

The study of nutritional management of mother plant and seed priming by biofertilizers on improve salinity tolerance of wheat (*Triticum aestivum* L.) cv. Sayonz at germination period.

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Abstract

Salinity is one of the important factors that reduce the growth and yield of crops in Iran; however, determining appropriate methods for reducing its negative effects is important. In order to study the effects of nutritional condition of mother plant and bacterial biofertilizers seed priming on germination indices of wheat (*Triticum aestivum* L.), in salinity condition, an experiment was conducted during 2009 at Faculty of Agriculture, Ferdowsi University of Mashhad, Iran. This experiment was conducted as factorial layout based on randomized complete block design with three replications. Studied factors consisted of: four levels of nitrogen fertilizer applied on mother plant in field (0, 55, 110 and 165 Nitrogen kg.ha⁻¹), seed priming by three types of biofertilizers (Nitrajin, Biophosphouros and distilled water) and four levels of salinity stress (0, -0.4, -0.8 and -1.2 MPa). Results indicated that the seed priming with biofertilizers had a positive effect on germination indices of wheat. The maximum radicle number per seedling (2.39), radical length (5.34 cm) and plumule length (3.56 cm) were observed in seed primed by Nitrajin biofertilizer and the minimum of those characteristics were shown in control. In addition, the lowest and highest mean germination time were obtained in seed priming by Biophosphouros (2.89 day) and control (3.42 day), respectively. The highest germination indices were obtained at 55 and 110 kg.ha⁻¹ Nitrogen. The maximum germination rate (2.59.day⁻¹), number of radicle per seedling (2.34), radical length (5.75 cm) and mean weight of radical (0.0022 g) were obtained in seeds that were treated by 55 kg.ha⁻¹ nitrogen on mother plant. So, all factors related to germination and growth seedling were decreased by increasing salinity stress. Over all, results indicated that use of 55-110 kg.ha⁻¹ nitrogen with bacterial biofertilizers seed priming can improve germination indices under salinity stress conditions.

Keywords: Biofertilizer, Germination Percentage, Germination Rate, Plumule, Radical

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Investigation of weed community diversity in forage crop fields in different provinces of Iran

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Abstract

In order to evaluate the weed diversity in forage crop fields such as alfalfa (*Medicago sativa* L.), clover (*Trifolium* sp.) and sainfoin (*Onobrychis* spp.) in different provinces of Iran, a study was conducted by using data from reports of plant Protection Organization, Ministry of Agriculture during 2008. After evaluation of weed species and definition of weed family, these species classified based on functional diversity in four groups such as life cycle, growth type, photosynthetic pathway and persistence degree. The results indicated that the number of weed species and plant families were 37 and 18, respectively, in alfalfa fields. Most diverse families of monocotyledonous and dicotyledonous weeds were Poaceae and Asteraceae, respectively. Nine species of five different families were observed in sainfoin fields that among these weed families, the highest species diversity was in Poaceae family. In addition, in clover fields of different provinces, 20 species of 11 plant families were observed. The highest species diversity obtained in Poaceae family with six species and Brassicaceae family with four species. The highest similarity index for alfalfa fields (100%) was observed between West Azerbaijan- Ardabil, West Azerbaijan- Zanjan, West Azerbaijan- Kordestan, Ardabil- Kordestan, Zanjan- Kordestan, Zanjan- Gilan, Kordestan - Gilan, West Azerbaijan- Gilan and Ardabil- Gilan. The highest similarity for sainfoin fields (0.60) was between East Azerbaijan- West Azerbaijan and West Azerbaijan- Fars. Also, in clover fields, the highest similarity index was obtained between Fars and Isfahan provinces.

Keywords: Aalfalfa, Clover, Sainfoin, Similarity index, Species diversity

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Effects of corm planting density and manure rates on flower and corm yields of saffron (*Crocus sativus* L.) in the first year after planting

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Abstract

In order to investigate the effects of high corm planting density and applying manure on flower and corm yields of saffron (*Crocus sativus* L.), a field experiment was conducted at Research Station, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran, during growing season of 2010-2011. A completely randomized block design with three replications and 20 treatments was used. The experimental treatments were all combination of different planting densities of corm (100, 200, 300 and 400 corms.m⁻²) and different levels of manure application (0, 40, 60, 80 and 100 t.ha⁻¹). Results of variance analysis showed that corm planting density and manure application rates had significant effects on flower number, fresh and dried flower and stigma+ style yields of saffron. In addition, mentioned characteristics of saffron significantly affected by interaction effects of corm planting density × manure rate. Based on the results, fresh and dried flower yields of saffron significantly increased by increasing planting density up to 400 corms.m⁻². In addition, on planting density equal to 400 corms.m⁻², increasing manure up to 80 t.ha⁻¹ had significant effects on fresh and dried flower yields of saffron. However, the responding saffron to manure was decreased by reducing corm planting density. Therefore, it seems that appropriate manure application rate depends to corm planting density.

