



Effects of salinity on yield quantity and quality of three rapeseed cultivars under different atmospheric carbon dioxide concentrations

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Abstract

Background and Objectives: Soil and water salinity is the main constrain of cultivation in hot and dry regions such as Iran. Approximately 36% (6.8 million hectares) of arable land in Iran have suffered various degrees of soil salinity. About 90 percent of edible oil consumption in Iran has imported. Rapeseed with special growth habit can be cultivated in different area in Iran and is the best crop rotations for cereals that are include about 70 percent of crops cultivation area. On the other hand the concentration of atmospheric carbon dioxide due to human activities is increasing. Increasing of CO₂ concentration can affect on growth of plants. Laboratory studies have shown that increasing CO₂ concentration, will increase water use efficiency, net photosynthesis, biomass production and yield in most plants. The effects of free-air CO₂ enrichment on the growth of summer rapeseed was investigated and showed that at the end of the flowering, shoot biomass significantly increased to 40%. But in the final harvest, biomass and grain yield increase was not significant. Therefore, the effect of increasing carbon dioxide concentration on the response of canola varieties under saline conditions is essential.

Materials and Methods: The experiment was conducted in Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran, in the 2010, 2011 growing season. Four levels of salinity (0, 5, 10 and 15 dS.m⁻¹) on three cultivars of rapeseed (Okapi, Zarfam, and RGS) at three levels of atmospheric CO₂ concentration (350, 700 and 1050 μmol mol⁻¹) were studied. Three levels of CO₂ concentrations have been considered as three environments that two other treatments (salinity and cultivar) carried out in them in a completely block design with factorial arrangement. 20 Kg black pots were prepared. Pots were filled with farm soil. To preparation of

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saltwater, natural salt and Tap water with electrical conductivity of 588 micro-Siemens per centimeter was used. In order to apply the CO₂ treatment, growth chamber in greenhouse (9 m long, 2 meters in width and height of 2.5 m) were established. The top of chambers were covered with plastic film about 20 cm over the walls. CO₂ was supplied from a CO₂ cylinder gas purchased from commercial sources.

Results and Discussion: Results indicated that effect of salinity on grain yield was significant and yield decreased from 2.8 t ha⁻¹ at 0 dS m⁻¹ up to 1130 t ha⁻¹ at 15 dS m⁻¹ salinity. Number of pod per plant was affected by salinity more than other yield component. Elevated CO₂ has no significant effect on yield and yield component, only in the second year of experiment, elevated CO₂ (1050 ppm) has been able to partially ameliorate the negative effect of salinity. Grain yield significantly affected by cultivar and RGS003 had the highest yield (2300 kg ha⁻¹) and zarfam and okapy had the second and third rank respectively. Oil and protein content of grain has been decreased and increased by salinity respectively. CO₂ concentration had no effect on oil content. Oil content in cultivars reduced in all CO₂ concentration with increasing of salinity. Protein content was increased by increasing of salinity and CO₂ concentration.

Conclusion: Elevated CO₂ has no significant effect on yield and yield component, only in the second year of experiment, elevated CO₂ (1050 ppm) partially ameliorated the negative effect of salinity. Oil and protein content of grain has been decreased and increased by salinity respectively. Protein content was increased by increasing of salinity and CO₂ concentration.

Keywords: CO₂ concentration, Rapeseed, Salinity, Yield components



Response of morphological traits, yield components and yield of pumpkin (*Cucurbita pepo* L.) to the integrated management of irrigation interval and nitrogen fertilizer

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Abstract

Background and Objectives: Oilseed pumpkin is an introduced medicinal plant, the seeds as well as some other organs of which are being utilized in treating an array of human diseases in Iran. Considering the plant importance in the health products' industry on the one hand, and the countrywide drought stresses and a lack of information on mineral nutrition of oilseed pumpkin, the study aimed to assess the effects irrigation interval and different levels of nitrogen fertilizer on some of morphological traits, yield components and seed yield of this useful medicinal plant.

Materials and Methods: This experiment was studied as split plot based on randomized complete block design with three replications at the Research Farm of Bu-Ali Sina University in 2012-2013 growing season. Irrigation intervals (6, 9, 12 and 15 days) as main plots and nitrogen levels (0, 60, 120, 180 and 240 Kg N ha⁻¹) were considered as sub-plots. Furrow irrigation system was used for crop irrigation and irrigation treatments were applied after full establishment of plants. Nitrogen fertilizer was applied at three stages of planting, flowering and fruiting. The evaluated traits were plant length, node number/plant, branch number/main stem, leaf number/plant, fruit number/plant, seed number/fruit, 100 seed weight, seed yield and chlorophyll meter reading.

