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Effect of replacement and additive intercropping series of ajowan with bean on yield and yield components

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Abstract

Background and objectives: Medicinal plants play major roles in human health services worldwide. Many people in both developing and developed countries are turning to herbal medicine. There is a growing demand for plant based medicines, health products, essential oils, fragrances, cosmetics and natural aroma chemicals in the national and international markets. The quality of the economic products of medicinal plants is an absolute necessity. Nutrient enrichment of soils by nitrogen fixing symbiotic bacteria present in bean has been known.

Materials and methods: In order to study the impact of replacement and additive intercropping series on yield and yield components of bean and ajowan as a medicinal plant, an experiment was conducted based on a randomized complete block design with three replications at the Agricultural Research Station, Shirvan College of Agriculture and Natural Resources during 2012-2013 growing season. Seven replacement and additive intercropping series such as 75% ajowan+ 25% bean, 50% ajowan+ 50% bean, 25% ajowan+ 75% bean, 50% ajowan+ 100% bean, 100% ajowan+ 25% bean, 100% ajowan+ 50% bean, 25% ajowan+ 100% bean and their monocultures were considered as treatment. Criteria such as yield components, biological yield, seed yield, essential oil content, essential oil yield and harvest index of ajowan and yield components, biological yield, seed yield and harvest index of bean were measured and calculated accordingly.

Results: The results showed that the effect of replacement and additive intercropping series was significant ($p \leq 0.01$) on yield components, biological yield, seed yield, harvest index and essential oil yield of ajowan and yield components,

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biological yield, seed yield and harvest index of bean. The maximum biological and seed yield of ajowan were observed in its monoculture with 192.82 and 113.19 g m^{-2} and these minimum were in 50%bean+100%ajowan with 43.50 and 12.79 g m^{-2}, respectively. The highest and the lowest essential oil yield of ajowan were obtained in its monoculture and 100%bean+25% ajowan with 3.51 and 0.54 g m^{-2}, respectively. The maximum number of branches per plant, number of pods per plant and number of seeds per pod were achieved in 75%ajowan+25%bean with 18 branches per plant, 35 pods per plant and 10 seeds per pod, respectively. The highest and the lowest biological yield and seed yield of bean were observed in its monoculture (1984.87 and 893.81 $g.m^{-2}$) and 25%ajowan+100%bean (552.42 and 252.50 $g.m^{-2}$), respectively. Range of partial land equivalent ratio (LER) for ajowan was calculated with 0.12-0.55 and it was 0.28-0.83 for bean and the highest total LER was computed in 50%bean+100%ajowan with 1.14.

Conclusion: Based on the result intercropping of ajowan and bean increase biodiversity, sustainability and stability of agroecosystem. It could be effective for ecologic production of medicinal plant. It could decrease chemical input because of nitrogen fixation.

***Keywords*:** Essential oil yield, Row intecropping, Medicinal plant, Land Equivalent Ratio

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Effects of weed interference duration on yield and yield components of chickpea in two different production systems

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Abstract

Background and objectives: Chickpea (*Cicer arietinum*) is the third most important pulse crop in the world, grown widely across Asia and the Middle East. Weed is one of the main limiting factors in Chickpea production. Several characteristics of chickpea, such as slow plant emergence, short plant height, and chickpea morphology allow weeds to compete effectively.

Materials and methods: To investigate the effect of weed interference duration and fertilizer type on yield and yield components of chickpea (cv. Hashem) grown under two different production system, a field experiment was conducted at Sabzevar in 2013-2014. Experiment was conducted as split plot in a randomized complete block design with three replications. Experimental factors were chemical and organic fertilizer application as the main plots and duration of weed interference (0, 2, 4, 6 and weeks after emergence 8 (weedy)) as sub plots. Agronomy management in chemical fertilizer application system including plowing with Moldboard, use of chemical fertilizers based on soil test and non-seed inoculation and in organic fertilizer application system including Chisel plowing, application 3 t ha^{-1} compost, seed inoculation and foliar application with organic liquid fertilizer. Other agricultural operations were similar in both tillage systems.