Keywords: Dry flower yield, Organic manure, Stigma yield

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The effect of organic fertilizers and different sowing dates on yield and yield components of flower and grain of Pot Marigold (*Calendula officinalis* L.)

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Abstract

In order to find out suitable organic fertilizers for elimination of chemical fertilizers usage and the optimum sowing date in Pot Marigold cultivation, an experiment was conducted in the Agricultural Research Station, Ferdowsi University of Mashhad, Iran, in 2007 growing season. For this purpose a split plot experiment based on completely randomized block design with three replications was used. The main factor consist of four different fertilizers (50 kg.ha⁻¹ N, 40 t.ha⁻¹ Cow manure, 20 t.ha⁻¹ Compost fertilizer and 10 t.ha⁻¹ Hen manure) beside control (without fertilizer) and three sowing dates (10th April, 1th May and 21th May) were allocated as sub factor. The results showed that the length time of emergence to budding, budding to flowering and flowering to ripening decreased by delay in sowing date, significantly. By delay in sowing date, plant height and dry matter also decreased because of reduction of vegetative growing duration. The various fertilizers had not significant effect on developmental stages and morphological characteristics of Pot Marigold. Nitrogen fertilizer and Hen manure in compare of other treatments had significantly ($p \leq 0.05$) higher level in number of inflorescences, yield of inflorescences, yield of petal and seed yield. Thus, Hen manure can be a suitable replacement of chemical fertilizers in Pot Marigold cultivation. The various sowing dates showed significant effect on the most measured characteristics of seed and inflorescences yield components of Pot Marigold. The highest of all studied characteristics were obtained in 10th April and 1th May than 21th May sowing dates.

Keywords: Compost, Inflorescences harvest index, N fertilizer, Organic manure

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Long term estimation of carbon dynamic and sequestration for Iranian agro-ecosystem: I- Net primary productivity and annual carbon input for common agricultural crops

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Abstract

Evaluation of carbon input is one of the most important factors for estimating soil carbon changes and potential for carbon sequestration. To evaluate the net primary productivity (NPP) and soil carbon input in agricultural eco-systems of Iran, data for yield, cultivated area, harvest index (HI) and shoot /root ratio in different crops including: wheat, barley, maize, cotton, rice, alfalfa and chickpea were obtained for different provinces. Then, allocated carbon to different organs of plant were calculated based on carbon allocation coefficients and finally, the net primary productivity based on carbon (NPPc) was calculated. The ratio of NPPc that was annually returned to soil was considered as carbon annual input. The results showed that the maximum amount of NPPc for wheat, barely and alfalfa were obtained in Khazari climate for rice, chickpea and cotton was achieved in warm-wet climate and for maize was gained in warm-dry climate. In all regions of Iran, chickpea had the lowest effect on NPPc and consequently on carbon sequestration. The highest amount of carbon input per unit area among studied crops and different regions were observed in Khazari region for alfalfa whereas, the lowest carbon input per unit area was relation to chickpea in cold region. The lowest gap between actual and potential of carbon sequestration was observed in alfalfa whereas wheat, rice and cotton showed the most gap by 0.4, 0.38 and 0.37, respectively.

Keywords: Carbon allocation, Carbon sequestration, Gap yield, Potential

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The effects of super absorbent polymer application into soil and humic acid foliar application on some agrophysiological criteria and quantitative and qualitative yield of sugar beet (*Beta vulgaris* L.) under Mashhad conditions

