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Selection of Almond Vegetative Rootstocks for Water Stress Tolerance Based on the Morphological Markers

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Introduction: One of the microbiological preparations used for this study was Effective Microorganisms (EM), being a commercial mixture of photosynthesizing bacteria, Actinomycetes, lactic acid bacteria, yeasts and fermenting fungi. The microbiological composition of the EM concentrateincludes*Streptomyces albus*, *Propioni bacterium freudenreichil*, *Streptococcus lactis*, *Aspergillus oryzae*, *Mucor hiemalis*, *Saccharomycescerevisiae* and *Candida utilis*. Moreover, EM also contains an unspecified amount of *Lactobacillus* sp. *Rhodo pseudomonas* sp. and *Streptomyces griseus*. Effective Microorganisms have a positive effect on the decomposition of organic matter, limiting putrefaction, increasing nitrogen content in the root medium of plants, phosphorus, improving soil fertility and as a result contributing to the growth and development of the root systems of plants.

Selection of almond vegetative rootstocks for water stress tolerance is important for almond crop production in arid and semi-arid regions. The study of the eco-morphological characteristics that determine the success of a rootstock in a particular environment is a powerful tool for both agricultural management and breeding purposes. The aim of this work was to select the new rootstocks for water shortage tolerance, impact of water stress as well as Effective Microorganism (EM) on morphological characteristics of almond rootstocks.

Materials and Methods: In order to select the new rootstocks for water shortage tolerance, impact of water stress as well as EMonmorphologicalcharacteristics of almondrootstocks were studiedin thedepartment ofHorticulture, Ferdowsi University of Mashhad, in 2011-2012. The experiment was carried out with four replications in a completely random blockdesign to study the effects of two concentrations of EM (0 and 1%), three irrigation levels (normal irrigation 100%-control-and irrigation after depletion of 33 and 66% of available water), and four almond rootstocks including GF677 and selected natural hybrid of peach × almond (H1and H2), and almond vegetative rootstock (local control).In this study,EMtreatments for 60 days before stress treatments were applied so that in each irrigation, EM solution to a concentration of one percent was given to half of the experiment pots. Other pots were irrigated equally with normal water. Stress levels were applied from July as follow: full irrigation, watering after unloading 33% and 66% soil moisture availability. In order to evaluate the performance, seedling survival, plant growth, number of leaves, leaf area, root fresh and dry weight and leaves and root length were measured.

Results and Discussion: Analysis of variance showed that between rootstock levels across all treatments were significantly differences at 0.01 level of probability. Comparison of means showed that the highest fresh and dry weight and leaf are awere observed forGF677and H1.Rootstockannualgrowth rate was also different. Most of the growth was related to the H1 Rootstocks. Thes urvival ratewas significantly different from the Rootstocks ofGF677,andH1showedthe highestpercentage of survival. The degree of adaptation to drought in varieties of almonds is different. The results showed that changes ingrowthparametersinGF677and H1were observed less often than other rootstocks. Because of strong roots,GF677and H1continue to attract more minerals under stress conditions.

Analysis of variance showed that the between irrigation levels for all treatments were significantly different at 0.01 level of probability. Comparison of means showed that among the study traits, the highest amount was obtained from complete irrigation, while irrigationat66 percenthad the least amount. Water stress may directly affect photosyn thesis, through leaf photochemicalprocessorindirectly,byclosing stomata, reducingleaf area and growth.

The results showed that the levels of(EM) on the leaf surface, leaf number, annual growth, root dry weight and volume were significantly different ($p<0.01$). Comparison of means revealed that the application of EM increasedthese traits compared to control. Effective Microorganisms, can increase plant growth, leaf area, fresh

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and dry weight of shoots and roots, and plant biomass. This phenomenon could bedue to better growth of roots. It is due to the biological activity of micro organisms in composition of EM.

Considering the results of this study, among examined traits, length, dry weightand root volume were suitable markers for evaluating water stress tolerance in almonds and the H1 rootstock (natural hybrid of peach × almond) was identified as the resistant rootstock to water stress. Impact of EM on the growth factors and survival of seedlings was dependent on the type of rootstock and the impact of EM on the water stress tolerance was different from the genetic characteristics of the rootstock.

The relationship of linear regression was used to identify markers related to water stress. Between the markers tested, length, root volume and root dry weight have higher correlation with survival of rootstock. Accordingly, them entioned markers are appropriate to measure the amount of water stress tolerance of almond rootstocks.

Conclusion: The results of this study, Natural hybrid H1, are resistant rootstocks in dry conditions. Effect of Effective Microorganism (EM) on the growth and drought resistance characteristics, depends on the type of rootstock. Accordingly, this substance cannot berecommended for all root stocks and cultivars. Further investigation of the effects of the combination on the desired plant exists. In addition, the influence of these substances for full irrigation was higher, because more suitable growing conditions exist. On this basis, effect of this combination is dependent on environmental conditions.

Keywords: Effective Microorganisms, *Dehydration*, Natural hybrid, Survival of rootstock

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Effect of Different Levels of Nitroxin and Humic Acid on Quantitative Properties and Essential Oil of Ajowan (*Carum copticum* (L.) C. B. Clarke)

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Introduction: Unbalanced application of fertilizer and chemical pesticides reduce soil fertility and agricultural products quality. Application of bio-fertilizers is quite important for sustainable agriculture..According to the principles of ecological agriculture, soil fertility and plant nutrition play an important role in improving the yield and quality of medicinal plants. The use of biological fertilizers is one of the main strategies in ecological agriculture for plant nutrition. Organic materials are not the only source of bio-fertilizer but bacterial and fungal particles and materials from their activities in relation to nitrogen, phosphorus and other nutrients are examples of biological fertilizers too. Today particular attention has been paid to the canvas of biological nitrogen fixation byfree-living bacteria such as Azospirillum and Azotobacter companion agricultural systems. Nitrogen is mainly the first nutrient which its deficiency in the arid and semi-aridoccurs.It is due to this fact thatthe amount of organic matter that is the major source of nitrogen stored in these areas is negligible. Nitroxin contains the most effective nitrogen fixation bacteria (Azotobacter and Azospirillum). Nitroxin bacteria besides nitrogen fixation of atmosphere and counterbalance of macronutrients and micro nutrientsare required for plant uptake, with the synthesis and secretion of various hormones and growth regulators such as auxin (IAA), the secretion of various amino acids, antibiotics, andhydrogen cyanide hydrogen will cause siderophore growth and development of roots and aerial parts of the plant. Due to environmental concerns, the use of organic acids to improve the quality and quantity of crops and gardens is not possible. Small amounts of organic acids have significant impacts on physical characteristics, chemical and biological soil because of the useful hormonal effects of compounds in increasing production and improving the quality of agricultural products. Humic acid, as one of the appropriate fertilizer, is used in the agricultural organic system. Humic acid causes shoot growth increase due to the absorption of calcium, nitrogen, phosphorus, potassium, manganese, iron, zinc and copper. Bio-fertilizer application information on medicinal plants is very important. In the present study, nitroxin and humic acid effects on *Carumcopticum* extract were investigated.

Materials and Methods: In order to evaluate the effect of different levels of humic acid, organic fertilizer and Nitroxin bio-fertilizer on quantitative and qualitative characteristics of Ajowan, a factorial experiment in a randomized complete block design with three replications was conducted in Zabol University. The seeds used in this study were obtained from a local variety that was planted superficially. Active ingredientof the seed was extracted by distillation with water for threehours. Essence percentage was determined by sodium sulfate. The Kejeldal method was used to determine the percentage of nitrogen. The crude method was used to determine the concentration of calcium, potassium, phosphorus and magnesium in dry ash. A factorial experiment in a randomized complete block design with three replications was conducted at the Research Farm. Treatments include the seed inoculation with Nitroxin bio-fertilizer in fourlevels including N1= zero (control), N2 = 0.5, N3 = 1 and N4 = 1.5 L/ha and organic fertilizer humic acid as irrigation water solublefour-leaf stage on fourlevels H1 = zero (control), H2 = 1, H3 = 2 and H4 = 3 kg per hectare. SAS statistical software was used to analyze the data and mean of three traits were compared by LSD test at the 5% level**.**

Results and Discussion: None of the treatments affected plant height and Nitroxinhumic acid interactions were not significant. The results showed significant effects of humic acid on seed weight, number of umbels and lateral branches, essential oil percentage and yield. The highest percentage and oil yield was 4.17% and 64.75 kg per hectare of treated H4, respectively. Nitroxin effect on all traits was significantly different except oil percentage. Interaction of humic acid and Nitroxin treatments on yield and biological yield were significant. The highest yield (1758.33 kg per ha) was treated with N4H3.

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Conclusion: Our results showed that 1.5 L/ha Nitroxin and 3 kg humic acid per ha were the best treatments in the production of oil yield and percentage of Ajowan organic farming.

Keywords: Bio-fertilizer, Essential oil yield, Morphological characters

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The Role of Mycorrhizal Inoculation on Growth and Essential Oil of Peppermint (*Mentha piperita*)

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Introduction: Arbuscular mycorrhizal symbiosis is formed by approximately 80% of the vascular plant species in all terrestrial biomes. Using soil microbial potential including arbuscular mycorrhizal fungi (AMF) has been widely considered for improving plant growth, yield and nutrition. Medicinal herbs are known as sources of phyto chemicals or active compounds that are widely sought worldwide for their natural properties. Members of the Lamiaceae family have been used since ancient times as sources of spices and flavorings and for their pharmaceutical properties. Peppermint (*Mentha piperita*) has a long tradition of medicinal use, with archaeological evidence placing its use at least as far back as ten thousand years ago. Essential oils - are volatile, lipophilic mixtures of secondary plant compounds, mostly consisting of monoterpenes, sesquiterpenes and phenylproponoids.Arbuscularmycorrhizal fungi with colonizing plant roots improve nutrient uptake as well as improving essential oil yield of medicinal plants by increasing plant biomass. The aim of the present study was to evaluate the effect of AMF inoculation on essential oil content and some growth parameters of peppermint (*Mentha piperita*) plant under glasshouse condition.