Results: Results showed that the effects of treatments were significant on plant length, nod and branch number/main stem, leaf and fruit number/plant, seed number/fruit, 100-seed weight, grain yield and chlorophyll index of pumpkin. Also, interaction of treatments had significant effect on all traits except branch

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number/main stem and seed number/fruit. The highest and lowest grain yield was 84.84 and 25.26 g m⁻², which achieved at 180 Kg N in 6 days irrigation interval and non supplying N in 15 days irrigation interval treatments, respectively. Treatment of 180 Kg N in 6 days irrigation interval did not differ with treatment of 180 Kg N in 9 days irrigation interval. Drought stress occurrence and nutrient deficiency, especially nitrogen during development stages especially reproductive stages caused decreasing in yield components and eventually seed yield through reduction in chlorophyll content, reduction in photosynthesis period and material translocation resulted from current photosynthesis and also reduction of proportion of supplied remobilization of materials.

Conclusion: Generally, results of this experiment showed that the highest grain yield was obtained in the treatment of irrigation interval of 6 days with accompanying consumption of 180 Kg N, but there was no significant difference between the mentioned treatment and the treatment of 9 days irrigation interval and 180 Kg N. So, it can be concluded that irrigation interval of 9 days and application of 180 Kg N ha⁻¹ can produce satisfactory yield besides water saving and reduction in production cost particularly for using less nitrogen fertilizers.

Keywords: Deficit irrigation, Medicinal plant, Morphology, Resource consumption management, Seed weight



Effect of drought stress chemical and *biofertilizer* and salicylic acid on grain yield and yield components of Coriander (*Coriandrum sativum* L.)

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Abstract

Background and Objectives: Drought is one of the major stresses that adversely affect crop productivity and quality in many arid and semi-arid parts of the world, and the aim of this research is the effects of drought stress, fertilizer and salicylic acid on some of morphological and agronomic characteristics of coriandrum.

Materials and Methods: A field study was conducted in Kermanshah province in 2014. The experiment was laid out as split-factorial arrangement based on a randomized complete block design with three replications. Experimental factors were combination of 3 levels of drought stress 60, 90 and 120 mm evaporation from class A pan and fertilizer in 4 levels control, urea 100 Kg ha⁻¹, biofertilizer of Nitrokara and 50% urea + Nitrokara and the concentration of salicylic acid 0 and 1 mM. The traits were included number of umbel per plant, number of umbelet per umbel, number of grain per plant, 1000 grain weight, biological yield, grain yield and harvest index.

Results: The results showed that number of umbel per plant, number of umbelet per umbel, number of grain per umbelet, number of grain per plant, 1000 grain weight, biological yield, grain yield and harvest index were decreased under drought stress. In contrast salicylic acid and combination of urea with Nitrokara significantly increased all evaluated traits. Interactions effects of fertilizer × irrigation trait on number of grain per umbelet showed that the maximum and minimum mean observed at drought stress 60 mm evaporation from class A pan and 50% urea + Nitrokara with mean of 14.25 and trait of drought stress 120 mm evaporation from class A pan and control with mean of 5.33. Also mean comparison of interaction effects of irrigation × salicylic acid showed maximum

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and minimum mean of number of grain per umbelet in trait of drought stress 60 mm evaporation from class A and application of salicylic acid with mean of 13.91 and drought stress 120 mm evaporation from class A and non-application of salicylic acid with mean of 6.1 and also mean comparison of interaction effects of fertilizer \times salicylic acid showed maximum and minimum mean of number of grain per umbelet in traits application of salicylic acid with combination of 50% urea and Nitrokara and control with mean of 11.11 and 8, respectively. Interaction effects of irrigation \times fertilizer \times salicylic acid was significant in the all evaluated traits (with the exception of number of grain per umbelet) and application of salicylic acid with combination of urea and Nitrokara in all levels of stress particularly in normal irrigation condition (60 mm evaporation from class A pan) and drought stress 120 mm evaporation from class A with control had the highest and least amount, respectively.

Conclusion: According to the results, application of salicylic acid (1 mM) and biofertilizer Nitrokara involvement in remove of negative effects of stress and application of salicylic acid and biofertilizer Nitrokara could be increased grain yield and yield components of coriander as valuable medicinal plant under drought stress.