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Abstract

Drought stress is the most limiting factor of agricultural production through the world. To evaluate the effect of super absorbent and humic acid to reduce drought stress in sugar beet production, a strip split plot arrangement based on randomized complete block design with three replications was conducted at Research Field of Faculty Agriculture, Ferdowsi University of Mashhad, Iran during growing season of 2010-2011. The main plot factor was application and no application of super absorbent polymer and the sub plot factor was foliar application and no application of humic acid. Two irrigation intervals (7 and 10 days) assigned to strip plots. The results showed that super absorbent application comparing to no super absorbent affected leaf area index (LAI), sugar gross yield (SGY) and SPAD readings significantly, as the highest amount for this traits were 3.4, 4.7 t ha⁻¹ and 46.2, respectively. Humic acid foliar application resulted to the highest LAI (3.4) and SPAD reading (45.1) which significantly were different with other treatments. Irrigation interval of 7 days resulted to the highest LAI (3.8) and root yield (24.9 t ha⁻¹). The highest SPAD reading (49.9) resulted from super absorbent and humic acid application with 7 days interval irrigation interaction. Dry matter yield (DM) and leaf number per plant showed a positive and significant correlation ($p \leq 0.01$) with tuber yield (TY), SGY and SPAD readings. The strongest correlation coefficients were obtained for DM and LAI, and between DM and SGY. This positive and significant correlation emphasis that any factor increasing LAI will increase DM and thereby, SGY. The positive and significant correlations were observed between DM and SPAD readings, and between SPAD readings and TY. SGY estimation model predicted that SGY was determined by some variables such as TY, SP and SPAD reading. In general, these results indicate super absorbent application could increase soil water holding capacity and consequently stabilize production under dry stress conditions. In addition, humic acid application could increase economic sugar beet production, moreover maintaining environmental health issues.

Keywords: Foliar application, water absorbent hydrogel, Sugar percentage, SPAD reading

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Evaluation the effects of relay intercropping of Styrian pumpkin (*Cucurbita pepo* L.) with irrigated and rainfed chickpea (*Cicer arietinum* L.) on yield and yield components as affected by chickpea residue mulch

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Abstract

In order to study the effects of cropping systems and mulch application in relay intercropped Styrian pumpkin (*Cucurbita pepo* L.) with chickpea (*Cicer arietinum* L.), a field experiment was conducted as factorial layout based on a randomized complete block design with three replications at the Agricultural Research Station, College of Agriculture, Ferdowsi University of Mashhad, during growing season of 2010-2011. Treatments were five levels of cropping systems (monoculture of irrigated chickpea, monoculture of rainfed chickpea, monoculture of Styrian pumpkin, relay intercropping of irrigated chickpea/Styrian pumpkin, relay intercropping of rainfed chickpea/Styrian pumpkin) and two levels of chickpea residue mulches (with and without mulch). The results showed that plant height, number of pods per plant, biological yield, seed yield and 1000-seed weight chickpea were affected by different cropping systems ($p \leq 0.05$). Relay intercropping of rainfed chickpea/Styrian pumpkin increased number of pod per plant and seed yield of chickpea up to 37 and 23% compared to monoculture of rainfed chickpea, respectively. In addition, results showed that the interaction effects between cropping systems and mulch application were significant ($p \leq 0.05$) on number of fruit, fruit yield, number of seed per fruit, 1000-seed weight and seed yield of Styrian pumpkin. The highest Styrian pumpkin seed yield ($398 \text{ kg} \cdot \text{ha}^{-1}$) was shown in relay intercropping of irrigated chickpea/Styrian pumpkin. Styrian pumpkin seed oil percent was not affected by treatments ($p \geq 0.05$). However, application of chickpea residue mulch reduced the oil percent. Assessment of land equivalent ratio showed that the total systems of relay intercropping was superior compared to monocultures and the highest land equivalent ratio (2.37) was observed in relay intercropping of rainfed chickpea/Styrian pumpkin without mulch system. In general, the positive effect of intercropping on yield and yield components of chickpea, especially in the dry conditions and improved quantitative characterization of Styrian pumpkin herb, it can be inferred that the relay intercropping could be a suggested strategy for using resources to achieve optimal performance in order to achieve sustainable agricultural principles.

Keywords: LER, Medicinal plants, Oil percent, Resource utilization, Sustainable agriculture

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Study of possibility of improving root growth of two lentil (*Lens culinaris* L.) cultivars using symbiosis Mycorrhiza and Azospirillum under Rainfed Condition

