensions and relationships existing between them. In this study, photosynthesis, transpiration, stomatal conductance, stem length, number of yellow leaves, fresh and dry stem weight, fresh and dry Biological yield, affected by stress than other traits.

Keywords: Cluster Analysis, Correlation, Inberred lines, Intercellular concentration, Resistance and sensitivity, Transpiration



The effect of covariate of alternate bearing in adaptation studies in olive

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Abstract

Background and Objectives: In order to confirm the existence of interactions in quantitative terms, the most obvious method is to participate in the results of each year in combined analysis. In the meantime, horticultural products are affected by the influence of the inner (not the year) of the plant, and their alternate bearing from year to year, low or high. In this research, in order to eliminate this effect and adjusting the mean of the years, the alternate bearing index of each genotype is used as auxiliary variable in the model in order to determine the changes of each component of combined analysis and finally, varieties and genotypes compatible with the environmental conditions of this climate are introduced using stability parameters.

Materials and Methods: For this research, 100 genotypes and cultivars collected from all over Iran were used. These genotypes and cultivars were planted in a completely randomized blocks design (RCBD) with three replications at Olive Tarom Research Station and estimated yield of each tree in kg per tree for 6 years from 2011 to 2016. The alternate bearing effect was deduced from the data by calculating the ABI for each genotype during successive two-year periods and correcting the averages using it. Finally, the data were analyzed and combined in two main and corrected formulas, and finally from Ten stability parameters were used to identify a stable cultivar in year.

Results: The results of combined analysis of variance for different methods had a significant difference. So that the genetic component of the combined analysis table increased 61 percent in the corrected data compared to the original data. Also, the effect of the year of this table was dramatically justified from 37 to 14 percent, down 23 percent. The amount of interaction in both cases for corrected and non-corrected data was significant with 35% and 32%, respectively. The comparisons performed for the pair of corresponding years using the t-student test indicated the difference in mean performance for both the same year for the original and corrected data. The value of this parameter was calculated positively and negatively in succession. Which it shows that the effect of interacting the auxiliary variable is the alternate bearing index in the calculations. The absolute value of this parameter represents more exposure genotypes or varieties of the phenomenon of alternate bearing. The most stable cultivars in this study with desirable function and using the data correction method, Koroneiki and Conservalia cultivars, were determined according to three factors of stability in yield, yield and oil quality.

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Conclusion: The existence of an alternate bearing in horticultural products can significantly alter the results of compatibility studies in these products. The internal phenomenon, which does not depend on the year and its parameters, changes the actual suitability of the genotypes and the numbers of participants in the experiment. Intervening the alternate bearing index in compatibility analysis as an auxiliary variable is an important factor in reducing the effects of alternate bearing in calculations, adjusting the meanings of each genotype environment, and ultimately making the correct decision to reject or accept the adaptation of a genotype. This difference in the overall survey and determining the compatibility of cultivars is obvious in the two corrected and main data sets. On the other hand, consideration of the amount of yield, in addition to stability, is essential in determining the optimal cultivar.

Keywords: Alternate bearing index, Analysis of variance, Auxiliary variable, Modification of averages, Sustainability parameters



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Effect of ectomycorrhizal fungi symbiosis and mycorrhiza helper bacteria (*Bacillus cereus*) on nutrient uptake and growth of black pine (*Pinus nigra*)

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Abstract

Background and Objectives: Mycorrhiza is one of the most common and oldest symbiotic associations in the plants. Nowadays it is known that mycorrhizal fungus increase host plant growth by in direct ways such as improving plant nutrition by absorbing nutrients, as well as increasing water absorption and indirect way such as reducing biologic and non-biologic stress. Pine trees are the most popular trees in the landscape and forests, which have compulsory symbiosis with ectomycorrhizal fungi. The aim of this study was the investigate the symbiosis of three types of ectomycorrhizal fungi (*Cantharellus cibarius*, *Amanita caesarea* and *Boletus edulis*) and bacteria (*Bacillus cereus*) with black pine.

Materials and Methods: This experiment was conducted in a completely randomized design with three replications. The treatments were included: Control, *B. cereus*, the ectomycorrhiza funguses of *Cantharellus*, *Boletus* and *Amanita* and combined treatments (bacterial+ fungi). Seedlings were inoculated with fungi and bacteria after 60 days; then, the traits were evaluated after 15 months. The traits were included: root mycorrhization percent, plant height, stem diameter, stem and root dry weight, chlorophyll content and the uptake of nitrogen, phosphorus, potassium and calcium.

Results: Mycorrhization was significantly influenced by applied treatments at 1% probability. The highest (61.32%) and lowest (14%) percentage of mycorrhization were obtained by *Boletus*+*Bacillus* and *Cantharellus*, respectively. The uptake of potassium, nitrogen and phosphorus elements, chlorophyll a, plant height and root and stem dry weight were significantly affected by treatments; while, there were not observed significant difference between treatments in case of stem diameter, calcium uptake and chlorophyll b. All combination treatments (bacterial+fungi) dramatically increased plant height, stem dry weight, total chlorophyll and the absorption of potassium and nitrogen compared with control. Also the treatments of *Boletus*+*Bacillus* and *Amanita*+*Bacillus* had positivity effects on increment of phosphorus uptake, Chlorophyll a and root dry weight. In case of individual treatments, the results showed that only *Boletus* was effective in improving the stem dry weight and potassium and phosphorus uptake. In the case of separate treatments, the results indicated that only *Boletus* fungus was effective in increasing stem dry weight and potassium and phosphorus absorption. In other case there were no significant difference between control and other treatments. The highest and lowest values of evaluated traits were obtained by *Boletus*+*Bacillus* and control, respectively.