Keywords: 1000 grain weight, Biofertilizer of Nitrokara, Biological yield, *Coriander*, Harvest index



Effects of the Folate foliar application at different growth stages on quantitative and qualitative wheat yield

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Abstract

Background and Objectives: Wheat is one of most important crops, which has special place in people's nutrition in developing countries such as Iran. Also, due to reducing food diversity and lack of receiving enough micronutrient such as iron, malnutrition and anemia are the most challenging nutritional problems of these societies. Nowadays scientists try to not only improve the quality and quantity of wheat but also increase the accumulated micronutrients such as iron in wheat and help to reduce malnutrition. Due to role of folate in transfer of single carbon fragments, in this research effect of folic acid foliar application at different growth stages were investigated on wheat grains quantitative and qualitative.

Materials and Methods: In order to evaluate the effect of folate foliar application on yield and iron content of wheat at different growth stages, an experiment was conducted at Maragheh University research farm in 2013 using randomized complete block design. wheat seedlings was sprayed with 50 μ M folate at shooting, heading, milky, dough and combination of above mentioned stages during last hours of daytime.

Results: Results revealed that folate foliar application at different phenological stages of wheat caused to increase plant height, flag leaf area, and number of tillers compared with control, while it had no effect on number of spikelets per spike. In contrast, the percentage of sterile florets per spike significantly decreased in treated seedlings at all growth stages except heading stage. Also folate foliar application cause to increase the number of grains per spike at all growth stages except milky

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grain stage compared with control. In addition Folate foliar spray significantly affected 1000 seed weight only at milky and dough as well as combination of above mentioned stages. Because of folate foliar spray, biological and grain yield showed a significant increase in all phenological stages compared with control. Also, folate foliar application cause to significantly increase the content of grain iron except stem elongation stage compared with control.

Conclusion: As a conclusion, it can be stated that folate foliar application led to increase wheat yield and iron content at all growth stages. Special place of wheat in human nutrition and prevalence of anemia caused by iron deficiency, foliar application of folate is the short way for increasing wheat yield and iron micronutrient supply for human. But for achieving desirable quantitative and qualitative yield, it is better that folate get used to at last stages of wheat biological cycle. In addition, due to the positive effect of folate on the qualitative and quantitative aspects of food security is other advantages of this method.

Keywords: 1000 grain weight, Economical yield and biological yield, Fertile tiller, Number of spikelet per spike



Study of alfalfa crops by using isozyme markers

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Abstract

Background and Objectives: Alfalfa (*Medicago sativa* L.) is the most important forage crop grown in the temperate regions and it is cultivated over 32 million hectares worldwide. In fact, genetic diversity is critical for breeding selection programs to improve trait, generate new adapted cultivars. The enzymatic markers showing tetrasomic inheritance patterns can be used to perform genetic diversity analysis. The aim of this study was to determine genetic variations levels and clustering based on enzymatic band (0 and 1) in alfalfa populations.

Materials and Methods: Genetic diversity of 12 alfalfa half-sib families was studied by use enzymatic electrophoresis (rubisco, superoxide dismutase, esterase and peroxidase). 35 individuals of each variety, were investigated in the Agricultural Research Station of University of Tabriz.

Results: For enzyme markers rubisco and superoxide dismutase isozymes showed only one monomorphic band in all populations, but esterase and peroxidase enzymes had polymorphic bands. The resulting data based on presence and absence of enzymatic band (0 and 1) for 11 polymorphic isozymic bands were analyzed. Isozymic analysis showed that there were high levels of intra-family and low level of inter-family diversity. Average heterozygosity, as an index of within-population genetic diversity, was 0.289. Nei's genetic distances among families were low (0.002 to 0.059). Dendrogram was constructed via the Jaccard similarity coefficient

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and UPGMA method, that lead to the classification of the alfalfa populations in two groups, with 11 families in one group and only Chaleshte half-sib in the other group were located that were conform the pervious conclusion.

Conclusion: While the stability of enzyme markers will confirm, we can use in alfalfa breeding programs to produce cultivar with high biomass.