Materials and Methods: This study was performed on a loamy sand soil. The samples were air-dried, sieved (<5 mm) and thoroughly mixed. Some soil physicochemical properties were measured and then sterilized in 1 atm and 121°C for 2 h -. The pot experiment was carried out in a completely randomized design with four AMF treatments (1) control or no inoculation (C) 2) *Glomus fasciculatum* (Gf), 3) *Glomus intraradices* (Gi), 4) *Glomus mosseae* (Gm)and five replicates. -:. Rhizomes of peppermint were planted into a hole in a substrate where the inoculum had been previously added. Plants were kept in a glasshouse with a 16/8 h light and dark photoperiod, 26/22±2°C day and night temperatures, respectively. After 120 days of growth, at the end of the vegetative period some growth parameters including plant height, stem diameter, the number of lateral branches, leaf number, leaf fresh and dry weight and root colonization percentage of peppermint were measured. At full flowering stage, essential oil content was evaluated in the aerial parts of the plants as well as percentage and yield of essential oils were determined. Characteristics of essential oils analyzed by gas chromatography The components of the oil were identified by comparison of their mass spectra with those of a computer library or with authentic compounds and confirmed by comparison of their retention indices either with those of authentic compounds or with data published in the literature.

Results and Discussion Results showed significant effects of AMF inoculation ($P \leq 0.05$) on study parameters. Inoculation with AMF increased plant height, stem diameter, the number of lateral branches, leaf number, leaf fresh and dry weight, essential oil content (25 %) and final yield (28%). Effects of three AMF inoculations on *Ocimum basilicum* development differed from the Glomus species (*Glomus intraradices*, *Glomus fasciculatum* and *Glomu smosseae*). Overall, *Glomus fasciculatum* showed high efficiency as compared toG. mosseae and G. intraradices. Maximum shoot fresh and dry weights were obtained in plants treated with Glomus fasciculatum inoculation, followed by *Glomus intraradices*, *Glomus mosseae* and control (no inoculation). Effect of AMF inoculation on root colonization percentage was significant ($P \leq 0/05$). The highest and the lowest values of root colonization percentage (47 and 0 %) were –observed in plants inoculated with Gf and control, respectively. Essential oil content in inoculated plants was significantly higher than other treatments. The plants inoculated with AMF showed an improvement of oil composition. Menth one and isomenth one were higher in inoculated plants compared with control ones. These results demonstrated that AMF concomitantly increases essential oil production and biomass in peppermint which is rich in commercially valued essential oils. Fungal symbiotic associations have the potential to enhance root absorption area, and stimulate the acquisition of plant nutrients including metal ions. Mycorrhizal roots have been known to absorb phosphorus (P) faster than non-mycorrhizal plants. An increase in nutrient uptake especially P could have

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resulted from ameliorating of nutrients stress and an increase in photosynthetic rates, which could ultimately increase the host plant growth.

Conclusion: It is concluded that AMF inoculation in particular Glomusfasciculatum- with high efficiency of root colonization increasedthe photosynthetic pigments, nutrient uptake and plant relative water content which led to improved -bothyield of essential oils and nutrient contents.

Keywords: Essential oil, Glomus, Plant growth promoting microorganisms, Root colonization

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Study of Growth, Essential Oil Percentage and Essential Oil Component of Achilleaspp Under Shoushtar Climatic Condition in Fall Planting

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Introduction: Spices and herbs are part of daily food intake in many regions of the world. They have been used as natural sources of flavorings and preservatives. Yarrow (*Achillea* spp.) belongs to Asteraceae family and more than 100 species have been recognized in this genus. This plantis reportedto be a diaphoretic, astringent, tonic, stimulant and mild aromatic plant. It contains isovaleric acid, salicylic acid, asparagin, sterols, flavonoids, bitters, tannins, and coumarins. The plant also has a long history as a powerful 'healing herb' used topically for wounds, cuts and abrasions. The genus name *Achillea* is derived from the mythical Greek character, Achilles. Action is also reflected in some of the common names mentioned below, such as staunchweed and soldier's woundwort. The genus *Achillea* is a well-known medicinal plant, widely used in folk medicine against gastrointestinal disorders such as lack of appetite. This plant is native to Europe and Western Asia but isalso found in Australia, New Zealand and North America. Nineteen species of *Achillea* have been recognized in Iran distributed in different geographical and ecological regions. *Achillea* spp. are diaphoretic, astringent, tonic, stimulant and mild aromatic. Major components in *Achillea* spp. essential oil are sabinene, 1,8-cineole, camphor, α-pinene, β-pinene, borneol and bornyl acetate. The aim of this work is to investigate growth, essential oil yield and chemical composition of essential oils of *A. eriophora, A. millefolium, A. biebersteinii* and *A. tenuifolia*.

Material and Methods: This study investigated the growth and essential oil yield of four *Achillea* species in the North of Khuzestan situation,Shoushtar, in2008-2010. An experiment was conducted in combined analysis based on complete block design with 4 replicates. *Achillea* species examined concluded *Achillea eriophora, A. millefolium, A. biebersteinii* and *A. nobilis*. Seedling establishment, essential oil percentage andyield, flowering period and shoot dry weight was measured during the experiment. The clevenger apparatus was used to extract oils by hydro-distillation of leaf and head branches for 3 hours according to the method described in the British Pharmacopeia. For identification of components, Agilent gas chromatography model 6890 N, was equipped with MSD model 5973 N and fused with the silica capillary column (HP-5MS, 30m- 0.25mm) were used for qualitative and quantitative analysis.Analysis of variance was employed for statistical analysis of the data using a MSTATC software. The mean values were compared with the Duncan test.

Results and Discussion: The results showed that year, species and their interaction (year×species) had significant ($p<0.01$) effects on flowering date, flowering period, plant height, biomass, inflorescence dry weight, essential oil percentage and yield. The longest flowering period obtained from *A. millefolium* in 2008-2009 and 2009-2010 (74 days and 90 days respectively). In both years highest inflorescence number showed in *A. millefolium* and lowest *A. millefolium*was obtained from*A. eriophora*. Highest dry matter was obtained from *A. millefolium*, 1014 g m^{-2} at first year and 1211 g $m^{-2}$for the secondyear.*A. millefolium* had the maximum plant height in 2 years (84 and 85 cm respectively) but *A. eriophora* showed minimum plant height in both years compared toothers. The highest essential oil percentage was observed in *A. eriophora*, 0.75 % at first year and 0.71 % forsecond year. The highest essential oil value (108 g m^{-2}) was obtained from *A.eriophora*, at first year and 109 g m^{-2} at second year. In both years, the major constituents in *A. eriophora and A. nobilis* werecamphor, sabinene, camphen, β-pinene and α –Pinene. Maximum concentrations in *A. millefolium* were camphor, sabinene, β-pinene, 3-octanone and Borneol. Camphor, sabinene, β-pinene, 3-octanone and terpinyl acetate were major compoundsin *A. nobilis* in both years. In both years more than 85% of yarrow chemical compound was recognized.

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Conclusion: Results indicated *A. eriophora* and *A. millefolium* were perfect species for fall cultivation in Shoushtar climatic condition compared to other species. *A. eriophora* and *A. millefolium* had the highest essential oil yield compared to *A. biebersteinii* and *A. nobilis* because these species had thehighestplant dry weight and essential oil percentage than other *Achillea* species.

Keywords: α –Pinene, β-pinene, *A. eriophora* (Shiraz yarrow), Crop dry weight, Camphor

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Impact of Climate Change on Winter Chilling Trend for Deciduous Fruit Trees (Case Study: Hamadan)

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Introduction: Higher temperature as the result of climate change are likely to affect horticultural production. Deciduous fruit trees need winter chilling to break winter dormancy. Climate plays an important role in the successful production of deciduous fruit. Winter dormancy is one of the key factors of the annual cycle of deciduous fruit and nut trees along with the following breaking of the dormant state. This state is maintained through the winter period each year to protect against damaging cold temperatures. To be released from dormancy, trees require exposure to a predetermined quantity of cold temperatures in a process known as winter chilling or vernalization. Insufficient chilling can lead to sporadic and light bud break, poor fruit development, small fruit size and uneven ripening times. The main objective of this study is to investigate climate change effect on the winter chilling requirement (WCR) in Hamadan.

Materials and Methods: This research was performed based on the General Circulation Models (BCM2, HADCM3,GFCM2 and IPCM4) and different emission scenarios (A2, B1, A1B), as recommended by the Forth Report of the IPCC. The output of the GCMs was downscaled by LARS-WG model. The hourly weather data were generated as the inputs of three different Chilling Requirement Models (CRMs), and the winter chilling trend of deciduous fruit trees were predicted for Hamadan. The projected daily temperature time series were then converted into hourly temperatures. The projected hourly temperature data were run through each of the three chill models for all four GCMs in different scenarios.

Three chill models [the 0.0–7.2°C (CH), the Utah (UT), and the Utah Positive (UTPos) models] were used to investigate changes in chill accumulation in Hamadan, according to localized temperature change related to increases in global average temperatures. In addition, the winter chilling requirement time series were divided into two periods: baseline and future time. Historical daily minimum and maximum data from 1980 to 2010 were used from the Hamadan airport synoptic station. Future time horizon splittedinto early (2011-2030) and late (2031-2050) periods. For evaluating the long-term future changes in the chilling requirement, we used parametric and non-parametric tests.

