



The occurrence probability estimation of climatic factors affected on rainfed autumn wheat and barley in agricultural lands of Aq-Qala, Kalale and Gonbad Kavous townships by spatial analysis of GIS

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Abstract

Background and objectives: The climate potential of agricultural lands for crop production is mainly influenced by the amount and distribution of rainfall and crop water requirement. Evaluation of environmental variables and predict climate phenomena can be help to determine suitable areas for rainfed agriculture. In dryland farming, there is a significant correlation between grain yield and soil moisture, that the soil moisture content can be affected on all phenological processes in crop especially grain filling and it leads a reduce in economic yield. In this research, the statistical distribution analysis of Smada software program and spatial analysis of Geographic Information System (GIS) were used to estimate the occurrence probability of climatic factors in agricultural lands of Aq-Qala, Kalale and Gonbad Kavous townships.

Materials and methods: This research was carried out in 391,533 ha areas of agricultural lands in Aq-Qala, Kalale and Gonbad Kavous townships (Golestan province) during 2015. Studied environmental variables were as annual, autumn, spring and May precipitations, optimum temperature of germination, optimum temperature in heading and grain filling stages. In this research, the occurrence possibility of these climatic variables predicted in the return period of 25 years and at 95% probability level, using Distrib 2.0 program of Smada software. Then the spatial distribution map was prepared for each climatic variables at 95% probability level using various methods of geostatistical and interpolation methods and classified in GIS media. The performance criteria for evaluation were mean absolute error (MAE), mean bias error (MBE), root mean square error (RMSE) and cross validation method.

Results: The results of occurrences probability of climatic variables such as annual, spring and May precipitations, and temperatures showed that these variables are suitable for rainfed cultivation of wheat and barley in these townships. But, the autumn precipitation can be a limiting factor for some studied areas, in the return period of 25 years and at the 95% probability level.

Conclusion: Despite supplying water requirements of wheat and barley in autumn season in the most parts of the studied region, there is a limitation in the north and northeast lands of Gonbad Kavous township. This zone covers about 7.40 % of the total area (28, 974 ha of agricultural lands) with 68.76-80.00 mm rainfall that it is classified to semi-suitable zone (S₃). The results of this research can be used in agricultural planning and future management of dryland farming in Golestan province.

Keywords: Geostatistical methods, Occurrence possibility, Rainfed wheat and barley, Smada.

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The effects of a surfactants and potassium fertilizer on soybean (DPX cultivar) yield components with water tension

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Abstract

Background and adjectives: Potassium fertilizers may increase soybean yield and potassium concentration in leaves. Surfactants are surface-active agents, with simultaneous hydro and lipophilic molecular structures and specific physical and chemical attributes such as surface tension. Surfactants may enhance potassium exchange between soil colloids and the solution through enhanced dispersion of water, which increases available potassium for plant use and yield specially in soils with high specific surface area and limited potassium exchange. The objective in this research was evaluating the effect of a surfactant and potassium fertilizer on soybean yield components with water tension.

Materials and Methods: This study were carried out in Gorgan University of Agricultural Sciences and Natural Resources estate using split plot in completely randomized block design in four replications. Treatments were two levels of potassium fertilizer (108.3 kg ha⁻¹K equivalent to 208 kg ha⁻¹ potassium chloride) and no fertilizer use as main plots and four levels of 2-1 propandiol surfactant (0, 2, 4 and 8 l ha⁻¹) as subplots. Soil water contents at 0-8 and 8-16 cm depths measured at four occasions during growing season (namely 143, 173 and 201 days after planting). Mechanical resistance at 0-5 cm depth was also measured in six occasions (namely 49, 69, 89, 109, 129 and 151 days after planting) using a pocket penetrometer. Yield components obtained at harvest.