Keywords: Alfalfa, Genetic diversity, Half-sib families, Isozymic markers



Effect of physical priming on phenology, some of physiological traits and yield components of wheat under delayed cropping

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Abstract

Background and Objectives: Some of farmers in Iran cultivate soybean as a secondary crop after wheat harvesting in early summer. In this case, on-time planting of soybean will be important in its productivity. For better land use, exploitation of new technologies could be accelerated maturing of wheat and finally prepare better growth period and good yield production of secondary crop. Good crop establishment is a major challenge in crop production, a fact recognized by farmers as well as researchers. Seed priming is a feasible technology to enhance rapid and uniform emergence, high vigor and better yields in crop species. Ultrasonic waves can be a major role in earlier seedling emergence and maturing (5-10 days). Therefore, the present study was carried out to investigate the effects of physical treatments and sowing date on emergence, growth period and production of wheat (Alvand cv.) crop.

Materials and Methods: The experiments were conducted in greenhouse and research field of Islamic Azad University of Tabriz, Iran in 2013-2014. The wheat seeds were treated by ultrasonic, laser, magnetic field, gamma and beta irradiations for 3.5 and 5 min and were sown on 27th September and 17th October. Statistical analysis was performed by MSTAT-C software. Also, analysis of variance and LSD test ($P \leq 0.05$) were used for statistically test of sources of variation and means comparison, respectively.

Results: All the seed priming treatments improved coefficient of uniformity of emergence compared with non-primed seeds. Seedling vigor index responded positively and significantly to seed priming agents. There was no significant difference among laser, gamma and beta irradiations with a view to time from sowing to harvesting. Wheat seeds primed by magnetic fields, ultrasonic waves and

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lower exposure time of gamma had high chlorophyll in leaves. Gamma irradiation with exposure time of 3.5 min, as well as magnetic field and ultrasonic wave lead to producing heavier seeds with 50.5 g thousand seed weight, but only 40.5 g from those seeds treated under other agents and non-treated one. There is no significant difference between seed yields from sowing dates of 27th September and 17th October, and the yield ranged from 334 g m⁻² in average of control; laser and beta irradiations and higher exposure time of gamma up to 480.1 g m⁻² in other treatments.

Conclusion: It is concluded from the study that wheat seed priming by magnetic fields, ultrasonic waves and lower exposure time of gamma irradiation can be effectively used to improve the crop performance and yield especially in late sown plants.

Keywords: Chlorophyll, Delayed sowing date, Stand establishment, Ultrasonic wave



Effects of pre-Sowing treatments and nitrogen rates on quantitative and qualitative characteristics of silage maize SC 704

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Abstract

Background and Objectives: Due to risks and pollution of chemical fertilizer, need to reduce the usage of them and find the ecological approaches to provide nutrition sources for crops. One of the solution is pre-sowing plants. The present study was conducted to evaluate the effect of the pre-sowing treatments and nitrogen levels on qualitative characteristics of silage corn.

Materials and Methods: This research is performed at the Agricultural Research Station of Islamic Azad University of Karaj, Iran in 2013-14. The experiment was conducted as a split plot based on a randomized complete block design with four replications. Main factors include pre-sowing treatments in 4 levels (Perko PVH, Buko, Manure and Fallow) and sub factors also included nitrogen levels (120 and 240 and 360 Kg ha⁻¹, utilized urea source). Perko PVH and Buko belong to Brassicaceae family if they back to the soil they can increase the oraganic matter. Seeds (sc 704) were planted by pneumatic machine under 12 plants m⁻². At the end of the season, qualitative and quantitative characteristics, including dry matter digestibility, water soluble carbohydrates, crude protein, acid detergent fiber, neutrals detergent fiber, total Ash and forage yield were determined. Data analyses are done by using SAS (Version 9.1.3) statistic software mean comparison was done using the LSD test at probability level of 5%.

Results: Analyses of variance illustrated that the effect of pre-sowing treatments was significant ($P \leq 0.01$) on dry matter digestibility, neutrals detergent fiber and forage yield. In all traits, Perko PVH and Buko treatments were the best ones to compare with fallow and manure. The highest forage yield was observed by Perko

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PVH Pre-sowing treatments (78.23 t ha⁻¹) and the least forage yield for the manure treatment was (63.71 t ha⁻¹). The effect of nitrogen levels on dry matter digestibility, neutrals detergent fiber and forage yield had a significant difference ($P \leq 0.01$), so that with the increasing use of nitrogen, the rates of that traits increased. The Interaction effect of pre-sowing treatments and nitrogen levels was significant on a water soluble carbohydrates, crude protein, acid detergent fiber and Total Ash ($P \leq 0.01$), some how in Karaj region the suitable component was Perko PVH treatment by using 240 Kg ha⁻¹ nitrogen fertilizer. That's the highest percentage of crude protein (9.07%) was recorded at pre-sowing of Perko PVH and for 240 kg N ha⁻¹ and the lowest percentage of crude protein (4.6%) was related to the manure treatment and 120 Kg N ha⁻¹.