Conclusion: The results conclusively suggest that all ectomycorrhizal fungus especially *Boletus* had a symbiosis with *P. nigra*. This symbiosis was improved by mycorrhiza helper bacteria and co-inoculated of *B. cereus* with all fungi had more positive effects on increasing of mycorrhization, nutrient uptake and growth of *P. nigra*.

Keywords: *Amanita*, *Boletus*, *Cantharellus*, Chlorophyll, Mycorrhization Percentage

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Study of chloroplast DNA diversity and genetic relationships of some tea genotypes

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Abstract

Background and Objectives: The herbal tea [*Camellia sinensis* (L.) O.Kuntze] is a non-alcoholic beverage with many medicinal properties that has entered Iran in the last century and cultivated in the northern region. Many studies have been done on the nucleus genome of this plant, but the investigation of the organelles genome relationships in this plant is very limited. For the first time in this research, we have tried to investigate the diversity of this germplasm in Iran by using the genome of chloroplasts.

Materials and Methods: In this research, 35 tea-plant samples from six populations (east tea cultivation district (Nashtarood), central tea cultivation district (Lahijan), west tea cultivation district (Fashalem), imported genotypes from Georgia, imported clones from Japan, and imported clones from Sri Lanka) in three collections of the tea institute were studied. At first sampling of young and fully developed leaves was performed and the DNA genomes were extracted. By using five pairs of specific primers for the chloroplast genome (DT, LF, HK, SC and rbcL) and four restriction enzymes (BglIII, HinfI, AluI and PstI) with Polymerase Chain Reaction- Restriction Fragment Length Polymorphism (PCR- RFLP) method, the variety in the chloroplast genome of these plants was investigated. NTSYS and POPGENE were used for cluster and population analysis.

Results: In this study, about 6980bp of the tea chloroplast genome was amplified in polymerase chain reaction and examined by restriction enzymes. Results indicated that from the 20 primer/enzyme combinations, four combinations (DT/ HinfI, DT/ AluI, LF/ PstI and HK/ HinfI) were shown polymorphic pattern and these four compounds put samples into seven haplotypic groups (H1, H2, H3, H4, H5, H6 and H7). All these grouping were created due to the occurrence of insertion-deletion mutations in the range of 10-40bp. Mean of genetic variation within (H_S), Total (H_T) and degree of genetic differentiations (G_{ST}) were 0.25, 0.46 and 0.45, respectively.

Conclusion: The results of investigation of 35 tea samples showed that there was no cognitive genetic structure between the different sample regions. These results also confirmed the possibility of utilization Polymerase Chain Reaction-Restriction Fragment Length Polymorphism (PCR-RFLP) technique to investigation of genetic diversity and identify genotypes and varieties of tea.

Keywords: *Camellia*, Chloroplast universal primer, Hanplotype, Restriction enzymes

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Genetic diversity of *Salvia santolinifolia* Boiss ecotypes growing in Hormozgan province using morphological traits

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Abstract

Background and Objectives: *Salvia santolinifolia* Boiss. is a perennial and aromatic plant which belongs to Lamiaceae family and grows wild in south of Iran. Due to the drought stress of recent years and the limited spread as well as extensive harvesting of *S. santolinifolia* from natural habitats, conservation of its germplasm is very important. In current study, genetic diversity of some wild populations of *S. santolinifolia* grown in Hormozgan province was studied based on morphological markers and potential assessment of this plant in natural environment.

Materials and Methods: In order to study the diversity of morphological and functional traits of different ecotypes in Hormozgan province, 120 genotypes belong to four ecotypes (including Abmah, GhotbAbad, Dorahi-Meymand and Sirmand) were collected in a nested design at flowering stage in winter and spring of 2018. In this research, some vegetative and reproductive characteristics such as plant height, plant width, leaf length, leaf width, branch number, number of flowering branches and inflorescence length were investigated. Data were analyzed using SAS, R and SPSS softwares. The cluster analysis was performed by input method and factor analysis was done using the Variomax rotation method.

Results: The results of variance analysis showed that significant differences ($P \leq 0.01$, 0.05) were found among the studied *S. santolinifolia* ecotypes for studied traits. Some morphological characteristics such as plant height, diameter of canopy, branch number, subdivision number, leaf length, leaf width and inflorescence length were significant at 1% probability level. The main stem diameter was significantly different at the 5% probability level. Genetic diversity indices such as Margalef, Shannon-Weiner and Simpson for estimating diversity within ecotypes in *S. santolinifolia* revealed that all four ecotypes had high diversity within ecotypes. The branch number (58.25%), diameter of canopy (50.11%), number of flowering branches (49.64%), dried weight (48.54%) and fresh weight (47.43%) had the highest diversity among studied ecotypes. The highest plant height was obtained in Sirmand ecotype, and also the highest diameter of canopy and branch number were in GhobAbad ecotype. The highest leaf length and leaf width were showed in Sirmand and GhobAbad ecotypes and finally, Dorahi-Meymand ecotype had the highest inflorescence length. The correlation coefficients between evaluated traits showed significant positive and negative correlations between some important traits. PCA analysis results demonstrated that studied characteristics divided in 6 groups which

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justified 68.44% of the total variance. Cluster analysis divided the four ecotypes into two independent groups. The two ecotypes of Abmah and Qotbabad were in one group, while Sirmand and Meimand ecotypes were in another group.

Conclusion: The findings of this study showed that there is high morphological diversity among the wild growing *S. santolinifolia* ecotypes in Hormozgan province which can be very valuable for use in breeding programs in order to create high quality and desirable food industries and the medicine was used.

Keywords: Analysis of variance, Cluster analysis, Ecotype, Morphological variation, *Salvia santolinifolia*