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Abstract

This study was conducted aiming to evaluate the possibility of improving the root growth of lentil (*Lens culinaris* L.) using Mycorrhiza symbiosis with cooperation *Azospirillum* bacteria under rain-fed conditions. A tri-factorial experiment was conducted on the basis of Randomized Complete Block Design with four replications in Khalkhal area during 2012 cropping season. The experimental treatments were all combination of Mycorrhizal inoculums in three levels (not use, use Mycorrhiza *Glomus intraradices* and use Mycorrhiza *Glomus mosseae*), *Azospirillum* in two levels (not use and use *Azospirillum brasilense*) and Lentil cultivar with two levels (Mashhadi coarse grain cultivar and Naz fine seed cultivar). The results showed that the effect of Mycorrhiza on traits of root dry weight, root colonization and Mycorrhizal root dry weight were significant at the 1% probability level. The highest values for root dry weight, root colonization and Mycorrhizal root dry weight were recorded in plants which inoculated with *G. mosseae*. In addition, *Azospirillum* had a significant effect ($p \leq 0.01$) on root colonization, but effect of Lentil cultivars on all traits was not significant. The results showed that the interaction between *Azospirillum* and Lentil cultivars on root colonization at the 5% probability level and interaction between Mycorrhiza and Lentil cultivars on root colonization at 1% probability level were significant. Also, three-way interaction *Azospirillum*, Mycorrhiza and Lentil cultivars showed the root colonization trait at the 5% probability level were significant. The highest value for percentage of root colonization was recorded in treatment of use *Azospirillum brasilense*, use Mycorrhiza *Glomus mosseae* and Naz cultivar (46.19%).

Keywords: Bacteria, Biofertilizers, Fungi, Colonization

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Leaf appearance rate and seed yield of fennel (*Foeniculum vulgare* L.) as affected by interfering effects of lambsquarters (*Chenopodium album* L.)

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Abstract

In order to evaluate seed production index of lambsquarters (*Chenopodium album* L.), leaf appearance rate and yield of fennel (*Foeniculum vulgare* L.) under inter-specific competition a factorial experiment was conducted in Islamic Azad University, Tabriz Branch, Iran, during 2011-2012. Factors included five weed densities (0, 2, 4, 6 and 8 plants per meter row) and its relative emergence times of simultaneously sown, 10, 20 and 30 days after fennel emergence based on randomized complete blocks design with three replications. Results indicated that 8th leaf in fennel appeared after 35.4 days. Time to appearance of 12th leaf in weed densities of 0-4 plants per meter row was 50 days, while, in higher weed densities it was delayed about 11.9 days. Fennel seed and essential oil yields increased with decreasing weed density and delay in its emergence time. Low density and late emergence of lambsquarters caused seed production index to decrease. In simultaneously sown treatments, seeds production index was 9.8% while, in treatments of 10, 20 and 30 days after fennel emergence it was decreased to 5.8%, 3.6% and 3.8%, respectively. In this study, treatments with higher biomass production of lambsquarters, resulted in greater weed seed production and lower seed yield in fennel, being important for lambsquarters management in fennel fields.

Keywords: Biomass, Essential oil yield, Leaf appearance rate, Phyllocron, Weed density

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Investigating some quantitative and qualitative characteristics of wild marjoram (*Origanum vulgare* sub sp. *Virid.*) as affected by different levels of azocompost and urea

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Abstract

In order to investigate the effect of organic and chemical fertilizers on growth characteristics of wild marjoram, a factorial experiment was conducted based on randomized complete block design with three replications at the Agricultural Research Station, Ferdowsi University of Mashhad during 2012-2013 growing season. Treatments were comprised of four urea levels (0, 21.7, 108.7 and 195.7 kg.ha⁻¹) and four azocompost levels (0, 2.2, 11.1 and 20 t.ha⁻¹). The ratings from each fertilizer were adjusted separately based on 0, 40, 80 and 120 kg N.ha⁻¹. In the present study, several traits such as plant height, canopy crown, number of lateral branches/plant, number of flowers/plant, dry weight of leaves and flowers, total dry weight, leaf area index, economic yield, harvest index, essential oil content and yield were measured. The results showed that main effects of chemical and azocompost fertilizers on all characteristics of wild marjoram except for harvest index and essential oil content were significant. In addition, interaction between experimental factors was significant for all traits except for essential oil content. Plants treated with 40 kg chemical fertilizer.ha⁻¹ and 80 kg Azocompost.ha⁻¹ had the highest values in all traits except for canopy crown, total dry weight, essential oil content and yield. At the highest when compared with the lowest N level, a significant increase of 577.68 and 441.7 kg.ha⁻¹ in economic yield occurred by applying azocompost and urea, respectively. It seems that the application of azocompost had better results than nitrogen fertilizer alone. The highest correlations ($r=0.99^{**}$) occurred for number of branches.plant⁻¹ vs. plant height, for number of branches.plant⁻¹ vs. plant height and for dry weight of leaves and flowers vs. economic yield. The number of lateral branches.plant⁻¹ ($r=0.98^{**}$), leaf area ($r=0.97^{**}$) and plant height ($r=0.96^{**}$) had the highest positive correlation with economic yield, indicating the importance of these traits in contributing to final yield.

