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The Application of Plant Growth Promoting Microorganisms and Phosphate Fertilizers on Yield, Yield Components and Water Use Efficiency of Wheat at Levels of Irrigation Water

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Abstract

Background and Objectives: Water deficit and low soil fertility are the most important factors limiting plant growth and yield in arid and semiarid regions. The use of chemical fertilizers is the most common way to provide the necessary nutrients for plants including phosphorus. Due to the fixation of high amount of the phosphate fertilizers, especially in calcareous soils, overuse of these fertilizers in addition to their low efficiency, also causes environmental and economic problems.In addition to providing plant nutrients, use of beneficial soil microorganisms can increase tolerance to environmental stresses such as drought. Therefore, the aim of this study was to investigate the role of mycorrhizal fungi and phosphate solubilizing bacteria on yield and yield components of wheat and improving the efficiency of phosphate fertilizers at different levels of irrigation water.

Materials and Methods: This study was conducted as a factorial experiment in a randomized complete block design with three replications on wheat (Anfarm 4 cultivar) at the research farm of Faculty of Agriculture, Birjand University in crop year 2017-2018.Experimental treatments consisted of four levels of irrigation water (I_0, I_1, I_2 and I_3, 100%, 75%, 50% and 25% of field capacity (FC), respectively) and four levels of fertilizer treatment (F_0, F_1, F_2 and F_3, Control, plant growth promoting microorganisms (PGPM), 150 kg ha^{-1} triple super phosphate (TSP), and PGPM+ 75 kg ha^{-1} TSP, respectively). For determination of the plant height and tiller number, 10 plants were selected from each plot and then their numbers counted. Also, the spike number, spike length, number of seeds per spike, 1000-seeds weight, grain and biological yield, seed P concentration, root colonization and water use efficiency was recorded.

Results: Results showed that with decreasing water use to 25% of FC, plant height (19%), tiller number (35%), spike number (22%), grain number (17%), 1000-grain weight (20%) and grain yield (35%) decreased, but the seed P concentration (42%) was increased. Water stress reduced grain yield more than biological yield. Application of irrigation water by 75%, 50% and 25% of FC, decreased grain yield by 25, 36 and 44% and biological yield by 21%, 30% and 38%, respectively. On the other hand, application of PGPM and chemical fertilizers increased the above parameters at various irrigation water levels. According to the results, there was no significant difference between TSP application and PGPM+ 50% TSP application at different levels of irrigation water for most of the studied indices such as spike number, seed number, 1000-seeds weight, grain yield and seed P concentration. Combined application of PGPM+ 50% TSP at irrigation water levels of 75, 50 and 25% of FC, increased grain yield by 79, 88 and 75% and biological yield by 57, 71 and 61%, respectively compared with the same irrigation water levels. Also, the application of 150 kg TSP ha^{-1} and decrease of water use to 25% of FC reduced root colonization by 22 and 33%, respectively.The positive effect of PGPM on yield and yield components of wheat, especially under water deficit conditions,can be attributed to the production of auxin, organic acids and siderophore by bacteria, and the colonization of roots by fungi and access to more soil points, thereby increasing the uptake of nutrients such as phosphorus and water for the plant.

Conclusion: According to the results, although the application of chemical fertilizers had the most effect on most of the measured indices, the application of PGPM with 50% of chemical fertilizer was not statistically different from the full application of fertilizer. In other words, due to the environmental

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problems and high cost of chemical fertilizers, the use of PGPM can reduce up to 50% of fertilizer use without affecting yield. In addition, the results showed that simultaneous application of chemical fertilizers and PGPM under drought conditions had better results than the application of chemical fertilizer alone, indicating the high potential of beneficial soil microorganisms to adapt to adverse environmental conditions and thus improve plant growth and yield. Therefore, the simultaneous application of chemical fertilizer and PGPM is recommended, especially in conditions of water scarcity in wheat production.

***Keywords*:** Birjand, Mycorrihiza, Phosphorus, Water Deficiency, Wheat.

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Evaluating the effects of tank-mixing of 2,4-D and sulfosulfuron on wheat, wild mustard (*Sinapis arvensis* L.) and sweet clover (*Melilotus officinalis* L.) using isobole curves

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Abstract

Background and Objectives: Application of herbicide is inevitable for controlling weeds in agriculture and increase the quality and quantity of crops. On the other hand, resistance of weeds to herbicides should be considered in herbicide application. The mixing of herbicides increases the efficiency of herbicides and leads to better and more effective weed control as well as delaying the occurrence of resistance. The following study was conducted to investigate the efficacy of mixing of sulfosulfuron and 2, 4-D and its phytotoxicity on wheat.