Conclusion: According to the results of this research, the combined usage of organic fertilizer with nitrogen fertilizer, enhances the quantitative and qualitative characteristics of corn silage. Hence, by useing of the organic fertilizers, meanwhile considerably reducing the chemical fertilizer consumption and consequently reducing the environmental impacts. The results showed that perko and buko treatments have positive and significant effect on qualitative and quantitative parameters of corn silage and the reaction of corn silage to pre-sowing product is different. In general, It could be concluded that by cultivation the pre-sowing crops and return the their remnants to the soil leads to soil fertility and consequently improve the quantity and quality of corn silage and can be considered as one of the ways to achieve sustainable agriculture.

Keywords: Buko, Crude protein, Dry matter digestibility, Perko PVH, Water soluble carbohydrates



Effect of drought stress on physiological characteristics and seed yield of sunflower at different levels of nitrogen

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Abstract

Background and Objectives: When sunflower crop exposed to water stress, crop management should be changed for obtaining acceptable yield and increasing the resources efficiency. This reduces the cost of production and on the other hand may save nitrogen that is not associated with increased yield. And also help to maintain or improve the quality of groundwater.

Materials and Methods: The study was conducted in a farm located in the city Hamidieh the city of Khuzestan province (latitude 31 degrees 33 minutes and longitude 48 degrees, 10 minutes with a height of 13 meters above sea level) in the summer of 2010. Soil texture was loamy clay soil with 7.7 pH and electrical conductivity of 1.3 dS m⁻¹. To evaluate the effect of drought stress on physiological characteristics and yield of sunflower in different levels of nitrogen the study was conducted by midmature hybrids of sunflower (Euroflour cv). This study was conducted in split-plot arrangement based on randomized complete block design with three replications. Irrigation as the main plot at three levels of optimum irrigation, moderate stress and severe water stress that irrigation water by discharging 50, 70 and 90 percent moisture and nitrogen as subplots in three levels of 80, 140 and 200 Kg of nitrogen per hectare.

Results: The results showed that grain yield, proline, chlorophyll a and b reduced under drought conditions. Drought stress caused a significant decrease in grain yield, chlorophyll a and b and the relative leaf water content, but increased the amount of proline. The main reason for the reduction of grain yield in drought stress treatments was reducing the number of seeds per head and seed weight. Nitrogen treatment affects grain yield, protein and chlorophyll a and b. With increasing nitrogen application in optimum irrigation and drought moderate stress, these attributes significantly increased.

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Conclusion: In this research, under severe water stress, low nitrogen consumption and in moderate drought stress conditions 140 Kg nitrogen per hectare was suitable. According to various environmental conditions in terms of irrigation, different levels of nitrogen (using 80, 140 and 200 kg N ha) for increasing the yield of sunflower seeds (Euroflour cv.) and providing favorable conditions in terms of water supply and management is important.

Keywords: Drought stress, Euroflour varieties, Nitrogen, Sunflower, Yield



The effect of different green manure crops and nitrogen sources on weed biomass and some growth characteristics of canola

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Abstract

Background and Objectives: Canola (*Brassica napus* L.) is one of the main oil seeds. Type of canola nutrition is the effective factor on grain yield, oil percent and quality. The application of green manure plants and biological fertilizer for reducing chemical fertilizer application and increasing yield approach is the main issue in order to sustainable agriculture goals. Green manure crops are the plants that turned under all of the plant tissues for soil improvement aims. Weeds are one of the main factors for canola reducing yield. Weeds decreased canola grain yield by decreasing plant height, leaf area index (LAI), the number of fertile flower and silique. So that, the aim of recent research is study the canola growth parameters and its LAI and weed biomass in canola fields under green manure crop and different nitrogen sources.

Materials and Methods: This field experiment was conducted in experimental farm of Agricultural Faculty of Shahid Chamran University of Ahvaz in 2013-2014 growing season. This experiment was conducted in split plot arrangement with randomized complete block design in three replications. The treatments include different green manure crops including millet (*Pennisetum sp*), mung bean (*Vigna radiate*), barley (*Hordeum vulgare*), mixed cropping of *Pennisetum sp* and *Vigna radiate* and fallow (without green manure application) and subplot were different nitrogen sources at three levels includes (no nitrogen fertilizer (control), 100% chemical nitrogen and 50% chemical nitrogen + biological nitrogen fertilizer (Nitroxin). Grain yield was determined after margin removing by harvesting 2 m² area from center of each plot and the plant samples were hand harvested. For measuring weed biomass and canola LAI sampling was done at three stages

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(50, 100 and 150 days after planting date that were in early stem elongation, flowering and anthesis phenological stages of canola, respectively with 0.5×0.5 m² quadrat. The weeds sample weighted after drying and canola LAI was measured with photometric method and Leaf Area Meter Aparatus.