Results: Maximum soil water content obtained by four liter per hectare surfactant and soil water content diminished as the rate of application decreased. Higher rates of applications lowered mechanical resistance at all stages of applications, which could be due to higher water content in fine pores. Potassium application increased final soybean yield and yield components significantly but surfactant affected biological yield only (at 5% significance level). Surfactant application without potassium fertilizer was ineffective on yield production, but increased yield in combination with potassium fertilizer. Surfactant reduces surface tension, which allows free dispersion of water and potassium in fine pores, which enter soil solution where roots thrive. More soil water with surfactant reduces soil mechanical resistance and increases root growth and potassium uptake by fertilizer application. In the Study of interactions between the surfactants and potassium fertilizer, the potassium fertilizer in combination with 4 liter per hectare surfactant produced maximum soybean yield, hundred seeds weight, seed number per shell, branch number, harvest index, seed number per unit surface, biological yield and plant number per unit surface. Potassium fertilizer in combination with 8 liter per hectare surfactant produced maximum plant height, node number in main stem and number of shells per branch.

Conclusions: By decreasing surface tension, surfactant improves dispersion of water within soil pores, which results in more surface-soil water retention and content. More soil water content diminishes mechanical resistance against root growth and increases soybean yield. Potassium fertilizer application in combination with 4 liter per hectare surfactant increased soybean yield significantly due possibly to more plant potassium uptake.

Keywords: Surfactant, Soil water, Soybean yield, Potassium

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Evaluation of adaptation of different varieties of Canola (*Brassica napus* L.) under the climatic conditions of Shirvan

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Abstract

Background and objectives: Canola (*Brassica napus* L.) is one of the most important oil crops in the world. It has placed in third rank after Soybean and Palm. Canola yield was 1592 and 1567 kg.ha⁻¹ in Iran and the world in 2003 respectively. It has increased 2125 and 2043 kg.ha⁻¹ in Iran and the world in 2014 respectively. Considering the importance of rapeseed oilseeds, by selecting and comparing the appropriate factors, it can be increased the quantitative and qualitative yields and is found the appropriate cultivars for the climatic conditions. Selection, introduction and expansion of adaptable and high yielding rapeseed varieties are a good ways to provide part of the edible oil needed by the country. It was showed that there is a direct linear relationship between the amounts of radiation is received by each pod and the number of seeds per pod. Also researchers have shown that accelerated development together with decreasing plant growth after flowering is the main factors in reducing yield. Some researchers examined the relationship between climate and production, and showed that weather information has a major role in the application of production models, especially in tropical regions, at different timescales. The yield of rapeseed varieties in a cool area with a long growth period is usually higher than the yield of the same cultivars in warm conditions and short growth period, and even in a region, yield when cultivars are planted on time is higher than a delay in planting. This research was conducted in order to evaluate the growth indices and yield and yield components of various rapeseed varieties and also assessing the adaptation of different cultivars to the climate conditions of the Shirvan area.

Materials and Methods: This experiment was conducted as randomized complete block design with four replications at Higher Education Complex of Shirvan, North Khorasan, during growing seasons 2014-2015 and 2015-2016. Treatments were included 18 varieties and 2 lines of canola. Before the plants showed elongation, aboveground biomass and LAI were measured from destructive sampling and it had been continued at intervals of 8 to 10 d until physiological maturity. Yield and components were measured at the end of the growing seasons. Prior to any analysis, the uniformity analysis of variances (Bartlett test) was performed that the error analysis was the same for two years. The cluster analysis was also performed using the mean distance (average) method.