Materials and Methods: In order to investigate the effect of mixing 2,4-D and sulfosulfuron herbicides on wheat and wild mustard and sweet clover weeds, a factorial experiment was conducted in a completely randomized design with three replications in the fall of 2015 at Pardis Greenhouse of Gorgan University of Agriculture Sciences and Natural Resources. In this research, two herbicides commonly used in wheat fields of Golestan province including: dual purpose sulfosulfuron (apyros) herbicide, and broad-leave herbicide 2,4-D were used. Herbicides were applied at 8 rates of 0, 0.1, 0.2, 0.4, 0.6, 0.8, 1, 2 X of recommended dose, 2000 g.ai L^{-1} 2,4-D and 26.6 g.ai L^{-1} sulfosulfuron with tank mixture ratios of (0:100), (25:75), (50:50, (25:75), (100:0). Log-logistic function was fitted for the data related to dry weight of plants against various doses of herbicides for each mixture and the dose required to inhibit 50% growth (GR_{50}) was estimated. Then, isobole curves and mixture models were used to determine the effect of 2,4-D and sulfosulfuron mixing.

Results: The number of survived sweet clover and wild mustard plants (as compared to control) decreased by increasing application rate of 2,4-D and sulfosulfuron herbicides and their different mixing ratios. Mixing of 2,4-D and sulfosulfuron affected the dry weight of sweet clover and wild mustard weeds. The amount of 2,4-D and sulfosulfuron required for 50% reduction in dry weight of wild mustard weed were 0.639X and 0.906X of recommended dose. This values for sweet clover weed were 1.043X and 1.063X of recommended dose of the herbicide noted above, respectively. Also, mean comparison of wheat plants of weight showed that there was no significant difference in dry weight of wheat plants when sulfosulfuron herbicide was used solely. This suggests that sulfosulfuron herbicide has no effect on weight loss of wheat.

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Conclusion: The results obtained in the following study indicate that the mixing of the two studied herbicides reduces the efficacy of sulfosulfuron herbicide. Also, the mixing of sulfosulfuron and 2,4-D did not have a significant effect on dry weight of wheat at the recommended dose.

Keywords: Dose-response, Dry weight, Herbicide, Log-logistic function,

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Effect of plant densities and weed competition on yield and yield components of Red-bean genotypes

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Abstracts

Background and objectives: Weed management in red-bean (*Phaseolus vulgaris* L.) is very important because of relatively high reduction of crop growth and yield, in weedy condition. Therefore, focusing on variation of bean genotypes and plant densities may clue to solve the problem. In this study, the effects of plant densities of three red-bean genotypes in the case of weed infestation on growth, yield and yield components were evaluated.

Materials and Methods: This experiment was conducted as split plot based on a randomized complete block design with three replications in Research Farm of University of Guilan in 2017. The main plots included red-bean genotypes (Darakhshan and Sayyad cultivars and D81083 line), and the sub-plots were planting densities of 15, 25 and 35 plants.m^{-2} in weedy conditions, and 25 plants.m^{-2} in weed free condition.

Results: The plant height and yield were affected by the genotypes and the plant densities of red-bean in weedy and weed-free condition, but the harvest index was not affected. Biological yield, number of pods per plant, number of seeds per pod and the dry weight of 100 seeds varied based on genotypes and plant densities. The highest plant height was seen in Sayyad, D81083 and Darakhshan genotypes respectively. Plants height in treatments with the density of 25 plants.m-2 did not show significant differences in weedy and weed free conditions; while the densities of 35 and 15 plants.m-2 of plants in weedy treatments had the highest and the lowest heights, respectively. The highest amount of seed yield, biological yield, number of pods per plant, number of seeds per pod, and 100 seeds weight, of all three genotypes were found on weed free conditions. In all plant densities, the highest amount of seed yield was belonged to line D81083 and the lowest amount was belonged to Seyyad, while there were no significant differences between seed yield of both and Darakhshan cltivar. Among weedy treatments, the highest amount of biological yield and number of pods per plant were found in cultivar of Derakhshan with 25 plants.m^{-2}. For Sayyad cultivar, the highest amount of biological yield, and for line D81083, the highest amount of biological yield, number of seed per pod and 100 seed weight were observed in densities of 25 and 35 plants.m^{-2}. For Sayyad cultivar, there were no significant differences among plant densities on number of pod per plant, and 100 seed weight. The lowest number of pod per plant of darakhshan cultivar was found in 35 and 15 plants.m^{-2} in weedy condition, but in line D81083 it was seen in 15 plants.m^{-2}. There were no significant differences for number of seeds per pods and 100 seed weight of Darakhshan cultivar between density of 25 plants.m^2 and weedy condition, and also for number of seeds per pods of Sayyad cultivar and line D81083 between density of 25 and 35 plants.m^2 and weedy conditions with density of 25 plants.m^2 and weed-free treatments. The lowest seed per pod for all genotypes were found in 15 plants.m^{-2} in weedy conditions. There were no significant differences between Darakhshan cultivar and line D81083 for indices of competition, ability withstand competition

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and yield loss, whereas competitive ability of Sayyad cultivar was lower than two other genotypes.