Results and Discussion: The model results showed a decreasing WCR trend during the recent decade. In general, the outputs of downscaled climate models predicted a decreasing WCR trend for the study site. For the time horizon of 2031-2050, this dramatic reduction in the WCR varied rom 25 percent to 40 percent. Future chill profiles differentiated between the WCR models as demonstrated through Hamadan global average temperature, causing a small decline in accumulated chill unit, with further warming causing greater decreases. This decrease in the UT models can be due to the negative effect of high temperature during this period. The study result which showed the WCR mean during early time horizon 2011-2030, was not significant but further time horizon 2031-2050 had a very significant change, as compared to the baseline. The aim of this study was to assess changes in the WCR rather than completing a model skill analysis. Through using previous climate model performance studies a justification of the addition of GCMs was described. Such defenses for model selection are recommended in all climate change impact studies. Test of model output in other scenarios and different GCMs showed an insignificant versatility between them.

Conclusions: This research represents a significant update to the previous climate impact analysis of chill in cold semi-arid climate of Hamadan. It also highlights that sensitivity studies as a useful method for impact assessments. The severity and rate of decline of winter chilling requirement, depends on which chill model was used. The general trend showed decreasing of the winter chilling requirement against the winter temperature trend. Therefore, in the context of global warming, the earlier flowering dates of many deciduous tree species is likely leads to increased risk of damage during the late spring frost. For future fruit farm management, decisions can be implemented with deliberation of the likely changes in the winter chilling requirement reported here. There might be some adaptation, at least to some degree, being essential for most production areas in Hamadan

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and other similar climate conditions within the next 40 years. Reduction in winter chilling, prevents breaking winter dormancy, which finally may lead to serious damage to deciduous fruits.

Keywords: Air Temperature, Dormancy, GCMs, Emission Scenarios, Global Warming, LARS-WG

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Effects of the Base Substrate and Dietary supplementson Growth Indices Florida Oyster Mushroom (*Pleurotus florida)*

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Introduction: Oystermush rooms contain a wide enzymatic system to catalyze lignocellu lose and naturally live in organs of plants that are protein-rich. Agricultural and industrial wastes contain organic cellulosic materials such as cereal straw, sawdust and leaves that are suitable substrate for growth of oyster mushrooms. Previous studies have shown that dietary supplements increase growth indices of oyster mushrooms.

Materials and Methods: Spawn of Florida oyster mushrooms wereprovided experimentally on grains of wheat. The experiment was conducted in the laboratory of the Agricultural College of Mehr Shar, Islamic Azad University of Karaj, Iran in 2011. Two factors were considered in this study substrate (A) and dietary supplements(B). Sugarcane bag asse (A1) and wheat straw (A2) were shed into polyethylene bags after they were pasteurized by boiling vapor and spawning was conducted according to wet weight of straw bags which was 4 kg. Supplements of Nitrogen werecottonseed powder, 2%soya flour, and urea0.5% that were added to substrate according to dry weight of substrate (1334 gr). Mushrooms were transferred to the laboratory after cropping in order to measure dry and wet weight. They were packed and dried in the oven during 24-72 hours at 60-70ºC. In order to estimate the biological efficiency, the produced crop was divided by weight consumed substrate that was multiplied by 100. A completely randomized factorial statistical experiment according to completely randomized design with 16 treatments and three replications was conducted. MSTAT soft ware was used for statistical analysis and the Dunkan test was used for comparing mean data with probability of 5%.Finally figures were drown using Excel.

Results and Discussion: In wheat straw substrate mushrooms were produced with high biological efficiency and yield, because compared to sugarcane bagasse, wheat straw needs a shorter period for fermentation, contains more nutrients, catalyzed faster than sugarcane bagasse soit provided mycelium with the nutrient amount of biological efficiency that increased byadding dietary supplements there for ethe yield was higher than control. Temperature of substrate increased by combining urea, cotton seed powder and soya flour nitrogen supplements, and that large amount of nitrogen were released into the environment and high temperature substrate.

So expansion of mycelium decreased and mushrooms with low biological efficiency and low yield were produced. The highest biological efficiency (23.03 %) and the highest yield (4/921 gr) were obtained through wheat straw that fed by cotton seed powder + soya flour (A2B6).The lowest biological efficiency (10.48 %) and the lowest yield (419 gr) were from control treatment (A1). Frequency of nitrogen in cotton seed powder is one of the most important reasons of increasing biological efficiency and yield. Another efficiency biologic factor was used in cultivation of fungi was C/N ratio, since nitrogen is a necessary factor for the activity of ligninoletic enzyme that is produced by basidiomycets. Cultivated fungi on wheat straw were wetter than mushrooms cultivated on sugarcane bagasse, because wheat straw has 10-15%water and sugarcane bagasse has 9% moisture. Wheat straw with cotton seed + powder soya flour (A2B6) and control treatment (A1) had the highest moisture (92.26%). Byaddition of dietary supplements in the surface of enriched substrate, fruit body density had increased in control, so mushrooms were less exposed to the air flow, but the combination of nitrogen supplements, the arrival of more nitrogen andsubstrate heat increased and that the mushrooms had less humid. In wheat straw substrate more number of body fruits was obtained in comparison with sugarcane bagasse substrate..418 numbers of body fruits obtained from wheat straw by cotton seed powder + soya flour (A2B6) and 163 mushrooms were obtained from control treatment (A1). Absorbable chemical compounds in the medium were used faster and the number of mushrooms in wheat straw substrate with cotton seed powder and soya flour (A2B6) increased while combination of supplements and heat due to entrance of nitrogen caused death of mycelium and decreasing number of mushrooms. The results analysis of variance, substrate effect and mean compare supplement effect was significant at 1% on biological efficiency. Yield, moisture, number of body fruit, mean interaction effect of substrate and supplement was significant at 0.05on biological efficiency, yield and moisture but mean interaction effect of substrate and supplement on the number of body fruit was significant at

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1%.

Conclusion: Medium has a deep impact on growth indices of Florida oyster mushrooms in such a way that obtained mushrooms from rich mediums had higher growth indices than control. The impact of dietary supplements on growth indices is different and by adding an appropriate amount of dietary supplements to medium increases growth indices.

Keywords: Biological efficiency, Number of body fruits, Sugarcane bagasse, Wheat straw, Yield

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Effect of Superabsorbent Application under Different Irrigation Regimes on Photosynthetic Pigments in *Cuminum cyminum* and its Relation with Seed and Essential Oil Yield

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Introduction: Cumin, sometimes spelled cummin (*Cuminum cyminum* L.; Apiaceae), also known as Zeera is native from the East Mediterranean to India. Its seeds are used in the cuisines of many different cultures, and it is also used as a medicinal plant, serving as a digestant, as well as being used to treat anemia and the common cold. Cumin is a drought tolerant plant, has a short growth season of 100 – 120 days, with optimum growth temperature ranges between 25°C and 30 °C. Drought is one of the most important environmental factors that influences seed yield of crop plants in arid and semi-arid regions,through physiological response of plant. To reduce drought stress damages, some synthetic materials like hydroplus superabsorbent polymers, highly hydrophilic due to low cross-links in their structure, can be used to save soil moisture. Thus, superabsorbent polymer may have great potential in restoration and reclamation of soil and storing water available for plant growth and production.

Materials and Methods: To evaluate accumulation of photosynthetic pigments and seed yield of cumin, a factorial experiment was conducted based on randomized complete blocks design with three replications at the Research Farm of Urmia University (latitude 37.53° N, 45.08° E, and 1320 m above sea level).- The soil texture of experimental site was clay loam (28% silt, 32% clay, 40% sand) with 22.5% field capacity, 1.54 g/cm^3 soil density, and pH 7.6. Treatments were four irrigation regimes (irrigation after 50, 100, 150 and 200 mm of evaporation from class A pan) and different amounts of superabsorbent polymer (0, 60, 120, 180, 240 and 300 kg/ha). To measure the chlorophyll content (Chlorophyll *a*, *b*, and total chlorophyll), 0.25 g of grounded leaves were adjusted to 25 ml by distilled water, and 0.5 ml of this solute was mixed with 4.5 ml acetone 80%. The upper zone of centrifuged solution was taken for spectrophotometery at 645nm and 663 nm wavelengths. To measure the yield of cumin seeds, 2 m^2 of each plot was harvested and immediately were dried in the shade and at a temperature of 25 ° C. Essential oil, 25 g of powdered seeds in a one-liter flask, was extracted (W/W) by the Clevenger method (Hydro distillation) for 3 hours.

Results and Discussion: Analysis of variance showed the significant interaction between the superabsorbent polymer and irrigation on the amount of leaf chlorophyll *a*, chlorophyll *b*, total chlorophyll, seed yield, percentage and yield of essential oil. This implies a different physiological response of cumin plant in terms of adding different amounts of superabsorbent and irrigation. Means comparison indicated that the highest concentration of chlorophyll *a* (0.266 mg/l) and total chlorophyll (0.518 mg/l) were obtained from plants irrigated after 50 mm of evaporation without polymer application. The maximum (0.259 mg/l) and minimum (0.028 mg/l) leaf chlorophyll *b* belonged to irrigation after 200 mm of evaporation using 60 and 240 kg/ha polymer, respectively. The highest yield of seed (1226 kg/ha) and essential oil (36.5 kg/ha) were obtained from well-watered plants (irrigation after 50 mm of evaporation) and 60 kg/ha of polymer. Increasing irrigation intervals from 50 to 200 (50, 100, 150 and 200) mm of evaporation, need 120, 180 and 120 kg/ha polymer correspondingly for production of optimal yield of cumin. Essential oil of cumin plants was gradually and significantly enhanced by increasing irrigation distance, up to 150 mm of evaporation from pan, (with this particle)follow down by severe stress. Like seed yield the lowest yield of essential oil (0.9 kg/ha) belonged to plants irrigated after 50 mm of evaporation using 120 kg/ha superabsorbent (less than irrigation after 200 mm of evaporation). In general, in the case of well-watered plants, irrigation after 50 mm of evaporation with a small amount of superabsorbent (60 kg/ha) produced maximum seed yield and oil. However, if there is no access to water and increasing irrigation intervals twice (irrigation after 100 mm of evaporation from pan) for maximum performance requires the use of 120 kg/ha polymersince the essential oil of irrigation after 200 mm of evaporation is very low. But, if we use higher amounts of superabsorbent (300 kg/ha) more than double the yield of essential oil was obtained from this irrigation level.