Results: Results indicated that among the studied cultivars, in addition to the difference in terms of growth indices, including leaf area index and crop growth rate, the time to reach their maximum was different too. In the second year of experiment, because of significant decrease of radiation relative to the first year and consequently reduction of growth indices, leaf area

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index for the studied cultivars was decreased and it was one of the factors that limited grain yield in the second year. Positive and significant correlation of flowering duration with yield ($r=0.66^{**}$) and the number of pod.plant⁻¹ ($r=0.88^{**}$) has showed its importance in determination of yield. Also, the most important of stage at making yield was affected by environmental conditions such as temperature, radiation and rainfall. In order to investigate growth indices the cultivars based on cluster analysis were divided three groups including high (Bilbao), moderate (Karaje 3) and low (Sarigol) yield then from each group a cultivar as representative was selected. LAI for Bilbao was higher than Sarigol and Karaje3. Also, Sarigol was achieved maximum LAI earlier than two other varieties. There was strong correlation between yield and maximum dry matter accumulation ($r=0.81^{**}$). In the first year of experiment CGR and RGR were higher than second. The part of difference of yield between two years associated with reduced growth indices and another was decreased harvest index. Generally, biological yield, harvest index, days to achieve maximum leaf area index and number of pods per plant displayed 99% of the total yield- related changes.

Conclusions: It can be concluded that radiation was the determinant factor of yield and the occurrence of physiological phenomena, spatially leaf area index, with higher radiation was caused yield increase. The cultivars with higher leaf area index and also they were their leaf area index corresponded with higher radiation exposure (group A) had higher biological yield and hence more grain yield. In addition to biological yield, harvest index was another determinant of grain yield of cultivars, which was strongly influenced by flowering durability. Varieties whose flowering period was accompanied by more radiation (less cloudy days) had more flowering durability. Generally, biological yield, harvest index, days to achieve maximum leaf area index and number of pods plant⁻¹ displayed 99 % of the total yield- related changes.

Keywords: Harvest index, Leaf area index, Phonological characteristics, Seed yield, Solar radiation

Estimation of irrigated wheat yield (*Triticum aestivum* L.) using data of remote sensing data (Case study in Shahrekord County)

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Abstract

Background and objectives: In order to improve food security as one of the most crucial needs of the society, prediction and estimation of wheat yield should be considered by decision makers in the country. On the other hand, agricultural production is always at risk of climate and international markets changes, however, this risk is never completely eliminated, but we can estimate the yield before the harvest season to minimize them. Nowadays, one of the methods of yield estimating is using satellite- imagery. Remote sensing data allow estimating crop yield based on vegetation indices. The present study aimed to find a fast way with acceptable accuracy for predicting wheat yield in the field in Shahrekord County, Chaharmahal and Bakhtiari province, Iran by using Landsat 8 data.

Materials and Methods: In order to fulfill the goal three sets of Landsat 8 imagery data dated on June 4th, 20th and July 6th 2016 were downloaded from <http://earthexplorer.usgs.gov>. The acquisition dates were corresponded with milk, dough and ripening stages of wheat growth cycle. Concurrently three wheat cultivated farms were selected in the Shahrekord County, based upon surface area, homogeneity in wheat cultivated farms and satisfaction of landlords with sampling. Coordinates of samples were recorded using GPS device (Garmin etrex). In the whole, the yield of 60 plots (0.25 m²) from selected fields were used for yield prediction. The density of plants per plots was considered and the yield in each plot was estimated. Nine introduced vegetation indices by literature were considered and the correlation coefficients between indices' valued and estimated yields were calculated. The models were evaluated using the coefficient of determination (R²) and standard error of estimation (SEE), reduced variance (RV) and mean estimation error (MEE). Image processing and statistical analysis were carried out using ILWIS 3.3 and Sigma Plot 10.0 software, respectively.

Results: The results showed that among the imagery data, the highest correlation coefficients existed between wheat yield and vegetation indices developed by images dated on 20th June 2016 corresponded to wheat dough stage. The coefficients of determinations (R²) of models with vegetation indices NDVI, NRVI, OSAVI, RVI, SAVI, RDVI, DVI, EVI and GNDVI were 0.86, 0.86, 0.86, 0.86, 0.86, 0.83, 0.81, 0.80, 0.78, respectively. The results indicated that the most appropriate models were Polynomial and quadratic. The results also showed the potential of satellite images for yield prediction at pre-harvest stage with an accuracy above 80 percents.