Conclusion: Generally, it would be concluded that regardless of some differences exist in weed competition effects on yield component, all three red bean genotypes were sensitive to weed infestation during growing season and showed considerable seed and biological yield reduction, especially in low plant densities (15 plants.m-2).

***Keywords*:** Full season competition, planting pattern, weed-crop interaction, yield reduction

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Investigation of phonological development and yield of different faba bean genotypes in Gorgan

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Abstract

Background and objectives: Faba bean (*Vicia faba* L.) is one of the most important legumes for its biological N_2 fixation, seed high protein content and its ability to grow over a wide range of climatic and soil conditions. Various faba bean genotypes are available which are attributed with high potential regarding grain yield-influencing traits. Detection of diversity is important for characterization of crop plant collections in order to detect the presence of valuable trait variation for use in breeding programs. Identification and introduction of high yielding genotypes may lead to increase in cultivation area and yield in unit area. An investigation was carried out to evaluate the phonological stages (growth and development stage), selection of the superior faba bean genotype(s) and to assess the genetic diversity present in the agronomic traits.

Materials and methods: This experiment was conducted at agricultural and natural resources research station of Gorgan in 2016-2017 cropping season using twenty-six genotypes of faba bean. The treatments were arranged in a randomized complete block design with three replications. Traits such as emergence rate, emergence uniformity, days from planting to flowering, days from planting to pod setting, days from planting to grain filing, days from planting to physiological maturity, number of branches per plant, plant height, Height of the lower pod, pod length, pods per plant, seeds per pod, 100-seed weight and grain yield were evaluated. For grouping of genotypes, cluster analysis was done on the Euclidean distance matrix with the Ward's method. The data were subjected to analyses of variance using the SAS and SPSS programs.

Results: There was a significant difference at $p<0.01$ among the genotypes regarding all studied traits. Results showed that the highest emergence rate, days from planting to flowering, days from planting to pod setting and days from planting to physiological maturity were associated with G-faba-18-2 (0.05 day^{-1}), G-faba-393 (129.66 days), G-faba-18-3 (150.66 days) and G-faba-393 (194.66 days), respectively. The highest pod per plant belonged to G-faba-393 genotype with 30.30. G-faba-8, G-faba-21 and G-faba-20 had jointly the highest seeds per pod with respectively 4.5, 4.66 and 4.56. The highest weight of 100 seeds belonged to G-faba-1-2 (203.1 gr). G-faba-8 (6314 $kgha^{-1}$), G-faba-7 (6206 $kgha^{-1}$), G-faba-1-2 (6118 $kgha^{-1}$) and G-faba-218 (5989 $kgha^{-1}$) produced the highest seed yield, followed by genotypes G-faba-20, G-faba-21, G-faba-5 and G-faba-332 were ranked. Cluster diagram using Ward's method for five traits, classified the twenty-six genotypes into three main clusters (I, II and III). Cluster I included 46.1% of total genotypes. The seeds per pod, 100-seed weight and seed yield of this

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cluster is more than the mean of total genotypes. Genotypes of cluster II could be used for increasing in grain yield for breeding programs.

Conclusion: The evaluated faba bean genotypes in this study showed significant phenotypic variability in terms of plant morphology, phenology and yield attributes. This variability showed suitable genotypes for the various agro- ecological zones of the country. Genotypes with appropriate number of seeds per pod, 100-seed weight and suitable pod length were able to produce more seed yield than other genotypes. G-faba-8, G-faba-7, G-faba-1-2 and G-faba-218 genotypes produced the highest grain yield per hectare. These genotypes had higher yield than Barakat cultivar, which is common in Gorgan. If these results are repeated in future experiments and stability of yield in the region, these genotypes can be used to achieve higher seed yield..