Results: Analysis of variance showed that cultivation system had significant effect on number of branches, number of pods per plant, number of seeds per pod and economic yield whereas plant height and biological yield was not affected by cultivation system. Weed interference duration statistically influenced all traits except for weed density and plant height. Cultivation system and weed duration

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interaction had significant effect on weed dry matter, plant height, number of branches, number of pods per plant, number of seeds per pod and economic yield. Organic fertilizer application system had 13.24% and 59.47 lower weed density and weed dry matter compared with chemical fertilizer application system, respectively. In organic fertilizer application system, Chickpea had more plant height, number of branches, number of pods per plant, number of seeds per pod, biological and economic yield than chemical fertilizer application system. Increasing of interference duration was decreased plant height (17.21%), lateral branches (33.34%), number of pods per plant (61.79%), and number of seeds per plant (73.12%), biological yield (54.25%) and economic yield (77.22). Study of logistic regression function coefficients fitted to yield reduction showed that the onset of yield loss was occurred at 24.5 days after emergence in chemical fertilizer application system while in organic fertilizer application system the onset of yield loss was postponed to 31.64 days after emergence.

Conclusion: In conclusion, results showed in both chemical and organic fertilizer condition, weed interference decreased economic yield. In organic fertilizer application system, weed interference until four weeks and in chemical fertilizer application system, weed interference until two weeks after pea emergence did not have significant reduction on yield.

Keywords**:** Chickpea, Competition, Cultivation system, Interference, Yield loss

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Evaluation of Species diversity effect on some of agroecosystem services in the intercropping of corn, soybean and marshmallow 2- Yield, Land equivalent ratio, soil microbial respiration and biomass, carbon sequestration potential

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Abstract

Background and objectives: Many researchers in agricultural ecosystems consider the multiple cropping as the most important factor for increasing the diversity of cultures (31, 21, 1). Increasing of crops diversity through intercropping can be effective to improve the functions and ecosystem services. Ecosystem services are "the conditions and processes through which natural ecosystems and the species provide continuity of life and needs of human". Ecosystem services are very diverse and have dimensions of ecological and environmental. One of the main functions of multiple cropping systems is the increasing soil biological activities. Increasing crops diversity through multiple cropping causes improving soil microorganisms and therefore soil biological activity as one of the ecosystem services increases (29).

Material and methods: The purposes of the study were evaluating of the intercropping efficacy for corn, soybean and marshmallow in terms of land equivalent ratio, microbial biomass and potential of carbon sequestration as different ecosystem services. For this purpose, an experiment was conducted based on a randomized complete block design with three replications at research farm of Ferdowsi university of Mashhad during growing season 2013- 2014. Experimental treatments included the different patterns of intercropping for corn, soybean and marshmallow based on replacement series at seven levels. Each plot had 6 rows. Soybean and corn in intercropping treatments including 4 rows of soybean and 2 rows of corn, soybean and marshmallow intercropping treatments including 4 rows of soybean and 2 rows of marshmallow, Corn and marshmallow intercropping

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treatments including 4 rows of Marshmallow and 2 rows of Corn, planting a mixture of three species and the sole cropping of the three species.The studied characterizes included land equivalent ratio (LER), microbial respiration and biomass and carbon sequestration potential. Anderson method (3) was used to measure microbial respiration. Fumigation -incubation method (12) was used for the measurement of soil microbial biomass.

Results: Results showed that LER was larger than one under all treatments of intercropping (without any significant differences, in range from 1.01 to 1.08), which indicating the efficacy of the intercropping compared to sole cropping systems. Using of the intercropping systems caused to increase in soil microbial respiration and biomass in comparison with sole cropping systems, so that the highest microbial respiration (94.17 mg CO_2 kg^{-1} day^{-1}) and biomass (820.34 mg kg^{-1}) were obtained by intercropping of corn + soybean + marshmallow. Experimental results showed that carbon sequestration potential affected by different patterns of intercropping and the highest carbon sequestration potential (1487.5, 3210.1, 4502.0 kg C ha^{-1} in scenarios of 30, 70 and 100% residue, respectively) was observed in corn + marshmallow intercropping. Therefore as comprehensive suggestion, increasing plant diversity through intercropping can be considered as one of the effective approaches to increase services such as improvement of microbial activity and potential of carbon sequestration; and the services valuation in multi-planting systems and comparing them with sole cropping systems were suggested for the next studies.