Conclusion: According to this study appropriate utilizing of satellite images and field observation at dough stage aided yield estimation of wheat in semi-arid regions. The most appropriate indices for yield estimation were NDVI, NRVI and OSAVI. Among the statistical models, polynomial and quadratic models with the highest coefficients of determination were introduced as the best models. Based upon the results Landsat 8 data and field samples could be used for wheat yield forecasting which help decision makers managing the market for this strategic crop. The results should be tested in other similar climates.

Keywords: NDVI, Remote sensing, Satellite images, Vegetation indices, Yield prediction.

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The effect of CaCl_2 , MgSO_4 and KH_2PO_4 on micropropagation and minitubrization on potato (*Solanum tuberosum* L.)

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Abstract

Background and objectives: Potato (*Solanum tuberosum* L.) is the most important food plant and the fourth most important crop in the world. Potato micropropagation can be affected by some factors including the composition and amount of salt of culture medium c. In this study, the effect of increasing in macro element including CaCl_2 , MgSO_4 and KH_2PO_4 in culture medium on micropropagation and tuberization of potato using three Agria, savalan and Marfona cultivars in MS medium were examined.

Materials and methods: To investigate the effect of different concentration of CaCl_2 , MgSO_4 and KH_2PO_4 on plantlet growth, three separate experiments were performed with four levels (1, 1.25, 1.5 and 1.75 times as much of base MS medium). Each experiment was performed independent and according to a factorial experiment (macro element×cultivar) in a completely randomized design (CRD) layout with ten replications. After 30 days, the different traits were measured including shoot length per plantlet, mean of root length per plantlet, number of roots per plantlet, leaf size per plantlet, number of nodes per plantlet and mean of minituber weight per plantlet. Then the regenerated plants were acclimatized and cultured in the field conditions in Damavand city for minituber production and the end of growing season number of minitubers per plant and mean of minituber weight per plant were measured.

Results: The results of increasing CaCl_2 in culture medium indicated that the increasing this salt in medium some traits including shoot length per plantlet and mean of root length per plantlet was improved. The result of the effect of KH_2PO_4 in medium culture indicated that by using most of the salt concentrations in the culture medium, most of the studied traits were significantly better. Also, the use of high concentrations of MgSO_4 in the culture medium significantly improved the studied traits.

Conclusion: In general results indicated that the increased of this concentration in macro element in medium culture have significantly increased mean of root length per plantlet, number of roots per plantlet, shoot length per plantlet, number of shoots and number of nodes per plantlet in contrast with control which leads to increased micropropagation rates and save on labor and time. The increased of mean of root length per plantlet and number of roots per plantlet led to fewer plants adapted to be removed. However, in most cases increasing in concentration of macro element in culture medium did not improve number of minitubers per plant and mean of minituber weight per plant.

Keywords: *Solanum tuberosum*, Macro elements, Tissue culture

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Effect of Phosphate fertilizer in salinity stress conditions on Cadmium fate in the plant and qualitative characteristics of tobacco

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Abstract

Background and adjectives: The use of phosphate fertilizers in tobacco cultivation is an important step in increasing yield. Since Triple Super Phosphate (TSP) fertilizer has a low amount of cadmium (Cd), phosphorus of fertilizer and salinity of irrigation and soil have interaction effect on the mobility and absorption of this element, therefore the exact determination of the absorbed Cd by the tobacco plant is crucial due to the use of TSP Fertilizer and different irrigation salinity stresses on the fate of absorbed Cd by tobacco and its smoke. Tobacco resistance to the salinity of sodium chloride was under 50 mM, and the salinity of 50 mM and more, reduced the photosynthesis and yield of the tobacco plant.

Materials and Methods: This study was carried out to investigate the interaction of three factors of TSP, irrigation water salinity, and soil Cd contamination on the Cd in the plant and qualitative characteristics of tobacco in Bardaskan city, 2016 and in the greenhouse condition. Irrigation salinity was at 3 levels of 0, 20 and 40 mM of NaCl, TSP was at two levels of 0 and 1.5 g.kg⁻¹ and soil Cd contamination were at two levels of 0 and 12 mg. kg⁻¹ soil in a factorial arrangement in a completely randomized design experiment. Data were analyzed by SAS statistical software and Tukey test was used to compare the means.