***Keywords*:** 100-seed weight**,** Cluster analysis, Plant height, Pod length, phenotypic variability.

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The effect of different concentration of humic acid foliar application in development stages on morphological characteristics and yield of Triticale

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Abstract

Background and objectives: Nowadays, triticale is considered as a high potential commercial crop in order to feed human and livestock. Regarding the fact that triticale is tolerant to inappropriate environmental conditions, it is an acceptable alternative for common wheat cultivation in inappropriate and low-fertile environments. Application of chemical fertilizers in cereal cultivation can lead to destruction of agro-ecosystems and cause environmental pollution. One of approach to solve this problem is use of sustainable agriculture principles in agroecosystems. One of these strategies is application of organic fertilizers such as humicacid. One of the important factors in the effectiveness of fertilizer is the application of concentration and time of consumption. Therefore, determination of the most suitable concentration and time of application of Humic Acid leaves in triticale is important. This experiment was conducted with the aim of determining the best concentration and time of foliar application of humic acids in order to increase the quantitative and qualitative yield of triticale in Khuzestan.

Materials and methods: The experiment was conducted at Research field of Agricultural sciences and Natural Resources University of Khuzestan during 2017-2018. Experimental design was a split plot based on randomized complete block design with four replications. Treatments included time of spraying at four levels as main plot (tillering, Stemelongation, flag leaf, pollination) and concentration at four levels as sub plots (0, 200, 400 and 600 $mg.lit^{-1}$). Traits included morphological characteristics, grain yield, yield components and qualitative characteristics were assessed in this experiment.

Results: Results showed that the effect of spraying time were significant on plant height, number of grain per spike and biological yield. The highest plant height (124.3 cm) was obtained from application of humic acid in stem elongation development stage and the highest biological yield (17438.33 $kg.ha^{-1}$) was gained from spraying of humic acid at flag leaf stage. Also, the interaction of time and concentration were significant on peduncle length, spike length, grain yield and harvest index. Highest grain yield (6796 $kg.ha^{-1}$) was obtained from200 $mg.lit^{-1}$ of Humic Acid application in flag leaf stage.

Conclusion: According to the results of this experiment, foliar application of 200 $mg.lit^{-1}$ humic acid in the flag leaf stage is recommended to gain maximum grain yield in triticale cultivation.

Keywords: Cereals, Foliar application, Grain yield, Organic Fertilizer.

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Effect of *Origanum vulgare* and *Thymus vulgaris* extract spraying on some of growth and physiological traits of sesame under different irrigation levels

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Abstract

Introduction: Limited irrigation leads to a wide spectrum of physiological and biochemical responses in plants, and one of the efficient plant mechanisms against water deficit for maintenance of cell turgidity is osmotic regulation. Nowadays, leaf spraying as complement to soil methods is effective against environmental stress. Since *Origanum vulgare* and Thymus vulgaris extract contain anti-oxidant compounds, it seems that these compounds may prove useful for reduction of stress intensity. Therefore, this research was carried out to investigate the effect of spraying of *Origanum vulgare* and Thymus vulgaris extract on some of growth and physiological traits *of Sesamum indicum* L. (Naz cultivar) under different irrigation levels.

Materials and methods: This experiment was conducted as split plot factorial in two years (at 2015 and 2016) as a randomized complete block design with three replications at Gorgan University of Agriculture. In this study, treatments included two different irrigation regimes include normal condition (every 15 days) and drought stress (every 25 days), three levels of *Origanum vulgare* extract include 0, 40 and 60 % and three levels of *Thymus vulgaris* extract include 0, 10 and 20 %. Irrigation regime levels were considered as the main factor and the levels of *Origanum vulgare* and *Thymus vulgaris* extract were assigned to sub plots. The first spraying application took place one month after planting and second and third placement at 12 days intervals.

Results: Results indicated that limited irrigation significantly reduced the measured indices of leaf area index, leaf dry weight, stem dry weight, fruit dry weight, plant height, chlorophyll a, chlorophyll b. The results also showed that limited irrigation increased content of flavonoid, carotenoid, Ca and K. The results of this study showed that using *Origanum vulgare* and Thymus vulgaris extract significantly improved the measured indices. Results indicated that the highest leaf area index (3.76 and 2.93), leaf dry weight (57.88 gr/m2), plant height (159 cm), chlorophyll a (21.7 mg g^{-1}Fw) and chlorophyll b (20.61 mg g^{-1}Fw) were attending in control conditions were associated with 60% *Origanum vulgare* and 20% *Thymus vulgaris* L. extract. The highest carotenoid (18.58 mg g^{-1}Fw), flavonoid (0.003 mg g^{-1}Fw), Ca (0.57 mg g^{-1}Fw) and K (2.97 mg g^{-1}Fw) were attending in limited irrigation conditions were associated with 60% *Origanum vulgare* and 20% *Thymus vulgaris* L. extract. It was found that the most measured indices in both control and also limited irrigation conditions were associated with 60 % *Origanum vulgare* and 20 % *Thymus vulgaris* essence. Application of plant extract (*Origanum vulgare* and *Thymus vulgaris* essence) was effective in both irrigation conditions (normal conditions and limited irrigation), but its effect was more pronounced under stress condition (every 25 days).