Keywords: Chemical fertilizer, Essential oil, Nitrogen, Organic fertilizer

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Evaluation of diversity in agricultural plants and effectiveness of management factors in non-hunting areas of Gharaviz and marginal regions

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Abstract

Biodiversity is a key to advancing sustainability in agriculture to meet demands for food production, pharmaceuticals and industry. This study investigates factors of agro biodiversity and management in three villages of the Gharaviz region and four villages in surrounding regions of Sarpole-Zahab County, Kermanshah province, Iran. Relevant data were collected from farms, direct observation and special questionnaires. Evaluations were made on the species richness index, the Shannon - Wiener index and Simpson's dominance. Results demonstrated that species with higher contribution in the study area belonged to seven families, and among these Poacea, Fabaceae and Solanaceae had the highest contribution. Wheat and corn were cultivated in all rural areas. Correlation between farm type (rain-fed farming and irrigated farming) to species richness indices (0.419^{**}); Shannon-Weiner (0.449^{**}) and dominance Simpson index (-0.315^{**}) was significant. Correlation between method of fertilizer application to species richness indices (-0.413^{**}), Shannon-wiener (-.377^{**}), and dominants index of Simpson (0.296^{**}) was also determined as significant. Results showed that application of chemical fertilizer resulted in less crops biodiversity but the use of organic fertilizer significantly increased agro biodiversity. Correlation between organic fertilizer application to species richness indices (0.452^{**}), Shannon-Weiner (0.419^{**}), and dominants index of Simpson (-0.338^{**}) was significant in that increased crop biodiversity was related to increased use of organic fertilizer. Effects of chemical fertilizer, fallowing use of cultivation instruments and machines, using inbred seeds, chemical herbicides and biological inputs on biodiversity indices were insignificant. In summary, improving agro ecosystem management practices in the region can serve to increase biodiversity and serve to improve agricultural sustainability in the study area.

Keywords: Biodiversity index, Farm type, Fertilizer application, Organic fertilizers

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CO₂ emission and global warming potential (GWP) of energy consumption in paddy field production systems

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Abstract

Climate change is one of the major concerns of the world which a part of that is derived from agricultural activities. Therefore, improving agricultural practices is considered as a strategy for mitigating the impact of climate change. The objectives of this study were to estimate the CO₂ emission and global warming potential (GWP) in three rice production systems and identify the methods for reducing the energy use and CO₂ emission. Three rice production systems including conservation, improved and conventional were studied in randomized complete block design with four replications a paddy field in Neka, Mazandaran, Iran. All field practices and data about production methods and inputs rate were monitored and recorded in 2012. Results showed that average of total energy input in production systems was 22793.02 MJ.ha⁻¹ that the lowest energy input (16102.98 MJ.ha⁻¹) was observed in conservation system. Electricity to pump of water for irrigation had the most contribution of energy input in production systems that was accounted as greatest global warming and CO₂ emission. Nitrogen fertilizer and fuel were ranked in second and third grade of CO₂ emission. Across the rice production, average GWP were estimated equal to 2307.33 kg CO₂-eq ha⁻¹. The lowest and highest GWP equal to 1640 and 2728 kg CO₂-eq ha⁻¹ were obtained in conservation and conventional systems, respectively. The lowest and highest GWP per unit energy input was gained in conservation and conventional system, respectively. Conservation system had the lowest GWP per unit energy output and improved system was ranked in second grade. Finally, it can be concluded that GWP has the positive correlation with field management and inputs use. Therefore, the lowest rate of CO₂ emission and GWP were obtained in conservation system.