Results and Discussions: The result showed that the highest grain yield (4467.2 Kg ha⁻¹) was related in mung bean and 50% chemical nitrogen + biological nitrogen fertilizer (Nitroxin) and the lowest (1434.2 Kg ha⁻¹) was obtained at no nitrogen fertilizer and green manure treatment (control). Also, the highest biological yield (10401.5 Kg ha⁻¹) was revealed at mung bean and millet intercropping and 50% chemical nitrogen + biological nitrogen fertilizer (Nitroxin). The lowest biological yield (3875 Kg ha⁻¹) was obtained at control treatment. The weed results showed that the highest weed biomass (150.33 g m⁻²) was obtained at the first sampling date, fallow and no nitrogen application and the lowest one (23.34 g m⁻²) was related at the third sampling date, in 50% chemical nitrogen + biological nitrogen fertilizer (Nitroxin) and the intercropping of millet and mung bean.

Conclusion: Application of green manure plants increased canola growth parameters due to reduction of weeds growth and their germination and increments of nutrient availability. Also canola growth increased with application of biological fertilizer (Nitroxin) which would be available soil nitrogen for canola than weeds. Also the results of this research showed that the green manure plants with chemical + biological fertilizers caused to canola growth and LAI improvement and decreased weed biomass with reduction of chemical fertilizer application.

Keywords: Biological fertilizer Nitroxin, Grain yield, Leaf area index, Sustainable agriculture



Effect of fungus *Piriformospora indica* on yield of soybean and millet in intercropping via competition indices

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Abstract

Background and Objectives: Nowadays the use of low-input farming systems and innovation modern management techniques of resources utilization in order to achieve the aims of sustainable agriculture has been particularly important. Bio-fertilizers application and intercropping systems are important approaches to achieve the objectives of ecological agriculture, which can improve temporal and spatial agricultural productivity. The use of bio-fertilizers in intercropping not only increases soil fertility, and reduces the use of chemical fertilizers, but also can lead to improve yield and quality of products. The endophyte fungus, are known as one of the most important classes of soil microorganisms, induce physiological and ecological alterations in their host plant and thus increase its yield. This study was conducted to evaluate the effects of fungus *Piriformospora indica* on yield, yield components and phosphorus content of soybean and millet in intercropping.

Materials and Methods: The experiment was carried out as a factorial based on a randomized complete block design with three replications, at the Research Station of Agricultural Faculty of Bu-Ali Sina University in 2015. The factors included of two levels of fungus *P. indica* (inoculated and non-inoculated) and five levels of replacement intercropping series consisted of monoculture of soybean (S), monoculture of millet (M), 67% S+ 33% M (67S:33M), 50% S+ 50% M (50S:50M) and 33% S+ 67% M (33S:67M). Different patterns of intercropping are replacement method and planting ratios were adjusted by altering the number of rows cultivation.

Results: The results demonstrated that in all intercropping treatments, the highest phosphorus concentration of soybean and millet (0.39 and 0.32 percent,

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respectively) were achieved in 50S:50M intercropping. Application of *P. indica* caused an increase in phosphorus concentration of soybean and millet about 31.6 and 22.9 percent respectively, compared to control. *P. indica*, caused an increase in the number of ears per plant of millet in different intercropping patterns. In inoculated with *P. indica* increased the number of ears per plant of millet at 50S:50M intercropping by 28.3 percent in comparison with no-inoculation. The highest number of pods per plant in soybean (54 and 53 pods in plant) obtained in 50S:50M and 33S:67M ratios with *P. indica*, respectively. Fungus *P. indica* increased number of seeds per pod of soybean up to 16.4 percent in compared to control. In all intercropping treatments, land equivalent ratio was more than one. Maximum value of land equivalent ratio (1.14) was achieved in 50S:50M intercropping in inoculated plants with *P. indica*. Calculating the aggressivity index showed that millet was more dominate than soybean.