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Conclusion: A significant interaction between irrigation and superabsorbent, recommended a certain amount of polymer used as the optimum level for each irrigation regime so that the proper yield of essential oil was affected by optimal superabsorbent quantities of chlorophyll, seed yield and essential oil content. In conclusion, the suitable amounts of superabsorbent polymer were different for each irrigation regime,thereforeit is recommendedless than 120 kg/ha for control (non-stress condition) and moderate drought stress- and - 300 kg/ha for severe stress to produce essential oil of cumin plants, respectively.

Keywords: Chlorophyll, Clevenger, Cumin, Evaporation Pan Class A, Polymer

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Evaluation of Some Morphological Characteristics, Water Use Efficiency and Essential Oil of Basil (*Ocimum basilicum* var. keshkeni luvelou) under Application of Malva Leaves and Superabsorbent Polymer

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Introduction: Medicinal plants are rich in active substances and primarily have been used in the manufacture of many drugs. Basil (*Ocimum basilicum* L.) is one of the important medicinal plants whichbelongs to the Lamiaceae family. Basil essential oil content (between 0.5 to 1.5 percent) varies according to climatic conditions of habitat location. Basilneeds a lot of water during growth period and it is very sensitive to water stress and shows wilting symptoms very soon after water shortage. Iran is located in an arid and semi-arid region which has little precipitation that is not enough for crop water requirements. Nowadays, the use of superabsorbent polymers is one of the ways to create sustainable agriculture and increase irrigation efficiency. They can store high water or aqueous solutions in root zone of plants and to reduce negative effects of drought stress. So, improvement of plant growth, increasing of irrigation intervals, reducing water loss and costs of irrigation is due to the application of superabsorbent polymers. Mucilages are also the herbal polysaccharides, soluble in water, and commonly include carbohydrates and can be used as hydrophilic polymers. The aims of this investigation were to study the effects of hydrophilic polymers on water use efficiency, morphological characteristics (dry matter, leaf area, and leaf number), essential oil quantity and yield of basil to harden plant to drought stress and to evaluate its potential to cultivate in arid regions. In addition, taking steps forward towards sustainable agriculture, by reducing the cost of agricultural production, helps protecting the environment.

Materials and Methods: This research was conducted as a pot experiment at the department of Horticultural Science, college of Agricultural, Ferdowsi University of Mashhad, Iran, during 2012-2013.The research was set out in a factorial experiment on the basis of completely randomized block design with three replications.Two hydrophilic polymer Stockosorb® (industrial) and malva leaf (herbal) with two application methods (mixed with soil, mixed with soil+root) at 4concentrations (0, 0.1%, 0.2% and 0.3% w/w) were used. Leaf number, leaf area, dry matter yield, water use efficiency, essential oil quantity and yield were measured. Improved seeds of *Ocimum basilicum* var. Keshkeniluvelou were sown and seedlings were transplanted to the pots in four-leaf stage. Hydrogels were prepared and mixed with water after weighing the polymers according to determined concentration. After establishment, all pots were irrigated with a determined amount of water after reaching to the highest concentration (0.3%) of the wilting point. So, in this state in addition to the treatment at 0.3% treatment, lower levels (0.2% and 0.1%)were reached to wilting point earlierand were exposed to water stress.

Results and Discussion: Superabsorbent polymers can by absorption of irrigation and rain water, prevent deep percolation of water and with decreasing irrigation interval and reduced water consumption and increase water use efficiency. The results showed that using Stockosorb superabsorbent polymer and malva leaf as herbal hydrophilic polymersare useful for water supply of the plant in water stress.Application of these substances on morphological characteristics, water use efficiency and basil oil, were superior to the control.According to the obtained results, malva leaf use in soil and roots in treatmentless than (0.1% and 0.2%)number and leaf area and higher than (0.3%)increased dry matter yield, water use efficiency and the essential oil quantity and yield. Stockosorb (0.2%) byboth applying methods increased dry matter yield and water use efficiency. Also Stockosorb (0.2%),soil application increased leaf number and area. The essential oil yield and quantity increasedwith use of Stockosorb in soil + root in for0.2% and 0.3% treatments, respectively.

Conclusion: Due to the importance of cultivation of medicinal plants to provide conditions to increase essential oil yield and quantity at the same time, the best method used were malva leaf and Stockosorb with concentrations higher than (0.3%) and soil application methodor the use of both polymers with application method in soil + root in the moderate concentration (0.2%).For that purpose, we obtained favorable conditions for improving the morphological characteristics, water use efficiency and increasing the quantity and of essential

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oil yield in drought stress simultaneously. The results showed that natural compounds can be a good alternative for chemical compounds, but further experiments are needed for their commercialization.

Keywords: Hydrophilic polymer, Medicinal plant, Mucilage, Stockosorb®, Water use efficiency

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Amount of Macronutrients and Micronutrients in Petiole of Some Iranian and Imported Grape Cultivars

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Introduction: Grapevine (*Vitis vinifera* L.) is one of the oldest and most important perennial crops in the world. Several native grapevine genotypes, highly appreciated for their organoleptic characteristics and commercial potential are still cultivated in Iran. Developing viticulture requires the conservation of autochthonous varieties that have evolved several mechanisms enabling them to cope with the local bioclimatic and edaphic conditions. Nutrition is a key component of vineyard management that has the potential to influence various factors in vine production that includes fruit set and quality. To develop suitable nutrient plant growers need to have an understanding of the factors such as cultivars, rootstocks, soil type, irrigation type and nutrients that they are applying in the vineyard. The uptake of nutrients from the soil depends on different factors namely; their soluble content in it, soil pH, plant growth stage, plant genetics and types of soil and fertilizers. Plant species have a variety of capacities in removing and accumulating elements. Vigorous genotypes are more capable of finding the necessary nutrients from the surrounding soil environment. This indicates that it does not require as much nutrient as poor vigor genotypes. So, for sustainable viticulture, it is important to know the interactive influences of cultivars, soil characters, climatic conditions, and irrigation type on vine productivity.

Materials and Methods: To evaluate and compare the amount of macronutrient elements (N, P, K, Mg and Ca) and micronutrient elements (B, Zn and Mn) in petiole of some Iranian grapevine cultivars including Bidanesefid Qazvin- Peikany Kashmar- Khalili Shiraz-Rasha and four foreign cultivars Thompson seedless, Flame seedless, Perlette and Black seedless,This study was carried out as –randomized complete blocks design -with-four replications in the Kahriz Horticulture Research station -.A total of 30 adult leaves per cultivar were taken from lower, middle and upper regions of the vines bulked together and transported directly to the laboratory. They were oven-dried for 48 h at 70 °C and grounded to pass through a 1 mm diameter sieve. The concentrations of the -mineral elements were determined using an atomic absorption and spectrophotometer.

Results and Discussion: The results showed there was significant difference among study cultivars in respect of elements concentration in petiole-. Among 8 cultivars, the highest and the lowest petiole N concentration were recorded in Flame seedless-and Peikany and Rasha cultivars respectively. P -concentration in Bidane sefid Qazvin was significantly higher than all tested cultivars. The highest and the lowest Mg amounts were measured in Peikany and Bidanesefid Qazvin, respectively. In petiole of cultivars B concentration was in the range of toxicity except Rasha that had the concentration less than -other cultivars. Iranian cultivars had lesscap ability to absorb Zn than abroad cultivars. The highest and lowest Zn were recorded in petioles of Thompson seedless and Peikany cultivars, respectively. It was reported that the mineral content of a grapevine is a combined result of the root systems ability to absorb, trans locate and accumulate the different nutrients. Previous investigations had clearly stated the differences in nutrients uptake and content of many grape cultivars. Furthermore, grape cultivars have shown differences in their nutrients uptake and distribution. These differences may be explained in different ways. First, cultivar may have different absorption capability or tendency for some specific minerals. Second, differences exist in translocation and distribution of nutrients and third, hormone synthesis of cultivar roots and their translocation is done. Finally, some nutrients might be assimilated mostly by roots; thus reducing the amount translocated to the shoots. In addition, some grape varieties may alter soil chemical characters and play a role in improving nutrients uptake. The rootstocks of *V. labrusca*and scions grafted on them achieve a higher ability in uptaking iron, even in markedly alkaline soils. Such tolerant varieties can mobilize iron by reducing soil pH at root level, thanks to their ability to emit H^+ and/or organic acids.In the

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latter case, iron is absorbed and transferred as a complex. Roots of some cultivars can also reduce Fe^{3+} to Fe^{2+} encouraging its migration from roots to leaves.

Conclusion: The studied grapevine cultivars displayed a considerable level of variability based on mineral content analysis. The results suggested that significant differences existed in the leaf petioles elemental concentrations among the grapevine cultivars analysis that might be in due part to the ability of the cultivar to accumulate metals. This study could be also used as a reference for grape growers to help them decide the best varieties that might grow under their soil conditions giving the best growth and yield productivity.