Keywords: Climate change, Energy, Environment, Global warming, Rice

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Investigation of thermal requirement, growth and yield characteristics of two species of Persian shallot (*Allium altissimum* and *A. hertifulum*) in different density, bulb weight and flowering stem removing

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Abstract

Persian shallot is one of the important medicinal and industrial plants in Iran which is under very dense utilization. Study of morphological characteristics of Persian shallot in agronomical systems is very important for expanding agronomic production. In order to evaluate some physiological and yield characteristics, and thermal requirement of two species of shallot, a field experiment was conducted at Research Field of Ferdowsi University of Mashhad, Iran in 2012-2013. The experimental treatments consisted of two Persian shallot (*Allium altissimum* from Khorasan and *A. hertifulum* from Lorestan), two groups of bulb weight (10-20 and 20-30 g), with three plant densities (10, 20 and 30 plants.m⁻²). A factorial experiment based on completely randomized block design with three replications was conducted. The results showed that in all phenological and yield characteristics, *A. hertifulum* was significantly weaker than *A. altissimum*. Leaf area and shoot dry weight in different plant densities and bulb weight in *A. hertifulum* were significantly lower than *A. altissimum*. The results also indicated that thermal requirement of *A. hertifulum* was less than the other species. Growth duration in *A. hertifulum* was 239 days with 1664 growing degree days (GDD) whereas *A. altissimum* needed 252 days with 2000 GDD. Plant density of 30 plant.m⁻² caused a significant reduction in yield and bulb weight of *A. altissimum* but the number of bulb.m⁻² was increased significantly. Same results were shown in *A. hertifulum* up to 20 plant.m⁻². Removing flowering stem treatment had significant effect on yield characteristics in both species. Removing flowering stem caused accumulation of more dry and fresh weight, diameter and volume in harvested bulbs compared to control.

Keywords: Density, Kalat, Lorestan, Shallot

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Effect of row spacing and plant density on yield quality and quantity of soybean under weed competition

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Abstract

In order to study the effect of row spacing and plant density on quantity and quality yield of soybean in weed competitive condition, a field experiment was carried out at research farm of Yasouj Agricultural College in summer of 2011. Experiment arrangement was the factorial split-plot based on randomized complete block design with three replications. The main factor included weed (control and non control of natural weed flora) and sub plots involved factorial of soybean row spacing (with three levels 30, 45 and 60 cm) and plant density (with three levels 40, 50 and 60 plants.m⁻²). Results showed increased density and reduced row spacing increased soybean yield so that the maximum grain yield was obtained in 60 plants per square meter (2405 kg.ha⁻¹) and 30 cm row spacing (2368 kg.ha⁻¹). Weed competition reduced up to 37 percent soybean grain yield. Increasing plant density and decreasing row space increased oil yield, whereas weed competition reduced up to 38 percent oil yield. In addition, with increased plant density and reduced soybean row spacing, weed dry weight was reduced, so that the minimum weed dry weight was obtained in 30 cm row spacing (531.3g.m⁻²) and 60 plants per m² plant density (523.2 g.m⁻²). The results indicating the effectiveness of the increase plant density and reducing row spacing of soybean for weed control.

Keywords: Grain yield, Oil, Planting pattern, Protein

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Effects of Deficit Irrigation on Yield and Yield Components of Maize and Determining of Water Productivity in Nekuabad Isfahan Irrigation Network

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Abstract

To illustrate the impact of various levels of deficit irrigation on yield and yield components of maize (*Zea mays L.*) cultivar, a study was conducted based on randomized complete block as a split plot design with 3 replicates and two treatments for three crop seasons. Four levels of deficit irrigation including: conventional, 100, 80, and 60% of water level use were considered as main plots and two varieties (704 and 647) as subplots in a experimental site located in Shahid Fozveh research station. Significant differences ($P \leq 0.05$) were noticeable in grain yield, as well as depth and column of kernel among the irrigation treatments. In addition, the effects of cultivars on grain yield, 1000 kernel weight, number of kernel per ear row, number of kernel per column, and depth of kernels were non-significant. Results showed that, a decrease of 36 percent water applied (60% irrigation level treatment) compared to full irrigation, yield declined 11.4% and a decrease of 20 percent water applied (80% irrigation level treatment) compared to full irrigation, yield declined only 2%. Based on the results and considering the quantitative characteristics of the crop, it was established that for the deficit irrigating of maize, the 80% irrigation level is the most advantageous treatment when water is not limited. However, when higher water productivity and the possibility of using the water saved are taken into consideration during severe drought conditions, 60% irrigation level treatment is recommended.

Keywords: Drought, Evapotranspiration, Furrow, Irrigation

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Effects of biofertilizers on growth criteria, quantitative and qualitative yield of summer savory (*Satureja hortensis* L.)