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Conclusion: Therefore, it can be stated that under dry conditions, the use of *Origanum vulgare* and *Thymus vulgaris* extract can induce tolerance in the plant in response to water deficit conditions. Since less cost is needed compared to other methods, therefore, in areas with low water conditions, it is recommended to use the *Origanum vulgare* and *Thymus vulgaris* extract.

Keywords: Calcium, Chlorophyll, Dry weight, limited irrigation, Plant extract**,** Potassium.

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Effect of different levels of irrigation water salinity on quinoa (*Chenopodium quinoa*) yield and yield components in spring cropping

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Abstract

Background and objectives: Increasing population and needs for food on the one hand, and the limitation of conventional water resources and the gradual development of soil and water resources salinity on the other hand, make sustainable approaches and practices for production by unconventional water and soil resources more important. One of these strategies for direct access to appropriate options and salinity tolerate was halophytes plants and species with inherent salt tolerance. Quinoa, as a facultative halophyte, had ability to growing in saline regions and irrigation with unconventional and very saline waters. This research was conducted to investigate the effect of different levels of irrigation water salinity on yield components, biomass dry weight, seed yield and harvest index of quinoa in spring cropping.

Materials and methods: This experiment was conducted in a lysimetric condition with completely randomized design with three replications in National Salinity Research Center at Yazd province in 2017-18 growing season. The levels of salinity were four levels 5, 10, 15 and 20 dS m^{-1} of irrigation water. Twelve weighting lysimers with length 85 cm, width 25 cm and a height of 30 cm were prepared and then each of the lysimeters were filled with a sandy loam soil with a bulk density of 1.4 g cm^{-3}. Seeds were sown at the beginning of March 2018; and the seedling were thinned to 10 plants per each lysimeter after reaching the four-leaf stage Irrigation carried out on the basis of soil moisture depletion at each irrigation considering about 20% leaching fraction. To control soil salinity, drainage water from the root zone was collected at each irrigation and its electrical conductivity was measured. At the end of the study, quinoa plants were manually harvested and dry biomass, grain yield and harvest index and traits such as plant height, etc. were measured after drying.

Results: The results showed significant decrease of quinoa yields, yield components and harvest index with increasing in irrigation water salinity. Increasing salinity from 5 to 20 dS m^{-1} resulted in 29.5%, 77.0%, 11.7%, 17%, 29%, 39%, 40%, 39% and 19% reduction in dry biomass yield, seed yield and harvest index, plant height, panicle length, panicle width, number of branch, number of panicle per plant, and 1000-seed weight, respectively. The results of correlation analysis revealed that seed yield and dry biomass (R^2=0.961**), plant height (R^2=0.952**) and number of branch (R^2=0.944**) were significantly correlated with grain yield.

Conclusion: Increasing salinity of irrigation water from 5 to 20 dS m^{-1} decreased biomass weight, seed yield and harvest index of quinoa in spring planting. However, there was no significant difference between salinity levels of 5 and 10 dS m^{-1} for seed yield, biomass weight and harvest index, but increase salinity more than 15 dS m^{-1} resulted to significant reduction of these traits.

Keywords: Harvest index, Quinoa, Salinity, Yield components.

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Evaluation of Freezing tolerance of deci-type chickpea genotypes (*Cicer arietinum* L.) in Mashhad climate conditions

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Abstract

Background and objectives: Low yield and instability, is one of the most important issues in chickpea cultivation. In most regions of Iran, chickpea is mainly planted in spring. Consequently, the plant will be exposed to abiotic stresses such as heat and drought during growth season, especially during the final stages of growth. To increase the chickpea yield, Autumn planting can be used, but low tolerance of common chickpea genotypes to freezing stress is a problem. Therefore, according to the benefits of autumn planting of chickpea, identification of freezing tolerant genotypes of chickpea along with suitable yield is a necessity. In this way, the present study was conducted as a field experiment to assess winter tolerance of 29 deci- type chickpea genotype in Mashhad conditions.