Conclusion: Application of fungus *P. indica* and replacement intercropping of soybean and millet, could improve yield and effectiveness indices of mixed cropping of above mentioned crops, because of increasing nutrient uptake efficiency.

Keywords: Endophyte fungus, Intercropping, Land Equivalent Ratio, Phosphorus



The effect of different concentrations of nano-molybdenum and calcium fertilizers on growth parameters and nodulation of Chickpea (*Cicer arietinum* L.)

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Abstract

Background and Objectives: The use of nano-fertilizers as an effective approach to increase the availability of nutrients for plants has been highly regarded. With using Nano-fertilizers, time and rate of release plant nutrients will be according to plant nutrition needs, so the plant can absorb the maximum amount of nutrients and thus the leaching of nutrients decreases and crop yield increases. The present research aimed to study the growth responses of chickpea during different growth and development stages under nano-molybdenum and calcium fertilizers treatments.

Materials and Methods: In order to investigate nano-molybdenum and calcium fertilizers on growth parameters, nodulation and amount of calcium and molybdenum of Chickpea (*Cicer arietinum* L.), an experiment was conducted as a factorial based on completely randomized design in green house of Payame Noor University of Mashhad in 2013. Experiment treatments included three levels of molybdenum (0, 2 and 4 ppm) and four levels of calcium (0, 100, 200 and 300 Kg ha⁻¹) that were prepared as nano oxides absorbed by plant. Studied traits were plant height, root length, leaf area, and root and shoot dry weight, the number and size of biological nitrogen-fixing nodules and amount of calcium and molybdenum in plant.

Results: The results indicated that the effect of different levels of calcium on plant height, size of biological nitrogen-fixing nodules and amount of calcium and molybdenum in plant were significant, statistically. Growth parameters of chickpea at different levels of calcium were significantly increased compared to control. The highest plant height was observed in treatment of 100 Kg ha⁻¹ calcium. The highest shoot dry weight (0.6 g per plant), leaf area (14 cm² per plant) and size of

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biological nitrogen fixing nodules (27 nodules per plant) were observed in treatment of 300 Kg ha⁻¹ calcium. The lowest rates of these parameters were obtained in the control. The effect of calcium treatment on the size of the nodule was not significant. Different levels of molybdenum nano-oxide only affected leaf area and plant calcium content, significantly. Nano-molybdenum levels had reduction effect on leaf area compared to the control, so that the highest and lowest leaf area were observed in the control of leaf area was 4 ppm molybdenum, respectively. Calcium absorption in the concentrations of 2 and 4 ppm molybdenum increased compared to the control, significantly. The interaction effect of molybdenum and calcium only affected amount of calcium and molybdenum of chickpea, significantly. With increasing molybdenum in the absence of calcium, amount of plant calcium increased, but with increasing molybdenum in the higher levels of calcium, this trend of calcium variation was not observed. The highest amount of calcium was observed in combined treatment of 4 ppm molybdenum and 0 Kg ha⁻¹ calcium. With increasing molybdenum nano oxide in the higher levels of calcium (200 and 300 Kg ha⁻¹), the amount of molybdenum in the plant increased. The highest amount of this parameter belonged to combined treatment of 4 ppm molybdenum and 300 kg per hectare calcium that was not different with 0 and 2 ppm molybdenum under condition of 300 Kg ha⁻¹ calcium, significantly. Increased soil pH by calcium carbonate or calcium oxide, is an effective way to increase the number of nodules in legumes. As well as changes in pH, affects the availability of nutrients so that the absorption of some elements such as molybdenum can be facilitated.

Conclusion: In general, the results showed that combined use of nano-calcium and molybdenum fertilizers can have a significant effect on growth characteristics of chickpea. This suggests that nanotechnology has a high potential for achieving sustainable agriculture by increasing nutrient absorption and use efficiency. Nanotechnology also reduces environmental pollution and thus improves agricultural production and food security.

Keywords: Biological nitrogen-fixing, Dry weight, Leaf area, Size of nodule



Effect of inoculation of *Pseudomonas fluorescens* FY32 bacteria to reduce the effects of salinity on canola (*Brassica napus* L.)

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Abstract

Background and Objectives: Salinity (sodium chloride) stress is a major environmental stress which along with drought stress is known to be the most effective abiotic stress which reducing crop production. Plant growth-promoting rhizobacteria (PGPR) colonize roots of monocots and dicots, and enhance plant growth by direct and indirect mechanisms. Modification of root system architecture by PGPR implicates the production of phytohormones and other signals that lead to enhanced plant growth. Inoculation of Plant Growth Promoting rhizobacteria and use of resistant varieties, are good practices to decline the negative effects of sodium chloride stress. This experiment was done to evaluate the effect of inoculation of *Pseudomonas fluorescens* FY32 in moderating the effects of salinity on canola varieties.