Results: The results of this study showed that the use of TSP in Cd-contaminated soils at 0, 20 and 40 mM salinity levels, increased shoot Cd concentration of the tobacco plant by 3.43, 4.94 and 33.3, 4 times of root Cd concentration and by increasing the salinity, the concentration of Cd in both root and aerial parts of the plant increased. With the increase in salinity from zero to 20 mM, the concentration of Cd in the smoke of cultivated tobacco in contaminated soil with Cd increased by 65% compared to zero salinity. Increasing salinity from zero to 40 mM, increasing the concentration of Cd in smoke Tobacco reached 83.2%. The application of TSP at all salinity levels showed an increase in the dry matter and root growth, concentration and amount of root and shoot Cd.

Conclusion: In 40 mM irrigation water, TSP caused the highest shoot Cd concentration in tobacco plant compared to the control, and the combined effects of both salinity and TSP factors were more than each of them separately. In all three levels of irrigation salinity, RF, TF and EF increased in the presence of TSP. The highest RF amount was observed with 1.71% in Cd-contaminated soil without TSP and in salinity of 20 mM irrigation water. As the salinity levels increased, EF increased, but the RF increased to 20 mM, and then the decrease was observed. With increasing salinity of irrigation water from 0 to 20 mM NaCl, Cd content of plants grown in Cd-contaminated soils increased by 33.7%, but this increase for 40 mM was 26.31%. With increasing sodium chloride irrigation up to 20 mM, Cd content of the tobacco plant increased. The application of TSP in high salinity of irrigated water and Cd-contaminated soils caused more Cd absorption by tobacco plants, so in which soil and water conditions, fertilization should be restricted.

Keywords: NaCl, Remediation Factor, Soil contamination, Triple Super Phosphate Fertilizer

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Inoculation effect of phosphatic microbial fertilizers containing temperature resistant phosphate solubilizing bacteria on nutritional indices of *Zea mays* L.

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Abstract

Background and objectives: One of the most important microbial fertilizers is phosphate microbial fertilizers, it can be prepared in liquid, powder or granular form, which after mixing the constituents, should be used for gentle heating (40-50 °C) to dry the fertilizer, such conditions will eliminate the bacteria that are added to the carrier. The use of temperature resistant phosphate solubilizing bacteria in granular phosphate fertilizers is one of the strategies to overcome the limitations of these fertilizers production.

Materials and Methods: In this research, the efficacy and effectiveness of phosphatic microbial fertilizers prepared from two temperature resistant phosphate solubilizing bacteria RPS9 and RPS7 and a non-temperature resistant bacterium PS4 (three bacteria belonging to *Pantoea agglomerans*) in the basal formulation of rock phosphate (45 g), sulfur (15 g) and bagasse (30 g) was evaluated on maize (cv. S.C.704). This experiment was done in green house condition and in completely randomized design with three replications. The research was conducted with seven treatments including negative control (without microbial fertilizer and chemical fertilizer), positive control (TSP based on 50% and 100% soil fertilizer recommendation), carrier without bacteria, three Phosphatic microbial fertilizers containing separate various bacteria PS4 , RPS9 RPS7. The irrigation of the pots was carried out through weighing at 0.8 FC.

Results: the results showed that the application of phosphatic microbial fertilizers significantly influenced on the total fresh, dry weight and uptake of phosphorus, potassium, iron, zinc in both root, and shoot tissues. The PS4 microbial fertilizer application had the highest amount of phosphorus absorption and in this regard was treated with chemical treatments SPT (100% and 50%) in same group and increased the rate of absorption of phosphorus by 25.07% compared to negative control and 23.49 % compared to control without carrier. In potassium parameters of the plant were also treated with SPT fertilizer (100%) and PS4 microbial treatment led to highest potassium uptake with average of 585.6 and 511. 3 (mg / plant), respectively. PS4 and RPS9 microbial treatments in the supply of phosphorus and potassium of the corn plant had performance similar to SPT. RPS9 of microbial fertilizer in the Fe parameter and RPS7 in Zn parameter had the highest performance.