Materials and Methods: Experiment was conducted as Complete Randomized Block Design with three replications and 29 deci-type chickpea genotypes in research station of Faculty of Agriculture, Ferdowsi University of Mashhad in 2016-2017. Genotypes were supplied from seed bank of Research Center of Plant Sciences, Ferdowsi University of Mashhad and seeds were planted on November 1st. The lowest minimum daily temperature during the growing season was -13ºC. To calculate survival percentage, number of plants per each genotype was recorded 30 days after emergence and on March 15th. At the end of the growth season, plant height, number of main and secondary branches, pod number per plant, 100-seed weight, seed weight per plant, seed yield per square meter, biomass, biological yield and harvest index were measured.

Results: significant differences were found among genotypes according to all the studied traits. While only one genotype was entirely killed as a result of freezing stress, survival range differed between 8-100% for the other genotypes. Among all 29 deci chickpea genotypes, 11 genotypes were tolerant (76-100% survival) and five were relatively tolerant (51-75% survival). MCC890, MCC349 and MCC873 had the highest winter survival with 98.1, 95.7 and 95.2%, respectively. In total, 9 genotypes including MCC373, MCC884, MCC869, MCC916, MCC349, MCC386, MCC870, MCC291 and MCC876 produced high yield of 154g.m^{-2} (equivalent to 1540 kg.ha^{-1}) and all of these genotypes had higher survival percentage than 66.7%, except MCC916. Significant positive correlation were found between seed yield and survival percentage (r=0.76**), number of secondary branches (r=0.23**), pod number per plant (r=0.52**), 100-seed weight (r=0.38**), biological yield (r=0.59**) and harvest index (r=0.58**).

Conclusion: According to the results of the present study, it seems possible to achieve cold tolerant deci chickpea genotypes for cultivation in cold regions. Based on cluster analysis, two

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groups of genotypes including 1) MCC10, MCC49, MCC207, MCC890 and 2) MCC868, MCC918, MCC884, MCC386, MCC291, MCC349, MCC916, MCC373 can be used in breeding programs due to their superior attributes such as early- season cold tolerance.

***Keywords*:** Autumn planting, Biomass, Seed yield, Survival percentage.

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The effect of foliar spray of nano silicone and salicylic acid on physiological traits and seed yield of spring rapeseed at water limitation conditions

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Abstract

Background and Objectives: water limitation is often the most important preventive factor in spring rapeseed in semi-arid Mediterranean regions. The use of nutrient nanoparticles and exogenous plant growth regulators by influencing plant physiological processes can play an important role in tolerance to water limitation. The aim of this study was to investigate the changes of some physiological traits and seed yield of spring rapeseed in response to foliar spray of nano silicone and salicylic acid under water limitation conditions.

Materials and Methods: This experiment was conducted as a factorial split plot based on a randomized complete block design with four replications at the Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardebili, in 2017. Water limitation treatments (control or full irrigation, irrigation withholding at stem elongation, flowering and *seed formation* stages), and foliar spray of silicon in form of Nano- silicon dioxide ($nSiO_2$) at three levels (0, 60 and 300 $mg.L^{-1}$) and salicylic acid (SA) at three levels (0, 0.5 and 2.5 mM).

Results: The results showed that the main effects of experiment factors on physiological traits and seed yield are significant. The lowest value of leaf greenness index (SPAD) was observed on Full Irrigation, whereas the highest values were obtained from foliar spray 60 $mg.L^{-1}$ $nSiO_2$ and 2.5 mM SA under irrigation withholding at flowering stage. At full irrigation and irrigation withholding at seed formation stage treatments, the spraying of 300 mg / l $nSiO_2$ resulted in a significant reduction in the quantum efficiency of photosystem II (Fv/Fm) in compared to the lower level of $nSiO_2$. Foliar Spray 300 $mg.L^{-1}$ of $nSiO_2$ with SA consumption resulted in the reduction of electrolyte leakage from membrane (EC) compared to control treatment. In full irrigation, the highest value of relative water content (RWC) was obtained, especially with foliar spray 300 $mg.L^{-1}$ $nSiO_2$. Also in between different levels of SA, The foliar spray 2.5 mM SA caused the highest RWC trait. The highest seed yield was obtained from full irrigation In combination with 300 mg. L^{-1} $nSiO_2$ and 0.5 mM SA (2847.3 $kg.ha^{-1}$), and the lowest value was belonged to irrigation withholding at flowering and stem elongation stages without foliar spray of $nSiO_2$ and or SA.

Conclusion: It was concluded that foliar spray $nSiO_2$ and SA alone or combined in both conditions of irrigation and or water limitation showed a positive effect on physiological traits and seed yield, however a higher amount of $nSiO_2$ could have a deterrent effect on the positive effects of SA.