Conclusion: Based on finding of this research multiple cropping increased soil microbial biomass and this can increase nutrition circle and productivity of soil. Although increasing microbial biomass may lead to reduction of carbon sequestration in the soil. Because under increasing microbial biomass conditions, residues decomposition rate and microbial respiration are increased and more carbon dioxide is entered to the atmosphere which results in reduction of carbon sequestration. It must be noted that microbial activity and quantity of carbon sequestration are more dependent on the environmental conditions especially temperature and moisture. Another important function of multiple cropping is carbon sequestration potential so that in multiple cropping increased this potential so using of multiple cropping can mitigate negative effects of climate change. Choosing species and keeping plant residues on soil surface have effective role in success of multiple cropping in carbon sequestration potential.

Keywords**:** Ecosystem Services, Microorganism, Multi-planting, Plant diversity

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The effect of foliar application of ascorbic acid and sodium nitro prusside on grain protein content, yield and some agronomic traits of safflower under water deficit stress

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Abstract

Background and purpose: Nowadays, the application of antioxidants and plant growth regulators has discussed for decreasing the negative effect of different stresses. Ascorbic acid and sodium nitroprusside are substance induce resistance to biotic and abiotic stresses. To evaluate the effect of ascorbic acid and sodium nitroprusside foliar application on some traits of safflower (*Carthamus tinctorius*), a field experiment was carried out in split plot factorial based on randomized complete block design in Shahrood University.

Materials and methods: Two levels of irrigation, including 8 days interval (well watered) and 16 days interval (water deficit stress) were in main plots, and foliar application of sodium nitroprusside in three levels (0, 50 and 100 µM) and ascorbic acid in three levels (0, 10 and 20 mM) were in sub plots. Stress treatment applied after plants establishment completely. The first foliar application of sodium niroprusside and ascorbic acid was performed in 63 and 65 days after sowing respectively and then repeat after 1 week.

Results: Results showed that water stress decreased the capitol diameter, kernel weight, fertile capitol weight and number of seeds in capitol. In this research infertile capital decreased under stress condition. Ascorbic acid foliar application increased fertile capitol weight and capitol diameter. The number of infertile capitol decreased by ascorbic acid and sodium nitroprusside foliar application. Ascorbic acid in 20 mM concentration increased significantly 0.69% in seed protein compared with control. The fertile capitol weight and capitol diameter

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increased significantly by sodium nitroprusside foliar application. Seed protein increased 1% by application of 100 µM concentration. Seed yield by application of 100 µM sodium nitroprusside concentration was 13.2% more than control. The result showed that application 100 mM sodium nitroprusside concentration and 20 mM Ascorbic acid concentration contained fertile capitol weight and increasing 35.1 percentages compared with control.

Conclusion: 20 mM Ascorbic acid and 100 mM sodium nitroprusside concentration can introduced as the best treatment compound.

Keywords: Ascorbate, Drought stress, Nitric oxide

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Evaluation of desiccation tolerance in developing peanut seed

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Abstract

Background and objectives: Acquisition desiccation tolerance is one of the main stages during seed development and maturation. Development of desiccation tolerance in peanut seed (NC2) was performed during maturity staged in four growing date by evaluating electrical leakage and seed viability test.

Material and methods: The experiment was conducted in the research farm of Gorgan university of agricultural and natural resources in randomize complete block design with four replications. Sampling was done weakly to harvest maturation from seeds produced in each planting date by handpick of 10 peanut plant. Some seeds were transferred to laboratory immediately and other part of seeds was dried slowly on air exposed condition and when it reached to 14-16 % of moisture content, standard germination test and electrical conductivity was done.