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Abstract

In order to investigate the effects of Plant Growth Promoting Rhizobacteria (PGPR_s) inoculation on the growth, yield and quality of essential oils of summer savory (*Satureja hortensis* L.), an experiment were conducted based on randomized complete block design with three replications at Research Institute field of Forests and Rangelands, Karaj, Alborz during growing season of 2012-2013. The experimental treatments included suspension of three species of rhizobacteria namely *Azotobacter*, *Azospirillum*, *Pseudomonas* in single and combination application of these bacteria included *Azotobacter- Azospirillum*, *Azotobacter -Pseudomonas*, *Azospirillum-Pseudomonas*, *Azotobacter- Azospirillum-Pseudomonas* and control (without any inoculation with bacteria), which applied as root inoculation on summer savory plants. Assessed traits included plant height, canopy diameter, dry weight and yield of shoot, leaf area and leaf dry weight, inflorescence number, dry weight and yield, percentage and yield of essential oil and component of essential oil content such as α -terpinene, and thymole. Results revealed that inoculation of plants with PGPR_s had significant effect on all of assessed parameters such as vegetative growth criteria and essential oil yield and quality. The highest value for traits such as plant height (45.67 cm), canopy diameter (40.54 cm), dry weight of shoot (33.82 g.plant⁻¹), aerial part yield (3578 kg.ha⁻¹), leaf yield (451 kg.ha⁻¹), inflorescence yield (1398 kg.ha⁻¹), essential oil percentage (2.33 %) and essential oil efficiency (2.43 %) were obtained by application of *Azotobacter- Azospirillum-Pseudomonas* combination and the lowest amount for all of mentioned traits were achieved in control treatment. The highest amount of α -terpinene(53 mg.L⁻¹) thymole (48.5 mg.L⁻¹) were obtained by inoculation with *Azotobacter - Pseudomonas* combination and *Azotobacter*, respectively. In general the highest plant dry weight and essential oil yield can be obtained by combination of three assessed PGPR_s. Inoculation of summer savory by PGPR_s enhancing root growth and development supplying favorable condition for plant growth with respect to supplying better condition for water and nutritional elements absorption from soils.

Keywords: *Azospirillum*, *Azotobacter*, Plant growth promoting rhizobacteria, *Pseudomonas*

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Assessing production systems and biodiversity of medicinal plants in agroecosystems of Qazvin province

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Abstract

In order to investigate biodiversity and production of cultivated medicinal plants in agroecosystems of Qazvin province, a study was conducted during year of 2011. Interviews were carried out with farmers by using semi-structured questionnaire to obtain information regarding to biodiversity and medicinal plants production systems in main regions under cultivation of medicinal plants including four regions of Qazvin province (Takestan, Abyek, Qazvin and Alamut). Then agrobiodiversity criteria such as species richness, diversity indices and Sorenson similarity index of medicinal plants were calculated. The results indicated that 36 medicinal plants species were cultivated in Qazvin province in which the most medicinal plants species under cultivation were belonged to Lamiaceae, Asteraceae and Apiaceae families. In addition, around 70% of medicinal plants agroecosystems in studied area were managed based on low input cropping systems. In general, species richness, was 16, 1, 24 and 20 in Takestan, Abyek, Qazvin and Alamut, respectively and also Shannon-Wiener index and species evenness index were 0.47 and 0.28, respectively in Qazvin province. Based on Sorenson similarity index, the highest similarity (0.61) was observed between Takestan and Alamut regions whereas Abyek with Qazvin and also Abyek with Alamut showed the lowest amount of similarity index. In general, results of this study revealed that Qazvin region was superior in most studied criteria compared to other studied regions that could be due to existence of medicinal plant industry in addition to geographical parameters in this region.

Keywords: Low input system, Similarity index, Species diversity, Species richness

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The comparison of micro elements (Mn, Fe and Zn) and heavy metals (Co, Cr and Cd) in the soil of perennial farms of saffron (*Crocus sativus* L.) in southern Khorasan Province