***Keywords*:** Electrolyte leakage, Relative water content, seed yield, SPAD.

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Effect of irrigation management and planting date on yield and productivity of rice (*Oryza sativa* L.)

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Abstract

Background and objectives: Lack of water resources and inefficiency of irrigation systems in rice fields, have made it necessary to optimize the usage style and increase the productivity of existing resources. It is necessary to find a crop water management approach with lower water consumption without affecting on the yield. Planting date is recognized as an effective factor on the different phonological stages of growth and finally crop yield.

Materials and methods: This research was carried out to investigate the effect of irrigation management and planting date on the yield and water productivity in rice cultivation (Hashemi cultivar). The experiment was performed as a split-plot experiment based on a completely randomized block design with three replications in two years of 2016 and 2017 in Rice Research Institute of Iran, Rasht. Irrigation interval was considered as the main factor in 4 levels including, flooding, 5, 10 and 15 days. Planting date was assigned to subplots at three levels (April, 21st, May, 11th and May, 31st).

Results: Based on the results, the effect of irrigation interval and planting date on the studied traits was significant at 1% of probability level. The highest paddy yield was observed flooding treatment (4271 kg per hectare) and the irrigation intervals of 5, 10 and 15 days with 3844, 3196 and 3264 kg/ha were in the next rank, respectively. According to the biomass yield, 15-day irrigation interval and flooding irrigation had the highest and lowest water irrigation productivity, respectively. In the study of different planting dates, the highest paddy yield (3795 and 3820 kg/ha, respectively) was observed on May, 11th, and May, 21th planting dates and the highest water productivity based on paddy and biomass yield was obtained on the April 21st planting date. The 5-day irrigation interval with a 10% reduction in paddy yield and saving 10% of irrigation rate was determined as the best irrigation management option under water-deficit conditions. The highest amount of water productivity was obtained in 10 and 15-day irrigation treatments, nevertheless, it is not defined as a logical option due to the significant decrease in yield compared to full flooding irrigation (with an average of 24 percent reduction in the paddy yield of rice and 14 percent reduction in the biological yield). Investigating the effect of irrigation combined with planting date on the amount of paddy yield reduction and water productivity, illustrated that the application of 5-day irrigation treatment in the planting date of April, 21st had the highest paddy yield as well as the least water productivity decline.

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Conclusion: Combination of planting date and irrigation interval can be effective in increasing paddy yield and water productivity by maximizing the use of the environment. Considering paddy and biomass yield of rice, water productivity and water consumption, five days irrigation treatment had the best paddy and biomass yield in April, 21st planting date. This treatment was the best treatment in terms of productivity and rice production, with 9% reduction in water use and 6% reduction in paddy yield of rice. Therefore, by using a five-day irrigation interval in the study area, water productivity increased by selecting appropriate planting date.

***Keywords*:** Irrigation, Planting Date, Rice, Water Productivity, yield.

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Evaluation of variations of agro-morphological traits in landrace lentil populations of Zanjan province and selection of superior genotypes in rainfed conditions

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Abstract

Background: The diversity of the genetic traits material is the basis of any breeding program and the existence of maximum variation is the greatest chance for success in the selection, especially in variable climatic such as rainfed conditions. Regarding the importance of lentil genetic resources for use in breeding programs of this plant, this experiment was conducted to investigate the diversity of important agronomic traits and selection of native lentil plants in dryland fields of Zanjan province.

Materials and Methods: For this purpose, 1040 plants of lentil from fields in five regions (including Khorramdareh, Khodabandeh, Ijrood, Mahneshan,and Zanjan (Armaghankhaneh) of Zanjan province were collected in the rainfed conditions at 2014-2015 cropping season. Plants were evaluated in terms of yield and morphological traits including plant height, height of the first branch from the ground, height of the lowest pod of the ground, number of pods, number of hollow pods, number of full pods, number of seeds, 1000-seed weight, seed weight, straw weight and biomass. To compare the populations of lentils, analysis of variance was performed in a completely unbalanced randomized design and populations were grouped by cluster analysis by Ward method. In order to select the best genotypes in each population, considering breeding goals, traits were sorted by degree of importance and superior genotypes were determined in each population.