Conclusion: Inoculation of microbial fertilizers containing plant growth promoting bacteria has stimulated plant growth and we have seen the incremental effects of measured parameters. PS4 bacterial treatment was similar to triple super phosphate treatment (100%) and RPS9 treatment was similar to triple superphosphate (50%). RPS7 has lower performance than two other isolates. Among the two newly-released temperature resistant isolates, both of which are *Pantoea agglomerans*, it seems rational to use RPS9 for this purpose.

Keywords: Bio-fertilizer, Phosphate solubilizing bacteria, Effectiveness, Temperature resistance

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Evaluation of drought tolerance of wheat cultivars under water deficiency stress after flowering

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Abstract

Background and objectives; In semi-arid regions, including large areas of Iran, decreasing soil moisture due to lack of rainfall and abrupt increase in temperature during the grain filling period, which is one of the most important factors in reducing growth of wheat, is a predominant climatic phenomenon. By recognizing the effects of drought stress and determining biochemical and molecular reactions to drought, the best response of the plant can be identified and used in breeding programs for select and produce new cultivars. The aim of this study was to investigate the effect of drought stress after flowering on some of the biochemical and antioxidant compounds of bread wheat cultivars and to identify some of characteristics of tolerant cultivars; those could increase both the tolerance and the production of yield in such conditions.

Materials and methods; Experiment was carried out in a field in north Aq-Qala, in a split plot model based on a complete randomized block design with three replications in 2016-2017. Moisture treatments in the main plots were consisted of optimal irrigation during the growing season (A1), irrigation interruption from the start of seed filling (A2), and irrigation interruption from the flowering stage (A3). And cultivars treatments in the sub plots were four wheat cultivars. In this experiment, the amount of optical pigments (chlorophyll a, b, and carotenoids) were investigated as sources of photosynthetic materials production, changes in the amount of water soluble carbohydrates (WSC) during the stress period as a compensatory source of grain, as well as the content of malondialdehyde (MAD) as the amount of damaging the cell membrane and the activity of superoxide dismutase (SOD) and peroxidase (POD) enzymes as plant enzymatic resistance against oxidative stress.

Results: The results of this experiment show the grain yield was reduced, with increasing tension, from 535 g/m² in A₁ to 464 g/m² in A₂, and 437.6 g/m² in A₃. With increasing tension the amount of remobilization of WSC to seed from A₁ to A₂ and A₃ was increased from 16.8 to 29.9 and 37.5 mg/g respectively. The cultivars of Kuhdasht and Karim (35.9 and 33.3 mg/g, respectively) indicated that they had better WSC remobilization than Ehsan and Gonbad (17.1 and 25.8 mg/g respectively). The activity of peroxidase and superoxide dismutase enzymes did not show any significant differences among Tolerant and sensitive cultivars under full irrigation conditions, but the activity of these enzymes in treatments of irrigation cutting in Kuhdasht and Karim cultivars was more than Ehsan and Gonbad. The content of malondialdehyde increased further with increasing water stress in Ehsan and Gonbad cultivars compared with Kuhdasht and Karim cultivars

Conclusions: The results showed that under drought stress conditions, the more increase of activity of antioxidant enzymes, POD and SOD, in Kuhdasht and Karim cultivars, compared with Ehsan and Gonbad ones, prevented more damages of oxidative stress on cell membrane

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so causes lower MAD content. The cultivars of Kuhdasht and Karim showed that under post-flowering stress conditions, could maintain a higher chlorophyll a, b and higher carotenoids as sources of photosynthetic material production. This feature enabled them to sustain higher yields under drought conditions by continuance of further production of photosynthetic materials and securing more seeds. The results also indicated that Kuhdasht and Karim cultivars had higher remobilize of SWC than those of Ehsan and Gonbad.