Keywords: Iron, Boron, Potassium, Leaf, toxicity

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The Effect of Isabgol (*Plantago psyllium*) Mucilage and Shiraz Thyme Essential Oils on Microbial Load and Improving Shelf Life of Fresh-Cut Carrot

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Introduction: Fresh-cut produce graduated to retail during the1990s, especially for lettuce, cabbage, carrots and other similar vegetables. The high microbial loads of these products after harvest can be substantially reduced through a cleaning in flowing chlorinated water and adistribution under ensured controlledrefrigeration. Therefore, a good number of convenient ready-to-use greens were launched to the market in the past decade. Nowadays, theuse of this technology to achieve similar results in fruit products is one of the most challengingtargets for processors. However, there is anumber of issues that still need to beovercomebeforefresh-cut fruit commodities can be sparked off to anoutstanding position in the segment of lightly-treatedrefrigerated foods. The importance of freshly cut products increases day by day. Tissue and cell rupture leads to a decrease in the shelf life of these products. On the other hand, these products due to increased enzyme activity, respiration rate and microbiological considerations that affect the health of these productsrequires highly attention.To increase the shelf life of the products and prevent undesirable changes in cut slices of fruit or vegetables a coating on the surface of these products has been suggested. Mucilages and essential oils of herbs are natural compounds that can be used to create such covers. The advantages of these coatings are their bactericidal effect, maintenanceof pleasant taste and other physical and chemical characteristics of the product and even decrease of environmental pollution. In this research, the effect of natural compounds such as *Zataria multiflora* essential oil (EO) and *Plantagopsyllium* mucilage on storage life and microbial load of fresh cut carrot was studied.

Materials and Methods: The research was conducted in two separate experiments on fresh-cut carrot: In the first experiment, the effect of different concentrations of *Plantago psyllium* mucilage (0,100, 200, and 400mgL^{-1}) and four concentrations of *Zataria multiflora* essential oil (0,100, 250,and 500 mgL^{-1}), in a factorial experiment on the basis of completely randomized designwith16treatments and three replications was evaluated. In the second experiment application of essential oil and mucilage on microbial load of fresh-cut carrot was examined in a split plot experiment on the basis of randomized complete blocks design with six treatments and three replications which *Zataria multiflora* EO (500 mgL^{-1}) and *Plantago psyllium* mucilage (400 mgL^{-1}) was set as main plot and storage time was set as subplot. The serial dilution technique and cultivation in special culture media were used to determine the microbial load. Treated samples were then packaged in polyethylene trays (175mL) and were stored at 4°C. After10 days of treatment different parameters such as weight loss, total soluble solids (TSS), titratable acidity (TA), pH, color, organoleptic properties, the amount of skin whitening and microbial load were evaluated.Means were compared using LSD test at the significant 5% probability level.

Results and Discussion: The results showed that the treatments had a significant effect on weight loss. Essential oil and mucilage treated samples with different concentrations and also a combination of the two had less weight loss than the control. Different concentrations of essential oil and mucilage individually significantly affected titra table acidity, soluble solids and pH. Samples treated with 100 and 250 mgL^{-1}essential oil, and with 100 and 200 mgL^{-1} mucilage had the highest acidity, and showed significant increase compared to the control. A little color changes occurred in the treated samples and their colors were very close to the control. Combination treatment with 100 mg.L^{-1}essentialoil plus 100 mgL^{-1}mucilagesignificantlyreduced skin whitening of fresh cut carrot. Analysis of variance indicates significant effect of treatments on all microbial contaminations which were evaluated. The means of aerobic mesophilic bacterial contamination and the coliform bacterial contamination were 6.67 log CFU/g and6.37 log CFU/g, respectively. Only mold and yeast contamination significantly increased during storage and was more pronounced in samples treated with psylliummucilage. After 10 days of storage, although some bacterial contamination increased, this increase was not significant. Fungal contamination starts at 5.35 log CFU/g and endsat 6.64 log CFU/g, which is approximately 1.3 log CFU/g

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increased. *E. coli* contamination was not observed in samples.According to the standards threshold, in this experiment, aerobic mesophilic bacteria contamination of the samples (except for samples coated with mucilage after 10 days of storage which their contamination exceeded) was in the standard threshold.However, coliform bacteria, mold and yeast contamination in all samples exceeded.

Conclusion: In general, results of this study showed that application of natural compounds of medicinal plants as edible coatings improved the quality and -extend the shelf life of fresh cut carrot. .However, disinfection of the product in this experiment was not sufficient to reduce the microbial contamination properly and treatments used could not reduce it at the standard limits, appropriate disinfection methods such as radiation and higher concentrations are also investigated in order to export this recommended product.

Keywords: Color, Edible coatings, Microbial load, Quality

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Effect of Salinity Stress on Physiological and Biochemical Traits in Citrus Genotypes

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Introduction: *Citrus* (L.) is a large genus that covers several major cultivatedspecies, including *Citrussinensis* (sweet orange), *C.reticulata* (tangerine and mandarin), *C. limon* (lemon), *C.grandis* (pummelo), and *C. paradisi* (grapefruit).Citrus is one of the world's important fruit crops and grown inmost areas with suitable climates between latitude 35◦N–35◦S. InIran, citrus industry is of paramount importance. Citrus species have been classified as salt-sensitive crops, although their relative tolerance can be influenced by climate, fertilization, soil type, irrigation method and rootstock. Citrus rootstocks differ in their ability to exclude $Cl^-$and/or $Na^+$from the scion. Many authors have contrasted the relative abilities of rootstocks to restrict movement of salts to the scions. The rootstocks Cleopatra mandarin (*C. reshni*), Rangpur lime (*C. limonia*) and Severiniabuxifolia (Poir) Tenore were relatively effective in restricting Cl^-transport to scions, whereas the rootstocks Swingle citrumelo and Carrizo citrange were found to be less restrictive. Although the mechanism by which some rootstocks reduce concentrations of ions in the scion is still unknown, it seems to depend on the vigor of the scion and on water requirements. There are a number of reports demonstrating that both scion and rootstock may influence Cl^-accumulation in leaves. Several papers reported that accumulation of Na^+ in shoots seemed to be more dependent on rootstock–scion combinations. Since, citrus species are different in salt tolerance and use of tolerant rootstocks can decrease salinity damages, sothis study was conducted to identify tolerant genotypes among unknown types from the Kotra Citrus Research Station, Citrus and Sub-Tropical Fruits Research Center (Ramsar).

Materials and Methods: The experiment was –arrangedin afactorial, based on completely randomized design in three replications with two plantsin each experimental unit in Iran Citrus Research Institute.Treatment included 10 citrus natural genotypes along with two varieties of Cleopatra mandarin (tolerant plant) and Swinglecitrumelo (sensitive plant) with six-month old and four salinity levels of sodium chloride: 0(control), 2, 4 and 6 dsm^{-1}, for 16 weeks in the greenhouse condition. Effect of salinity on fresh and dry weight of shoot and root, relative water content (using upper leaves), stomatal density (with counting of stomata using microscope), concentration ofCl (with titration method of silver nitrate) and Na (by flame photometry) in roots and leaves, content of total chlorophyll (using acetone 80%), proline (spectrophotometry at wavelength of 520 nm), lipid peroxidation (spectrophotometry at wavelength of 532 nm) and activity of peroxidase enzyme (spectrophotometry at wavelength of 470 nm)were investigated. Data analysis was done by SAS 9.1 software.

Results and Discussion: The results indicated that, the interaction of genotypes and salinity levels hadnot significant difference in relative water content, stomatal density and Na^+concentration - in roots but, other traits except total chlorophyll content which was significant at 5% level, were significant at 1% level. Shoot fresh and dry weight of genotypes No. 4 and 6 were significantly ($P<0.01$) reduced. Root fresh and dry weight in genotypes G 4, G7 and G 6, compared to control, significantly decreased ($P<0.01$). With increasing the salinity, leaf Na^+ content was the lowest in genotype G9 at 0.28% and was the highest in genotype G6 at 0.53%. The highest and the lowest leaf Cl contentwereobtained in genotypes G6 and G11 at 3.1% and 1.7%, respectively. Prolin content significantly ($P< 0.01$) increased in genotype G10 and Cleopatra mandarin than others. Total chlorophyll content significantly ($P< 0.05$) decreased in genotypes G6,G3 and G4. Swinglecitrumelo and genotype G5 had significant increase in POD activity. Genotype G9 had the lowest lipid peroxidation (14 mM) in comparison with the other genotypes.

Conclusion: In general, genotypes G4, G6 and G7 were more sensitive to salinity stress and had more Cl in their leaves which decreased plant growth. Genotypes G9, G10, G11 and G12 showed less damage in their leaves. In genotypes G9, G10, G11 and G12, lipid peroxidation and leaf Cl were lower than others. Based on the results, genotype G9 was better than others in terms of salinity tolerance. After Cleopatra mandarin and

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genotype G3, this genotype had the lowest Cl and Na concentration in leaves, respectively. So, genotype G9 can repel Cl from the leaves which is very important for salinity tolerance and also G9 could be considered as a tolerant genotype in citrus breeding program .

Keywords: Biotype, Proline, Tolerance, Sodium Chloride, Cleopatra mandarin

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Effect of Biofertilizers and Irrigation Intervals on Yield Component and Yield of Fenugreek (*Trigonella foenum- graecum* L.)