Results: The results of descriptive statistics indicated a high variation among studied traits, especially number of hollow pods (117.98 %) and seed weight (55.82 %) also for height of first branch, number of pods, number of seeds and seed and straw weight great variations were observed. Therefore, the selection for these traits in evaluated populations seems to be effective. The lowest coefficient of variation was related to plant height (10.79 %), first pod height (18.83 %) and 1000-seed weight (25.90 %). Analysis of variance results showed that there were significant differences between them in terms of all measured traits at 0.01 level. Ejroud population had the highest mean for most of the traits evaluated. Cluster analysis categorized these populations into three groups. The Armaghankhaneh and Ejroud populations were each grouped separately, and the three populations of Khoramdareh, Khodabandeh and Mahneshan formed the third group. Ejroud population had the highest percentage of deviation from the total mean for yield traits and also morphological traits that are important for mechanized harvesting. Finally, 492 superior genotypes were selected for study in rainfed conditions based on experimental design for yield traits and effective traits in mechanized harvesting.

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Conclusion: There were suitable variations within and between the lentil populations in terms of agro-morphological traits. Cluster analysis also categorized these populations into three groups. Because of the difference in plants in different regions due to the genetic variation of the plants, as well as the impact of the climate and their different growth environment, therefore, for selection of superior genotypes, evaluation and selection were carried out separately in the regions. Since lentils are self-pollinated and cleistogam and have high rate of elf-pollination (99%), so the populations of the lentils are homozygous so the seeds of selected genotypes are pure lineage and the method of this study was selection of pure lines. Pure lines from selected genotypes can be used in breeding programs.

***Keywords*:** Genetic Resources, Lentils, Seed yield, Selection, Variation.

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Effects of cultivars and pre plant and post emergence herbicides on yield, yield component of *Pisum sativum*

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Abstract

Background and objectives: Weeds are a serious threat to peas filed and reduce the amount of its production. Pea plants due to slow growth and small size, has little competitive power and weeds can highly reduce its yield. Farmers are pushing for cheaper and easier alternatives, such as chemical control, because of the high cost of manual weeding. The purpose of this experiment was to investigate the tolerance of peas varieties including Shamshiri, Pofaki and Do-manzooreh against herbicides used in these fields as well as evaluation of their yield under different weed management treatments.

Materials and methods: The experiment was conducted as factorial in a randomized complete block design with three replications in Kalaleh, Iran. The first factor was the weed management method, including the recommended dose of Trifluralin herbicides (2 $L.ha^{-1}$, preplant), Imazthapyr (0.7 $L.ha^{-1}$, post emergence), a mixture of two Bentazone (2 $L.ha^{-1}$) and Haloxyfop-r-methyl (1 $L.ha^{-1}$) and the application of Haloxyfop-r-methyl and Bentazon separately at intervals of one week with of the above doses, weeding and weedy, and the second factor was cultivars of peas including Shamshiri, Pofaki and Do-manzooreh. At the end of the growing season, 10 peas were selected from each plot, and number of pods per plant, number of seeds per pod, number of seeds per plant, green pod per plant, 100 seed weight and pod yield were measured. To determine the grain yield, the rest of the plot was harvested and generalized to the hectare. After normalizing the data in Minitab software they were analyzed by SAS software. The comparison of the mean of the data was done by the LSD test and the shapes were drawn in the Excel software.

Results: The results showed that the highest number of pods per plant was obtained from Weed and Trifluralin treatments in the Domezorah cultivar, and the least of them were isolated from individual treatments of Bentazone and Haloxyfopromethylene. In the same cultivar, the highest values of the traits included the number of grains in pods, number of seeds per plant, green pod weight and 100 seed weight were recorded from weeding and Trifluralin treatments and the lowest values of these traits were obtained from separate treatments of Bentazone and Haloxyfop r methylene. The highest values related to the number of pods per plant and the number of seeds per plant were obtained from weeding treatment at cultivar Pofaki. The highest green weight of pod in Pofaki cultivar was obtained from weeding treatments and separate consumption of Bentazone and Haloxyfop-r-methylene. While the weight of 100 seeds in this cultivar was not affected by any management practices.In Shamshiri cultivar, the highest number of pods per plant, pod weight and 100 seed weight was obtained from Persuit treatment and the number of seeds per plant was highest in weed treatment.

Conclusion: Regarding the results of this study, it seems that the management of Trifluralin in Do-manzooreh cultivar has a better effect on weed control than the rest of the cultivars, while at

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the same time it has less adverse effects on this cultivar. In Pofaki cultivar, application of Trifluralin herbicide caused poor emergence of peas. Totally, Pofaki cultivar showed more susceptibility to herbicides than other two cultivars and in most cases, Weeding treatments showed better results than chemical treatments at this cultivar. In Shamshiri cultivar, the effectiveness of Persuit herbicide was higher than that of Trifluralin, so that the traits measured in this treatment were always more than other chemical practices.

***Keywords*:** Bentazone, Imazthapyr, Pod, Yield