Materials and Methods: This experiment was conducted in hydroponic cultivation systems under split-split plot experimental design with three replications based on completely randomized design. Main factor is introduced as three levels of sodium chloride (0, 150, and 300 mM NaCl), Presence or absence of bacteria in the cultural system is sub factor and six varieties of canola is sub-sub factor (Hyola308, Sarigol, RGS003, Amica, Hyola420 and Olga respectively).

Results: Statistical analysis indicated that growth indices (RGR, AGR, LAR, NAR, LAD and LRGR) and leaf relative water content (RWC) were significantly ($P < 0.01$) affected by different levels of sodium chloride and bacteria. Salt stress reduced the growth parameter 50%. Inoculated seedlings showed positive effect of inoculation on growth indices except LAR. Levels of sodium chloride increased

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leaves proline content, but for inoculated seedling higher levels of sodium chloride stress showed higher proline content. The more sodium chloride concentration, the less soluble sugar content and chlorophyll a and b and total chlorophyll content were detected, showed reduced with the rate of increase in sodium chloride concentration. Sodium chloride stress caused increase level of sodium and chloride ions and decrease level of potassium ions of canola. On the other hand inoculation of rhizobacteria reduced accumulation of sodium and chloride ions and increased potassium content in canola varieties.

Conclusion: According to the analysis of the indices of growth and morpho-physiological data, it can therefore be concluded that the effect of sodium chloride stress reduced by inoculation of *Pseudomonas fluorescens* FY32 strain that produce ACC- deaminase enzyme. The presence of the bacteria and its symbiosis can promote plant growth in different ways and so the harmful effect of salinity and other abiotic stresses can be alleviated by the use of PGPR.

Keywords: Chlorophyll, Growth index, Ionic elements, Osmotic adjustment, PGPR



Effect of foliar application of salicylic acid on qualitative and quantitative characteristics of potato

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Abstract

Background and Objectives: Potato has an important role in human nutrition and food basket. This plant is the largest share in the production of food products in the world after wheat, rice and corn and has the second position after wheat in Iran. Potato plant is cool crop season and cannot grow well in areas with hot and long summers. Under heat stress produce tender skin that separates easily from the flesh. Salicylic acid is a chemical substance, based on recent report it has positive effects on plants tubers like potato. Then study was conducted on effect of salicylic acid on some qualitative and quantitative characteristics of potato crop (Sante cultivar) in 2012.

Materials and Methods: This research was conducted by randomized complete block design with five treatments and four replications in Valik Abad potato farm in Gorgan city. Foliar application in five levels (0, 20, 100, 500 and 1000 ppm) on experimental plant took in six stage every twice a weeks. Characters such as plant height, leaf greenness, and number of tubers per plant, total weight of tubers per plant, tuber skin thickness, the rigidity of tubers, tubers and starchy tubers weight loss during storage were measured. The data from experiments were analyzed by SAS software.

Results: Analysis of variance results showed that some plant characters such as shrub height, tuber number in every shrub, all tubers weights in shrub and some qualitative characters such as leaf chlorophyll value, tuber skin thickness value, tuber firmness value, tuber starch value, and weight loss during storage of tubers have been affected by treatments. The highest shrub height (28 cm), leaf

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chlorophyll (45.14 Density percentage), tuber skin thickness (0.28 mm), tuber firmness (7.4 Kg cm⁻²), tuber starch (0.1 mg g⁻¹ fresh weight tuber) and tuber weight stability during storage (64.25 g in 45 days) were obtained at 500 ppm concentration and also the highest tuber number (6.05 tuber) in shrub and all tubers weights (111.45 g) in shrubs were observed at 1000 ppm concentration treatment.

Conclusion: The results of this study indicated that salicylic acid has significant effect on the quantitative and qualitative characteristics of potato tubers so that the highest shrub height, leaf chlorophyll, tuber skin thickness, tuber firmness, tuber starch and tuber weight stability during storage were related to 500 ppm concentration and also the highest tuber number in shrub and all tubers weights in shrubs were observed at 1000 ppm concentration treatment.

Keywords: Foliar application, Potato, Qualitative characters, Salicylic acid, Storage