Results: Results showed that, with accumulation of seed reserves, seed moisture content was declined gradually by 70 percent in the beginning stage of development to 30% in the later phase of accumulation reserves. Germination of freshly harvested peanut seed started when more than half of total storage substances accumulate in seeds and moisture content was estimated about 40-46 percent. But seed which dried gradually germination started after seed accumulated 17, 27, 50 and 24 percent of total reserves and germination was started by 60-68 % of seed moisture content.

Conclusion: According to these results, desiccation tolerances was developed during 7 to 10 days and before aggregation less than 50 percent of total reserves in cotyledons. It could change significantly at different planting date and weather

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condition during plant growth stages. It seems that legume crop needs to spend some time in mother plants for acquisition desiccation tolerance and this period not only cause interruption for germination capability but decrease seed moisture content mainly.

Keywords**:** Germination, Peanut, Orthodox seed, Planting date, Physiological maturity

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Effects of water stress and nitrogen fertilizer on quantitative and qualitative characteristics of Dragonhead (*Dracocephalum moldavica* L.)

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Abstract

Background and objectives: Drought is one of the most important factors limiting plant growth around the world and the most common environmental stress which is limited produce approximately 25% of the world's land. Production of secondary metabolites in medicinal plants changes by environmental condition and also water stress is effective factor in growth and synthesis natural compounds in this plants. Nutrient management in drought stress condition and investigate interaction between them on plant characteristics dragon head due to lack of adequate information is very important. Therefore, the aim of this study was to investigate the use of nitrogen fertilizer in drought stress on qualitative and quantitative characteristics of dragonhead plant.

Materials and methods: In order to determine the effects of drought stress and nitrogen fertilizer on some quantitative and qualitative traits of dragonhead a field experiment was conducted based on a randomized complete block design with three replications in Khoy Firuraq in 2013. The treatments were consisted of irrigation (unstressed (control) and with holding irrigation during stem elongation and early flowering stages) and nitrogen fertilizer (without nitrogen (control), 150, 225 and 300 Kg N ha^{-1}). In this study, Plant height, distance between the first flower and ground, the number of lateral branches, number of flowering branches, total dry wight, percentage of essential oil, essential oil yield and seed yield of dragonhead were measured.

Results: The results showed that irigation treatment had significant effects on all traits (except of essential oil percentage) and nitrogen fertilizer application was

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significant on number of branches, total dry weight, essential oil and seed yield of dragonhead. Drought stress during stem elongation and flowering stages reduced all traites of dragonhead. Withholding irrigation at stem elongation stage produced the least (6.17 kg ha^{-1}) essential oil yield. High levels of nitrogen fertilizer application had no significant effect on the measured characteristics of dragonhead. Application of 150 Kg N ha^{-1} produced the most of the flower branches (17.11), total dry weight (2484.44 kg ha^{-1}), percentage of essential oil (0.39), essential oil yield (9.62 Kg ha^{-1}) and seed yield (1493.11 Kg ha^{-1}) of dragonhead.

Conclusion: Drought stress during stem elongation and flowering stage decrease of dragonhead qualitative and quantitative characteristics, and the use of high levels of nitrogen fertilizer had not a positive effect on quantitative and qualitative characteristics of dragonhead. In general, full irrigation and application of 150 kg N ha^{-1} is recommended as a superior treatment to achieve maximum qualitative and qualitave yield of dragonhead.

***Keywords*:** Medicinal plants, Secondary metabolites, Essential oil yield, Biological yield

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Study of stress indices for selecting tolerant wheat genotypes in rain-fed and saline conditions of Golestan province

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Abstract

Background and objectives: The region of the experiment is located in Golestan Province, Iran, with agriculture subject to various farming conditions (rain-fed and irrigation) and different levels of salinity (more than 38% of Golestan's total land area is salt-affected). Selection of tolerant wheat genotypes, not only for rain-fed conditions but also for different levels of salinity in the region is important.