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Abstract

In order to study concentrations of soil micro elements and heavy metals in some saffron planting regions of Birjand Province, an experiment was performed as factorial layout based on a completely randomized block design with three replications during 2013. Factors were three field ages (annual, triennial and quinquennial) and five saffron regions including Aryan shahr, Hosseinabad, Khosef, Golferiz and Mahmoei. Soil microelements and heavy metals concentrations such as Fe, Zn, Mn, Co, Cr and Cd of soil were measured. The results showed that the concentrations of Fe, Zn, Mn and Cr in soil were significantly affected by field age ($p \leq 0.05$). Effect of planting region was significant on soil Fe, Zn, Mn, Co and Cr concentrations ($p \leq 0.01$). Interaction effects between field age and planting region were significant on Fe, Zn and Co concentrations ($p \leq 0.01$). By increasing in field age soil Zn concentration was declined and heavy metals concentrations such as Co, Cr and Cd of soil were enhanced. Mn concentration in the quinquennial fields was 29 and 34% higher than annual and triennial first fields, respectively. Co content in the quinquennial fields was 53 and 46% higher than annual and triennial first fields, respectively. The maximum and minimum Fe concentrations were observed with 1.65 and 0.77 ppm for the fields of Khosef and Hosseinabad, respectively. The highest and lowest Fe concentrations were obtained with 2.436 and 0.77 ppm for the annual fields of Khosef and Hosseinabad, respectively. The highest Co concentrations were recorded in Hosseinabad and Khosef fields with 8.7 and 4.31 ppm, respectively. Thus, it is recommended to use ecological managements such as reducing the application of chemical fertilizers and improving the organic fertilizers to decline the concentrations of these elements in saffron fields.

Keywords: Environment, Heavy metal, Microelement, Organic fertilizer, Ecological management

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A comparison of utilization systems in terms of energy consumption of soybean (*Glycine max* L.) production in Moghan plain

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Abstract

Evaluation of energy flow in utilization systems is considered to be a valuable technique for evaluation the sustainability level of these systems. The aim of this survey was to compare utilization systems (cooperative, private and governmental) in terms of energy consumption in Soybean production and the evaluation of energy inputs effect in yield of Soybean in Moghan. For this purpose, the data were collected by using a face-to-face questionnaire from 14 cooperative members, 54 private and 14 agro-industry units. The maximum energy input was observed in governmental utilization system ($26784.84 \text{ MJ}\cdot\text{ha}^{-1}$), followed by cooperative utilization system ($24815.94 \text{ MJ}\cdot\text{ha}^{-1}$). Furthermore, the energy output in cooperative utilization system, private and governmental were calculated 41947.5 , 39948.61 and $43627.5 \text{ MJ}\cdot\text{ha}^{-1}$, respectively. The share of renewable energy from the total energy input in cooperative utilization system, private and governmental was estimated 37.47, 37.84 and 31.07%, respectively, while it was respectively 62.53, 62.16 and 68.93% for non-renewable energy. The share of non-renewable energy sources was relatively high. Therefore, it seems that efforts should be made to substitute renewable sources for some part of the non-renewable sources. Energy analysis indicated that output-input energy ratio (energy used efficiency) in cooperative utilization system, private and governmental were 1.68, 1.63 and 1.62, respectively. In all energy indices, cooperative utilization system compared to private utilization and governmental utilization systems was more suitable. The elasticity production estimates indicated, that among the energy inputs, irrigation was the most important input that influences total energy of Soybean production.

Keywords: Cooperative utilization system, Energy indices, Energy sources, Production function, Renewable energy

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Phytoextraction and estimating optimal time for remediation of Cd-contaminated soils by spinach (*Spinacia oleracea* L.)

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Abstract

The so-called phytoextraction in which hyperaccumulator plants are used to remediate the contaminated soils is proven to be an efficient method. The objective of this study was to investigate the capability and efficiency of spinach for phytoextraction of cadmium from Cd-contaminated soils. For this purpose, a completely randomized design with five treatments including 0, 15, 30, 60 and 120 mg Cd/ kg soil and three replications was established in natural conditions. After contaminating the experimental soils with different levels of cadmium, the seeds of spinach were planted. When plants were fully developed, plants were harvested and their cadmium contents in shoots and roots as well as the soil-cadmium were measured. The results indicated that by increasing Cd concentration in soil, the most Cd accumulation was occurred in the roots rather than shoots. Maximum cadmium concentration within the shoots and roots was 73.7 and 75.86 mg.kg⁻¹ soil, respectively. According to spinach ability to absorb high concentration of cadmium in the root zone and its high biomass and capability of cadmium accumulation in shoots, this plant can be used as a hyperaccumulator to remediate cadmium from Cd-contaminated soils. But, according to minimum remediation time and maximum dry matter for the 30 mg Cd/ kg soil, maximum Cd extracted by shoots in hectare/year was in 30 mg Cd/ kg soil. It can be concluded that spinach is a suitable plant for phytoextraction of slight to moderately cadmium contaminated topsoils.

Keywords: Heavy metals, Hyperaccumulator plant, Phytoremediation, Soil contamination

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