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Introduction Drought is one of the most important factors whichdecrease crop production in arid and semi-arid regions of the world (1, 20). Appropriate nutritional management has an effective role in the resistance to environmental stresses on crops (7). An important issue about sustainability of food production is the maintenance of soil fertility through the use of organic matter and biofertilizers. One option to increase agricultural production is the use of beneficial soil microorganisms such as PGPR and fungi (45). This group of bacteria through biological fixation of nitrogen, increase phosphorus and potassium solubility, an increasethe availability of mineral elements in the soil, inhibits pathogen appearance and producehormones that regulate the growth of plants to affect crop yield (18, 47). Mycorrhiza enablesymbiosis with the roots of most crop plants, through the availability of phosphorus, nitrogen and other nutrients and thus increases water absorption and produces plant hormones, increases resistance to pathogens and environmental stresses, strengthens the soil microbial community and induces improving the growth and performance of plants in agricultural systems (5, 32, 37, 40).Fenugreek (*Trigonella foenum- graecum* L.)is an annual herbaceous plant that reaches a height of 50 cm (14). Since limited water is at very critical level now, the importance of further research in this area is felt. So, the study of medicinal plants considring water management and organic food is very important. Therefore, the aim of this research is to evaluate the effect of organic and biofertilizers and irrigation on yield and yield components of fenugreek in Birjand.

Materials and Methods In order to study the effects of irrigation intervals and biofertilizers on quantitative traits and yield of fenugreek, an experiment was carried out in a split plot based on a complete randomized block design with 3replications at the research station, Faculty of Agriculture, Azad University, Birjand, Iran, during 2010-2011. Experimental treatments were irrigation intervals in three levels (every 6, 9 and 12 days) and biofertilizer in five levels (nitroxin, biophosphorus, and micorhyza fungi *G. mosseae*, *G. intraradices* and control-no fertilizer). Fenugreek was planted through furrow in mid-April 2010. The distance between rows and between plants was 30 and 10 cm, respectively. Seeds were covered by Nitroxin (including: *Azotobacterchroococcum, Azospirillum lipoferum* and *Azospirillum brasilense*) and biophosphrous (including: *Pseudomonas fluorescens*) and then were cultured.They were used at a depth of 2cm below the seed from *Glomusintraradice*and *Glomus mosseae*. Fenugreek was harvested in early July when the plants became yellow and at least 80% of the pods were reached. Statistical analysis of the data was performed using SAS 9.1 and MSTATC. Mean comparison were compared by the Duncan test at 1% and 5% level of probability.

Results and Discussion: Results of statistical analysis showed that irrigation treatments and biofertilizers had significant effect on most indices. Interaction effect of irrigation and biofertilizer were significant on seed and leaf yield ($p<0.05$ and $p<0.01$). The highest seed yield was observed in 6 days irrigation interval and using *G. mosseae* and biphosphorus (83.60 and 88.58 $g.m^{-2}$) with no difference in between,and the lowest seed yield was obtained in control treatment and irrigation interval of 12 days (9.41 $g.m^{-2}$). Increasing the absorption of minerals by biological factors in the soil improves crops biomass and yield (26, 34). The irrigation interval to achieve the highest seed and leaf yield in this experiment was 6 days. Increasing irrigation interval led to reduction of leaf and seed yield and all morphological traits. The highest forage yield was achieved from *G. mosseae* treatment (128.66 $g.m^{-2}$). Mycorrhiza fungi which symbiosis with the roots of most crop plants, through the availability of phosphorus, nitrogen and other nutrients, increasing of water absorption, increasing resistance to pathogens and environmental stresses induce improvement of growth and performance of plants in agricultural systems (40). Number of seed per plant was increased about 30.46 % in 12 days irrigation interval compared to 6 days. The maximum seeds number per plant (47.26) was obtained in biophosphorus treatment and

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there was no significant difference between other treatments. The researchers found that the use of biofertilizers in stress condition improves plant growth indices of Rosemary (23).

Conclusion In general, results showed that the application of biofertilizers including microorganisms of fungi or bacteria had positive effects on growth parameters of fenugreek. The best irrigation interval for fenugreek was irrigation every 6 days.Biomass and seed yield of this plant is reduced by increasing irrigation interval.

Keywords: Biophosphorus, Irrigation, Medicinal plant, Microorganism, Quantitative traits

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Evaluation of Yield and Yield Components of Leek (*Allium porrum* L.) in Intercropping with White Clover (*Trifolium repens* L.)

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Introduction: Leek, *Allium porrum* L. is one of the most important vegetables in Europe. Open canopy up to harvest in leek field raises problem in weed management and increase nutrient leaching during vegetation period. Intercropping in leek fields causes better weed control along with the other benefits of this type of method. Intercropping leek with White clover *Trifolium repens* L. as a cover crop is considered, because it is known to have high ability to fix nitrogen in the soil biologically and prevent nutrient leaching during the growing season. In this study, intercropping ofleek *A. porrum* L. and white clover *T. repens* L. is evaluated.

Materials and Methods This experiment was conducted in 2011 and located at the research farm Hessian State Estate Frankenhausen, Germany (51° 27′ 0″ N, 9° 25′ 0″ E),249 meter above sea level. The goal of this experiment was based on comparison between leek in intercrop system with white clover (The factors included different date of sowing composed early undersowing, sowed right after transplanting leeks and late undersowing, one month later) and leek in monoculture system. In addition, different cover crop management by cutting and without cutting the clovers has been considered. In monoculture system, applying hand weeding and no-weeding was evaluated. Therefore, this experiment consisted of 6 treatments (1 and 2: early undersowing of clovers with and without cut, 3 and 4: late undersowing of clovers with and without cut, 5 and 6: monoculture with and without hand weeding) with three replications and performed as a complete randomized block design. Analysis of variance, Duncan tests ($P \leq 0.05$) and orthogonal analysis wasapplied for comparison between the treatments.

Results and Discussion: The comparison between treatments with cover crop indicated a significant difference ($P \leq 0.01$) among treatments with early and late sowing time for clovers. Treatments with late sowed clovers (with and without cut) produced significantly higher dry matter in comparison with treatments with early sowed clovers (with or without cut). It seems late existence of clover at the early stages of development created more dry matterin leeks. Comparison indicated that treatments with clover but without cut, significantly created more dry matterin comparison with treatments, which clover cut. Existence of clover as mulch prevents weed growth and also biological Nitrogen fixation can be a reason for such observation. The results indicated that stem diameter for leeks in monoculture system and without hand weeding was significantly less than other treatments. Moreover, leek diameter in monoculture treatments with hand weeding was one of the greatest values. The largest amount of leek diameter was created in treatments with late sowing of clover, 48 days after transplanting leeks, whether clover has or not been cut. It seems despite all benefits of clover in Nitrogen fixation and prevention of weeds, that clover itself can be a considerable competitor with leeks as well.

Conclusions: The results of this experiment indicated that intercropping leek and clover can have a positive effect on dry matterproduction and quality of leek with proper timing of undersowing. We should consider that weeding was not possible for the whole growing season. Therefore, weeding at the beginning of the growing season and applying late cover crop could create more benefits of intercropping with a few competing effects on leek. In fact, weeding at the beginning of growing season establishes a good potential for nutrient absorption during the critical primary growing period of leek.

Keywords: Cover crop, Delayed cultivation, Plant management, Vegetables.

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Study of Androgenesis Ability and Callus Induction in Four Varieties of Tomato (*Lycopersicon esculentum* Mill) by Anther Culture

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Introduction Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetables which in addition of its importance as a food, is utilized as a model plant for cytological and cytogenetic studies. Tomato breeding programs are often based on the production and selection of hybrid plants. Producing hybrid plants and application of features that is needed to breed pure lines with high specific combining abilities, is highly required.New technologies such as doubled haploid can be an effective strategy to provide pure lines in tomato. Generation of homozygous doubled haploid lines through induction of androgenesis is a promising alternative method to the classical breeding programs. However, this technology is poorly developed in tomato so that some improvements in methodology are required. Genotype and stages of microspore development are critical factors for induction of androgenesis in tomato. Among them, the genotype is more important than other factors. The purpose of this study was to investigate the possibility of callus induction from anthers in some tomato genotypes.

Materials and Methods: In order to investigate the androgenic response and callus induction through anther culture in tomato, four varieties including Mobil-Netherlands, Baker, U. S. Agriseed and Khoram were chosen. To determine the appropriate stage of microspore development for anther culture, cytologycal studies were accomplished at different size length of flower buds (2-7.9 mm). Flower buds were incubated at 4^{o}C for 15 minutes and stained in acetocarmin %4 solution. Based on cytological studies in four tested cultivars, flower buds with size length 4-4.9 mm were chosen, as they had the highest frequency of meiotic microspores to microspores mid uninucleate. Pretreatments were colchicine solution (250 mgr/L) at 4 °C for 48 h. The anthers were cultured on MS medium containing 2 mgr/L IAA and 1 mgr/L 2ip. All changes in frequency of callus induction and diameter of callus were recorded for eightweeks. Diameter of callus was measured using a microscope equipped with a camera and Dino Capture 2.0 software version 4.1. Cytological studies were accomplished by microscopy research Olympus BX51 and photographed by a digital camera DP70. To determine the presence or absence of a significant difference between the observed proportions a chi-square test was used. All analysiswas conducted using statistical software JMP 8. Charts were providedusing Excel software.

Results and Discussion: Anther development stage is one of the factors determining the success of anther culture in the production of embryos. The results of most studies showed that the stage between meiosis and mid-stage of unicellular microspores is optimum to androgenesis response in tomatoes. Since microspores in the anthers are at various stages of development, to determine the appropriate size of flower buds, the relative frequency of each of the stages of development should be understood. Based on the obtained results, in all study cultivars, flower buds with a length of 4-4.9 mm (Containing anthers with an approximate length of 3-4 mm), due to having the highest frequency of meiotic and unicellular microspores, can be used for anther culture. Study of deformation and induced callus in this experiment showed that both the Baker and U. S. Agriseeds did not show callus induction. Anthers of varieties over three weeks after culture gradually became yellowish-brown and in the fourth week of the increased frequency of haploid were brown. After six weeks of culture, all anthers in both became brown and died. The anthers of the varieties, Mobil-Netherlands and Khoram, inflated at the second to fourth week, anther wall was eventually broken and callus was observed. At third week the frequency of deformed anthers were gradually increased. Four weeks after culture, the frequency of callus induction reduced and after five weeks of callus induction no change in frequencyof callus induction was observed. The results showed that frequency of callus induction was significantly different among genotypes ($P < 0.0001$). Two varieties of Mobil-Netherlands and Khoram had a relatively higher potential for androgenic response through anther culture compared to other lines.