Materials and methods: The experiments were conducted in 2011-2012 with nine genotypes of wheat in three environments of no salinity, severe salinity (19 dS/m) and moderate salinity (9 dS/m) and with eight genotypes of wheat in two environments (irrigated and rain-fed) in a randomized complete block design with three replications. For all the experiments, sowing was done from 18 to 20 December and the seedling density was 300 seeds m^{-2}. The plots consisted of six metre-long rows spaced 20 cm apart. The grain yields were measured by harvesting 4 m^2 of the central part of each plot at crop maturity. After harvest, yield were measured and selection indices, including stress susceptible index (SSI), tolerance (Tol) index, mean productivity (MP), geometric mean productivity (GMP) and stress tolerant index (STI) were calculated. In order to better evaluate the genotypes' relationships, principal component analysis (PCA) was done and a biplot based on PC1 vs. PC2 (principal components one and two, respectively) was provided.

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Results: The results showed that the correlation between yield of genotypes under non stressed condition with severe salinity (stress index= 0.76) was not significant, but in two other conditions, i.e., non saline vs. moderate salinity (stress index= 0.51) and rain-fed vs. Irrigated (stress index= 0.12), the correlation was positive and significant. PCA with different stress severity showed that the first and the second components included more than 90% of variation, then these two components were used. In severe salinity, PC1 separated high-yielding genotypes under non-stressed conditions whereas PC2 differentiated them under stressed conditions. In severe stress (0.52) and (0.12) PC1 separated high-yielding genotypes under stressed and non-stressed conditions, and PC2 differentiated genotypes with high sensitivity to stress. Then genotype with high and low level of first and second component was suitable. Among the studied indices, STI and GMP with Yp and Ys and SSI with Yp had positive and significant correlation.

Conclusion: In severe salinity based on SSI, Bam had the least SSI and it was a better genotype while biplot showed that Bam only had the highest value of PC2 and it was a good genotype under stressed condition. Under severe salinity, there was not a suitable genotype for both stressed and non stressed conditions. Some of cultivars which were tolerant in other regions of Iran, i.e. Bam and Arg in severe salinity had the highest yield and the lowest SSI suggesting that they are tolerant to high salinity. In moderate salinity and rainfed condition N-87-20 and Karim were the best genotypes, respectively. The biplot clearly simultaneously revealed the relationships needed for selecting genotypes under stressed and non stressed conditions.

Keywords: Wheat, Resistance indices, Salinity, Rain-fed, Irrigated condition

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Effects of Different Rates of Pelleted Animal Manure and Urea and Micronutrients on the Morpho-physiological Characteristics and Oil Yield of Pumpkin *(Cucurbita pepo* var. *styriaca)*

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Abstract

Background and objectives: Pumpkin is one the most important cultivated medicinal plants, because of high quality oil and its uses as edible and herbal medicine. A high oil production of pumpkin by lower amounts of chemical fertilizers is one of the important aims for researchers in agriculture.

Materials and methods: To find out the effects of different rates of pelleted animal manure and urea and some micronutrients on the morphophysiological characteristics and oil yield of pumpkin, a split plot experiment based on randomized complete block design with three replicates was conducted at the Research Farm of Abouraihan Campus, University of Tehran during 2010-2011 growing season. The pelleted animal manure and urea with four levels (150 kg urea, 50 kg urea+3.5 tone animal manure, 100 kg urea+1.5 tone animal manure and 150 kg urea+1.5 tone animal manure) were considered as the main plots and micronutrients with three levels (1000, 2000 and 3000 (mg Kg^{-1}); including iron, zinc, manganese from a chelate source and boron from boric acid source) were considered as sub plots.

Results: Results showed main factor had significant effect on plant height, branches number, female flowers, and oil yield ($p \leq 0.01$) but main factor had no significant effect on seed oil percentage. Mean comparison test showed that the highest plant length (329.6 cm), branches number (15.1), female flowers number (5.2), fruit number of plant (2.1) and oil yield (481.8 Kg h^{-1}) was obtained by

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applying 150 Kg urea+1.5 tone animal manure as pelleted. Also most seed oil percentage up to 45.1% obtained by 150 Kg urea application. The highest number of female flower (5.14), seed oil percentage (46.5%) and oil yield (431.6 $kg.h^{-1}$) was obtained by 2000 mg Kg^{-1} of microelements, but this treatment had no effects on other parameters. Variation of SPAD showed applying pelleted animal manure and urea and 2000 mg Kg^{-1} micronutrients was more effective on chlorophyll content. Improving these characteristics were related to positive effect of integrated application of manure and chemical fertilizer on plant nutrition and gradual releasing of nitrogen from pelleted animal manure. Also results showed that high amount of micronutrient application could have negative effect on morpho-physiological characteristics and yield of Pumpkin.