Keywords: Chlorophyll a, Cell membrane oxidation. Superoxide dismutase, Water soluble carbohydrates.

The effect of planting patterns and irrigation intervals on quantitative and qualitative yield of forage maize under drip irrigation system in Pishva-Varamin

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Abstract

Background and adjectives: According to the country's position in terms of water resources, implementation of newest plant pattern methods and application of advanced irrigation systems can be help to reduce existing threats. The aim of this study was to reduce irrigation water and to keep the highest crop yield.

Materials and methods: For this purpose, the evaluation of the irrigation interval and planting pattern on the yield of forage maize (cultivar ZP434), an on-farm experiment was conducted in Chaltazian, Pishva, as split-plot based on Randomized CompleteBlock Ddesign with three replications at 2017. This experiment in which main plots were irrigation intervals and sub-plots were planting patterns. Sub-plots size were 9 × 8 m. Irrigation treatments were carried out at three levels of 4, 6 and 8day intervals (I1, I2, and I3, respectively) with the same time and amount of water in each irrigation interval by drip irrigation. Treatments of planting pattern were also arranged in three levels of one row with spacing of 70 cm, two rows with spacing of 70 cm and two rows with spacing of 140 cm (P1, P2 and P3, respectively). P1 and P2 are the traditional planting patterns in Iran, and the P3 was considered as the newest arrangement of corn cultivation. In this experiment, a set of quantitative traits (stem diameter, plant height, number of grain per spike, spike weight, the ratio of spike weight to biological weight, the percentage dry material, fresh yield per hectare and dry yield per hectare), Qualitative traits (crude protein, percentage of neutral detergent fiber, percentage of acid detergent fiber, ash, crude fat, percentage of Non-fiber Carbohydrates) and the traits related to economic profit and water use efficiency were studied.

Results: results showed that irrigation treatments had significant effect on stem diameter, plant height, the ration of ear weight to total weight, the percentage of dry matter and forage yield at 0.05 of probability and dry matter yield (ha⁻¹) at 0.01 of probability. Also, the effect of planting pattern was significant on plant height (at 0.05 of probability) and stem diameter, number of seeds per ear, ear weight, the ration of ear weight to plant weight, yield (ha⁻¹) and dry yield (ha⁻¹) (at 0.01 of probability). Also, the results of quality analyze showed that irrigation treatments and plant pattern had significant effect on crude protein and crude fat at 0.05 (crude protein on irrigation treatments and crude protein and crude fat on plant pattern treatments) and at 0.01 (the irrigation treatments on crude fat). The interaction effect was significant on water use efficiency, gross profit and net profit. The result of water use efficiency showed that in all irrigation treatments, P3 was the best treatment. I2 was the best irrigation treatment for the net profit, and by checking the results of slicing the interaction on

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I2 irrigation treatment we found, they had no-significant effect between plant pattern treatments.

Conclusion: The current study, indicated that irrigation with 6 days interval against 4 days interval can produce the same crop yield using lower water in irrigation. Also, planting pattern of two rows with 140 cm space used lower water compared with one row with spacing of 70 cm, and two rows with spacing of 70 cm. Totally, results indicated the new planting pattern of P3 and irrigation interval of I2 used 3200 m³.ha⁻¹ and the highest crop yield compared with two other planting patterns in I3 that used 5900 m³.ha⁻¹ water. Using the new planting pattern irrigation water reduced and crop yield and the economic efficiency were at the highest level. The quality of silage also had not changed significantly.

Keywords: Dirp tape, Economic profit, Plant density, Water use efficiency.