Conclusions: The results showed that the and rogenes is in tomato is influenced by genotype. Two varieties including Mobil-Netherlands and Khoram showeda relatively high potential for induction of callus. It seems that

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by improving medium components and physiological conditions of donor plant in next experiments, there would be possibly more success in these two varieties in terms of haploid production.

Keywords: Callusinduction, Genotype, Haploid

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Evaluating Non-Linear Regression Models in Analysis of Persian Walnut Fruit Growth

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Introduction: Persian walnut (*Juglans regia* L.) is a large, wind-pollinated, monoecious, dichogamous, long lived, perennial tree cultivated for its high quality wood and nuts throughout the temperate regions of the world. Growth model methodology has been widely used in the modeling of plant growth. Mathematical models are important tools to study the plant growth and agricultural systems. These models can be applied for decision-making anddesigning management procedures in horticulture. Through growth analysis, planning for planting systems, fertilization, pruning operations, harvest time as well as obtaining economical yield can be more accessible. Non-linear models are more difficult to specify and estimate than linear models. This research was aimed to studynon-linear regression models based on data obtained from fruit weight, length and width. Selecting the best models which explain that fruit inherent growth pattern of Persian walnut was a further goal of this study.

Materials and Methods: The experimental material comprising 14 Persian walnut genotypes propagated by seed collected from a walnut orchard in Golestan province, Minoudasht region, Iran, at latitude 37◦04'N; longitude 55◦32'E; altitude 1060 m, in a silt loam soil type. These genotypes were selected as a representative sampling of the many walnut genotypes available throughout the Northeastern Iran. The age range of walnut trees was 30 to 50 years. The annual mean temperature at the location is16.3°C, with annual mean rainfall of 690 mm.The data used here is the average of walnut fresh fruit and measured withgram/millimeter/day in2011.According to the data distribution pattern, several equations have been proposed to describesigmoidal growth patterns. Here, we used double-sigmoid and logistic–monomolecular models to evaluate fruit growth based on fruit weight and4different regression models in cluding Richards, Gompertz, Logistic and Exponential growth for evaluation of fruit growth according to length and width(diameter) of fruit. Then to determine the most efficient model, different parameters of evaluation of model fitting were used. The best model was selected based on the highest value of $R^2$and the lowest values for RMSE, AIC and BIC. The data were analyzed using SAS software (version 9.2) and Solver in Microsoft Excel.

Results and Discussion

Growth model based on fruit weight: According to the actual and estimated growth model based on fruit weight, double sigmoid function and logistic–monomolecular model showed a good prediction of fruit weight changes versus time data (days after full bloom). However, in general according to evaluation criteria, double sigmoid model was the best model to predict walnut fruit weight. Based on total fruit weight, fruit growth occurs at two stages: in the beginning of the growth phase, there is a slow growth for 30 days and then it is continued with a rapid growth until 60 days after full bloom. Thereafter, growth was again slow. At the beginning of the second phase of growth (70 to 85 days after full bloom), fruit growth increased again and then, walnut fruits started to ripe on the tree in summer, bright green husk (outer pericarp layer) changed to a yellowish color and the growth again decreased (130 days after full bloom).

Growth model based on fruit length and width measurements: Based on the actual and estimated growth pattern the Richard model describes the growth of fruit better than other models. The first phase lasted for about 15 days and the second phase of growth was very rapid and it lasted for 35 daysin most of genotypes. Then, fruit length and width did not change significantly until harvesting time. However, due to subtle changes of fruit length and width following fruit rapid growth stage, fruit weight is preferred for describing fruit growth of the Persian walnut. During the first phase of development, increasing size and weight are associated with the formation of new and larger cells and tissues. The second phase includes attainment of final nut form, and it is characterized mainly by chemical changes. These include changes in the shell as the cells become lignified and more important changes in kernel composition.

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Conclusion: Based on thes tatistical testing and goodness of the fit, the best model between six nonlinear growth models, was double-sigmoid and Richard model swhich can be used to accurately predict fruit growth based on fruit weight, fruit lengt hand width, respectively.

Keywords: Double sigmoid, Growth model, Sigmoid growth, Fruit growth.

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Effects of Aminol-Forte Fertilizer Spraying on Physiological and Biochemical Responses of Pomegranate cv. Naderi under Drought Stress Conditions

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Introduction: Pomegranate (*Punica granatum* L.) belongs to the Punicaceae family and grows in subtropical and Mediterranean climates. Nowadays the widespread usage of inorganic fertilizers has increased and so people concern about their health. The use of organic fertilizer instead of inorganic fertilizers is one of the methods of preserving health. Pomegranate is one of the most important products of Iran. This fruit plant is cultivated in some regions in arid and semi-arid areas. Due to the long growing season of pomegranate, droughtstress is one of the main limiting factors in the development of pomegranate orchards in Iran. Utilization of amino acids can help to increase efficiency and improve the quality of the fruit under environmental stress. Thus, this study aims to findany possibility to increase the production and quality of the fruit during the drought. The goalof this study was to study the effect of organic Aminol-Forte fertilizer on physiological and biochemical responses of pomegranate cv. Naderi under drought stress conditions.

Materials and Methods: This research was carried out in AbShirin field located on the old road 40 km from Qom-Kashan during 2011. Asplit plot experiment based on randomized complete block design was conducted with two factors, irrigation treatment in three levels (100% required water, 75% required water and 50% required water) and Aminol-Forte fertilizer treatment in four levels (0, 2, 3 and 4 ml/l). Spraying was conducted in four stages (pre-anthesis, after fruit set, fruit growth andtwo weeks per-harvest). In the end of the experiment, chlorophyll index, soluble sugars, insoluble sugars, proline, canopy degree and stomatal conductance were measured. Statistical analysis was performed using SPSS 17 program. Means were separated according to the Duncan's multiple range test (DMRT) at 0.01 level of probability.

Results and Discussion: Analysis of variance of Aminol-forte fertilizer spraying on physiological and biochemical responses of pomegranate cv. Naderi under drought stress conditions showed that between irrigation treatment for chlorophyll index, proline and stomatal conductance were significant at 1% level of probability, and at 5% level of probability soluble sugarand insoluble sugar and canopy degree were significant. Fertilizer treatment at 1% level of probability was significant for proline and at 5% level of probability was significant for soluble sugars. Interaction was significant for soluble sugars, proline and canopy degree. Means showed that by increasing fertilizer level, soluble sugars content, proline and stomatal conductance significantly increased insoluble sugars and chlorophyll index decreased insignificantly. By decreasing irrigation levels, chlorophyll index, soluble sugars and proline significantly increased, meanwhile insoluble sugars and stomatal conductance significantly decreased. The highest chlorophyll index (65.44 SPAD) and the lowest chlorophyll index (56.48 SPAD) were obtained in 75% required water with 2 ml/l of fertilizer level and 100% required water with 3 ml/l of fertilizer level, respectively. The highest soluble sugars (14.94 mg/g) and the lowest soluble sugars (11.64 mg/l) were obtained in 50% required water with 0 ml/l of fertilizer level and 100% required water 2 ml/l of fertilizer level, respectively. The highest insoluble sugars (9.99 mg/g) and the lowest insoluble sugars (6.82 mg/l) were measured in 100% required water with 3 ml/l of fertilizer level and 50% required water with 2 ml/l of fertilizer level, respectively. The highest proline content (2.51µmol/l) and the lowest proline content (1.05µmol/l) were obtained in 50% required water with 4 ml/l of fertilizer level and 100% required water with 0 ml/l of fertilizer level, respectively. The highest canopy degree (-7.31˚c) and the lowest canopy degree (-9.38˚c) were measured in 50% required water with 4 ml/l of fertilizer level and 100% required water with 4 ml/l of fertilizer level, respectively. The highest stomatal conductance (38.23 $mmol/m^2/s$) and the lowest stomatal conductance (9.7 $mmol/m^2/s$) were obtained in 50% required water with 2 ml/l of fertilizer level and 100% required water with 3 ml/l of fertilizer level, respectively.

Conclusion: By increasing the level of Aminol-Forte fertilizer from 0 to 4 ml/l, soluble sugars content, proline and stomatal conductance significantly increased meanwhile insoluble sugars and the chlorophyll index decreased. Drought stress increased soluble sugars content, chlorophyll index, canopy degree and proline but,

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insoluble sugars and stomatal conductance decreased. According obtained results, it can be said, spraying of Aminol-Forte fertilizer containing amino acid could significantly reduce the negative effects of drought stress. In this study, the best results in terms of stress and no stress were obtained in 3 and 4 ml/l of Aminol-Forte fertilizer.