Conclusion: In general, results showed that applying 150Kg Urea+1.5 tone plleted animal manure with 2000 (mg Kg^{-1}) of micronutrients could be suggested as the best option for achievement of the best morpho-physiologial characteristics and oil yield of pumpkin.

Keywords**:** *Cucurbita pepo* var *styriaca*, Fruit number of plant, SPAD, Seed oil percentage, Oil yield

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Improvement of yield, oil and protein percentage of sesame under drought stress by foliar application of zinc and boron

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Abstract

Background and objectives: Drought stress is one of the most important environmental factors reducing growth and yield of crops, especially in arid and semiarid regions of the world. During drought stress, nutrient uptake diminishes due to rising of solute concentrations and so increasing of osmotic potential in the root zone. With increasing soil pH, micronutrient uptake decreases more than other nutrients. Zinc and boron deficiencies are mostly observed in these conditions, so that yield quantity and quality of oilseed crops, such as sesame, diminish even without any apparent deficiency symptoms. The aim of this study was to determine the effect of foliar application of zinc and boron on sesame yield, yield components and seed oil and protein contents under drought stress conditions.

Materials and methods: The experiment was conducted as a spilt pilot in a randomized complete block design with three replications at Fars research center for agriculture and natural resources in 2013. Main plots were included of three levels of drought stress (as irrigation after 75, 110 and 145 mm evaporation from class A evaporation pan) and sub plots were included of four levels of foliar applications (no boron and zinc (water), zinc sulfate, boric acid, and combined zinc and boric acid).

Results: Results showed that zinc and boron foliar application significantly increased number of capsule per plant in 75 mm evaporation treatment. Zinc also increased number of capsule per plant in 145 mm evaporation treatment. Maximum

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1000 seed weight obtained from boron foliar application in irrigation after 145 mm evaporation treatment. In irrigation after 110 mm evaporation level number of seed per capsule significantly increased (25.4%) with foliar application of mixture of zinc and boron compared to control. Irrigation after 145 mm evaporation (relative to two other treatments) had the minimum seed yield (1535 Kg ha^{-1}), But there were no significant difference between irrigation after 75 (1947 Kg ha^{-1}) and 110 (2115 Kg ha^{-1}) mm evaporation. Foliar application of zinc and boron (compared to control) significantly increased oil percentage and foliar application of zinc, boron and mixture of zinc and boron (compared to control) significantly increased protein percentage. Maximum seed yield (2119 Kg ha^{-1}) obtained from foliar application of zinc. Irrigation after 145 mm evaporation, compared to other irrigation treatments, significantly decreased HI.

Conclusion: In general, foliar application of zinc, boron and mixture of zinc and boron under drought stress treatment, could improve yield, yield components, oil and protein percentage of sesame.

Keywords: 1000 seed weight, Biological yield, Class A evaporation pan, Harvest index

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Assessment of genetic diversity through morphologic characteristics in different rice genotypes

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Abstract

Background and objectives: Rice (*Oryza sativa*) is one of the most important cereal crops and is the staple food source for over fifty percent of the world's population. The population of rice-consuming countries is multiplying daily, and it is estimated that rice production must be increased in the recent years and increasing yield will be the main goal of plant breeders. This has to be achieved by the development of high yield rice varieties with improved nutritional quality and tolerance to biotic and abiotic stresses. Studies on genetic diversity and genetic structure of natural populations are important in order to define strategies for plant breeding.

Materials and methods: One hundred diverse rice accessions including global genotypes from different countries and international breeding lines were chosen to assess genetic relationships between traits. The experiment was carried out in an incomplete block design (lattice) with three replications. This collection was used to measure important agronomic traits such as yield and yield component, grain shape and flag leaf characters and early maturity.