Keywords: Proline, Canopy degree, Chlorophyll index, Soluble sugars, Stomatal conductance

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Extraction and Identification of Volatile Components of Two *Salvia* Species Native to Iran (*Salvia limbata* and *S. multicaulis*) by Using Solid Phase Micro-Extraction Method

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Introduction: There are 58 species belonging to sage genus as annual and perennial plant in different regions of Iran that 18 species of them are endemic to Iran and they have different medicinal properties such as antibiotic, sedative, carminative, antispasmodic and commonly used in treatment of respiratory problems: infections, cough, cold and sore throat and cosmetics industries. The present study has aimed to evaluate the composition of essential oils achieved by Solid Phase Micro-Extraction method from aerial parts of two *Salvia* species native to Iran: *Salvia limbata* and *Salvia multicaulis.*

Materials and Methods: The experiments were carried out at the Research Station of Agriculture College, TarbiatModares University in Tehran, Iran during the years 2011-2013. The seeds of *Salvialimbata* and *Salvia multicaulis*were collected in Ardabil and Isfahan provinces in 2009. The seeds were sown in planting trays(filled with soil and cocopeat 1:1) under controlled greenhouse condition (temperature: 26±1°C, light: 3000 lux, relative humidity: 65%) in the last week of February 2011. The soil of experimental pots (soil and coco peat 2:1) was a clay silt loam with pH of 7.4. After two months,seedlings with uniform height and stem diameter with two true leaves were transferred to a growth chamber adjusted to 30/20 °C, 50% relative humidity, light intensity of approximately 3000 Lux and 16 h photoperiod.Aerial parts of two cultivated plantsincluding*Salvia limbata* and *Salvia multicaulis*at flowering stage were harvested in June 2012 and kept at 80°C until further experiments. Volatile compounds were extracted by solid phase micro-extraction (SPME) method for the first time in Iran for these species. Before the SPME, the leaves lyophilized and then were used. The optimization of SPME extraction and desorption conditions were performed by analyzing dried leaves of *Salvia officinalis* L., used as the matrix. The sample preparation procedure was as: 15 mg of dried sage leaves mixed into a 20 ml screw-on cap HS vial to 5 ml of 5% Ethanol and 0.5 mg of Na2SO4. The vials were sealed after stirringwith a Teflon (PTFE) septum and an aluminum cap (Chromacol, Hertfordshire, UK) for the production of headspace and the successive analysis. The sample vial was put in the instrument dry block-heater and held at 40°C for 20 min to come into equilibrium. The extraction and injection processes were automatically performed using an auto sampler MPS 2 (Gerstel, Mülheim, Germany). The fiber was, then, automatically inserted into the vial's septum for 10 min, to allow the volatile compounds absorption onto the SPME fiber surface. Each SPME fiber was conditioned before its first use, as recommended by the manufacturer. In order to desorb the volatile metabolites, the SPME fiber was introduced into the injector port of the gas chromatograph device, model GC 7890A, Agilent (Agilent Technologies, Santa Clara, USA) coupled with a mass spectrometer 5975 C (Agilent) wherein the metabolites were thermally desorbed and transferred directly to a capillary column HP-Innowax (30m×0.25 mm×0.5µm Agilent J&W) and analyzed. The identification of VOMs was accomplished by comparing the retention times of the chromatographic peaks with those, when available, of authentic standards run under the same conditions. For volatiles for which reference substances were not available, the identification was performed by matching their retention indices (RI) determined relative to the retention time of a series of n-alkanes (C8–C20) with linear interpolation, with those of authentic compounds or literature data (Van Den Dool&Kratz, 1963). Confirmation of metabolites identification was also conducted by searching mass spectra in the available database (NIST, version 2005; Wiley, version 2007).

Results and Discussion: 66 volatile components were identified in *Salvia limbata*, which Sabinene

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(19.16%), β-Pinene (19%), α-Pinene (16.3%), α-Terpinolene (14.41%), 1,8-Cineole (10.86%) and Limonene (3.73%) were highest amounts. 58 volatile compounds were identified in*Salvia multicaulis* thatCamphene (28.85%), α-Pinene (12.33%), Camphor (10.73%), Limonene (9.01%), 1,8-Cineole (5.47%), β-Pinene (4.58%) and Bornyl Acetate (3.75%) had the maximum amounts, respectively. The main part of volatile constituents of *Salvia limbata* and *Salvia multicaulis*plantsbelonged to monoterpenes (91.57 and 84.28% respectively) and sesquiterpenes (5.12 % and 7.58 %, respectively).

Conclusion: The results obtained in *Salvia limbata*and *Salvia multicaulis*in respect to main components are similar to previous papers (3, 16). However, there is some compound such as α-Terpineol in *Salvia limbata*which has not been reported. According to the obtained results by solid phase micro-extraction is closer to plant compounds.

Keywords: Monoterpenes, *Salvia limbata*, *Salvia multicaulis*, Secondary metabolites, sesquiterpenes

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Evaluation of Biofertilizer "Myco-green" on Water Relation and Efficiency of Potato Minituber Production in Drought Stress Condition.

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Introduction Today biological fertilizers are suitable substitutes for chemical manure. Hence they can improve soil fertility in sustainable agriculture system (Mandal et al, 2007). Moreover, in some composition they are accompanied with plant growth promoting rhizibacteria (PGPR), namely Pseudomonas and some Bacillus species. These bacteria can improve growth rate of the plants by some physiological aspects namely, cidrophore acid production, increasing endogenously phytohormone and helping more phosphor absorption and fixation of biological nitrogen (Tilack et al., 2005). The symbiosis of mycorrhiza with plants confers numerous benefits to host plants including improved plant growth and mineral nutrient absorption, tolerance to diseases and stresses such as drought, temperature fluctuation, metal toxicity, salinity and other adverse conditions (Fortin et al, 2002. Ryan et al, (2003) and Smith and Reed, (2008).Mycorrhizal plants are capable of absorbing more water in lower potential of water as compared with non-mycorrhizal plants (Sanchez and Blanco, 2001). Micro propagation of potato by micro and mini tubers have been established for improving multiplication rate and possibility of reserving some more stock plants as germplasm. Multiplication of the minitubers already have been accompanied by lower establishment that causes low vigor and performance of the plant. This experiment was performedto study the effect of biological manure accompanied with mycorrhiza and plant growth promoting rhizobacteria on water relationship and vigor of the plantlets derived from minituber in water stress condition.

Material and Methods Myco-green is produced by Peat grow company in Malaysia and has been spreading in floriculture, seed beds, vegetable crops, seedling plant of oil palm and many other plants. The experiment was performedatthe University of International Technology Mara Sarawak (UITM). As first step, soil bed composition was combined with peat and perlite (1:3 ratio). Then it was completely mixed by Mycogreenbiofertilizers by 1 percent of weight ratio. Mixed soil bed and biofertilizer were transferred to boxes. Minitubers of two potato cultivars (Agria and Marfona) were cultivated in the boxes arranged with 6×8 cm distance. The test was conducted in a factorial experiment based on completely randomized design with four replications. The factors included three interval irrigation regimes (5, 8 and 11 days) and two potato cultivars. The amount ofwater supplement according to their treatment was evaluated by weighing the boxes and was calculated as the amount of field capacity base. Fertile grow as a completed micronutrient had been mixed thoroughly in the soil bedby 1% weight proportion because myco-green didnot possess it. Some water relation traits such as leafosmotic potential, relative water content (RWC), osmotic adjustment and leaf proline content were measured. The method described by Bierman and Liderman (10) was used for root colonization assessment. Mini-tuber obtained from any plantlet was weighed, arranged in four groups including less than one gram, between one to three grams, between three to five grams and more than five grams. To assess mini-tuber dry matter of any replication, three mini-tubers were randomly selected and sliced to one mm thick. The first group of samples were weighed-and then placed inside the drying oven for 48 hours at a temperature of 85ºC. The dried samples were weighed again and mini-tuber dry matter percentage was calculated. Two-way analysis of variance (ANOVA) of the data was carried out using SAS software (v. 8.02, SAS Institute, Cary, NC) and the means were compared by the Duncan's Multiple Range Test.

Results and Discussions: Results- showed that application of myco-green biofertilizers had significant effect ($p < 0.01$) on relative water content of the potato plantlets' leaves bythree interval irrigation regimes in three phases. Interaction -between cultivar and interval irrigation regimes was not significant. 5 and 8 days interval irrigation regimes had more RWC and did not significantly differ with each other. the higher amount of RWC in two irrigation regimes can be correlated with colonization of mycorrhiza. In contrast, RWC was diminished in 11 days interval irrigation regime. We can conclude that although mycorrhiza was able to absorb more water by increasing water conductivity, but this ability is not limited and can be ultimate by critical

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threshold of water accessibility. Concentration of free proline amino acid was higherin plantlets treated by 8 and 11 days interval irrigation regimes in comparison with control regime. We can conceive that proline levels are correlated with changes of osmotic potential in the plant. Cultivated plantlets in 5 days interval irrigation regime donot confront the water stress. Therefore, donot take more signaling agent for induction of producing endogenous proline. Interval irrigation regimes of 5 and 8 days produced larger minituber size in comparison with 11 days irrigation regimes. Howeverthere were no significant differences amongthree interval irrigation regimes in production of the smallestminituber size. Dry matter of minituber was not affected by application of biofertilizer in three interval irrigation regimes. Addition of biofertilizer in this research was applied in three interval irrigation regimes,whereas there is no unapplied biofertilizer treatment in this experiment, so we cannot pretend that biofertilizerdoesnot affect the dry matter of minituber. Yet, there is considerable achievement that dry matter of minituber had the same levels in three irrigations regimes even by reducing much more water (11 days irrigation interval treatment).

ConclusionsIt is concluded that Myco-green biofertilizer containing mycorrhiza and plant growth promoting rhizibacteria had considerable effect on growth vigor by adjustment of water stress through promoting mineral nutrients absorption and increasing osmotic potential capability. This ability could be different with intensity of water deficiency. There is more effect of biofertilizers in mild water stress as compared to severe water stress conditions.

Keywords: Minituberyield, Organic fertilizer, Osmotic adjustment, Water deficiency