Results: The ANOVA revealed significant ($P<0.01$) variation for all the traits. Orthogonal comparisons for three categories of Iranian genotypes, foreign varieties and inbred lines, revealed Iranian genotypes were defined as a rich source for grain quality genes, while foreign varieties despite the lack of grain quality had appropriate grain yield, whereas breeding lines had suitable potential in yield components. Ward's clustering method classified genotypes in three main groups with different characteristics. Principal components analysis explained 84.8% of variation with five first components.

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Conclusion: The present study, evaluate important agronomic traits to find out status of Iranian germplasm against foreign inbred lines and varieties, results determine that foreign germplasm with appropriate characteristics could be a complementary material beside Iranian germplasm in rice breeding projects. Evaluated population has an appropriate variation for all traits. According to the results of the orthogonal comparison, each of the Iranian genotypes, foreign genotypes and breeding lines had unique characteristics. However, Iranian genotypes could be considered appropriate in terms of grain quality traits but against foreign varieties had high yield but not suitable in grain quality. Though, breeding lines sounds a good source for yield component traits. Hence, the population could be a rich and diverse collection of important agronomic traits. In present study cluster analysis and principal component analysis separate the rice genotypes based on morphological traits, and individuals with similar characteristics were classified in similar group.

Keywords: Rice, Genetic diversity, Principal components analysis, Cluster analysis, Orthogonal comparisons

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The effects of nitrogen levels and intercropping pattern on forage yield and competition indices of barley and pea

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Abstract

Background and objectives: Intercropping or simultaneous growing of two or more crops on the same piece of land has the potential of enhanced ecosystem productivity. In a cereal-legume intercropping system, an increase in cereal and decrease in legume yield is reported. Several indices such as land equivalent ratio (LER), relative crowding coefficient (K), competitive ratio (CR), aggressivity (A), actual yield loss (AYL) and intercropping advantage (IA) will be used to describe the competition and the economic advantage in intercropping. The objectives was to study the effect of nitrogen fertilizer and intercropping pattern on forage yield and competition indices of land equivalent ratio, relative crowding coefficient, aggressivity, competitive ratio, actual yield loss, intercropping advantage, equivalent yield and system productivity index.

Materials and Methods: This experiment was arranged as factorial layout based on a Randomized Complete Block Design with three replications at the research farm of Gonbad Kavous University during growing season of 2011- 2012. Two factors were five planting patterns including monoculture of barley, 25, 50 and 75% pea replacement of barley and monoculture of pea and four nitrogen levels of control and 25, 50 and 75 kg N ha^{-1}.

Sowing date was 29 Nov. 2011 and plants harvested at 26 April 2012. The traits were forage dry yield and indices of land equivalent ratio, relative crowding coefficient, aggressivity, competitive ratio, and actual yield loss, intercropping advantage, barley equivalent yield of pea and system productivity index. For analysis variance of data software of SAS Ver.9.1.3 were used and treatment mean differences were separated by the least significant difference (LSD) test at the 0.05 probability level.

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Results: The results showed that monoculture of barley had maximum forage yield with 17.16 ton ha^{-1}. By reducing for barley in intercropping ratio, forage yield was reduced so that minimum yield obtained from 25% barley + 75% pea with 9.62 ton ha^{-1}. Monoculture of pea had minimum yield with 6.71 ton ha^{-1}. Forage yield increased by increasing of nitrogen consumption. Land equivalent ratio for total intercropping ratios were less than 1, this indicated that intercropped barley with pea was not suitable. Relative crowding coefficient, Competitive Ratio and Aggressivity for barley in intercropping ratios were greater than pea. Intercropping did not have economic benefit.

Conclusion: Forage yield and barley equivalent yield in monoculture of barley and intercrop treatments was greater than pea. Nitrogen consumption increased forage yield and barley equivalent yield. Land equivalent ratio, relative crowding coefficient, aggressivity, competitive ratio and intercropping advantage in barley was better than pea. Actual yield loss in barley was positive and in pea was negative. System productivity index in 25% instead of barley was higher than two other intercropping treatments.

***Keywords*:** Aggressivity, Equivalent yield, Intercropping, Land equivalent ratio, System productivity index