The effect of weed interference duration on yield and yield components of cumin (*Cuminum cyminum* L.) in irrigated and rainfed condition

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Abstract

Background and objectives: Cumin is one of the most important medicinal plants, due to its specific characteristics and its cultivation area of 18,000 hectares, it has the first rank among cultivated medicinal plants in the country. Khorasan Razavi is one of the most important producers of this crop. Annually, Cumin cultivated on 8100 ha as irrigated and on 4000 ha as rainfed. One of the main problems of producing this valuable herb is the less competitive ability with weeds, so that weed competition can reduce the grain yield by up to 92%.

Materials and methods: To investigate the effect of weed interference duration on yield and yield components of Cumin (*Cuminum cyminum* L.) in irrigated and rainfed condition, a field experiment was conducted in Sabzevar in 2013-2014. Experiment was conducted as split plot in a randomized complete block design with three replications. Experimental factors were cultivation method (irrigated and rainfed) as the main plots and duration of weed interference (0, 15, 30, 45, 60 and 75 (weedy) days after emergence) as sub plots. In irrigated conditions, four irrigation stages were carried out during planting, branching, flowering and seeding, while in rainfed conditions only one irrigation time was carried out at planting. Other agricultural operations were similar in both conditions. A three parameter logistic equation was used to determine the beginning of the onset of reduced yield based on the duration of the weed interference period.

Results: The results of analysis of variance showed that irrigated cultivation had more weed dry weights, number of umbrellas per plant, number of seeds per umbrella, biological yield and economic yield than rain-fed, which had a significant difference with rainfed cultivation method, while weed density and number of lateral branches were not affected by cultivation method. Means comparison showed that irrigated condition had 1.92% and 26.22% more weed density and weed dry matter compared with rainfed condition, respectively. In irrigated condition, Cumin had more plant height, number of branches, number of umbels per plant, number of seeds per umbels, biological and economic yield than rainfed condition. Increasing of interference duration was decreased plant height (24.28%), lateral branches (33.37%), the number of umbels per plant (30.99%), the number of seeds per umbels (43.88%), biological yield (45.25%) and economic yield (44.81). In both irrigated and rainfed condition. Increasing of weed interference was decrease yield and yield components of cumin which decline was higher in rainfed conditions. Fitted logistic regression function coefficients showed that the onset of yield loss was earlier (23.15 days after emergence) in rainfed condition while in irrigated condition the onset of yield loss was postpone to 28 days after emergence. The critical timing of weed removal to prevent 5% grain yield loss was 14 and 16 days after

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emergence and 10% grain yield loss was 18 and 25 in irrigated and rainfed condition, respectively.

Conclusion: In conclusion, results showed in both irrigated and rainfed condition, weed interference reduces economic yield. In rainfed condition weed interference until 23 days after emergence and in irrigated condition weed interference until 28 days after cumin emergence had not significant reduction on yield.

Keywords: Cumin, Competition, cultivation method, interference, yield loss.

Determining type of seed dormancy in milk thistle (*Silybum marianum* L. Gaertn): Effects of after-ripening and gibberellic acid treatments under different temperatures

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Abstract

Background and objectives: Medicinal plants are important economically as they are used in raw or processed forms in traditional or modern industrial medicine. Nowadays, the increased market demands have resulted in extraordinary and inappropriate harvest of these plants, destruction of their natural habitat associated with the increased risk of extinction. Therefore, it is necessary to cultivate and domesticate these plants to prevent their excess utilization in natural habitats. The presence of dormancy in seeds of medicinal plants is one obstacle for domestication of these plants. Milk thistle (*Silybum marianum* L. Gaertn) is a medicinal herb from the Asteraceae family, whose seeds contain valuable medicinal compounds. The presence of seed dormancy in this species is the primary problem in the domestication process as it leads to the non-uniform germination and also emergence in the field. Accordingly, the first step in the domestication of any wild plant is to identify its type of seed dormancy with the aim of introducing the most effective method to release it. Therefore, the present study was conducted with the aim of: 1) determining the type of seed dormancy; 2) studying the germination reaction of milk thistle seeds to different levels of gibberellic acid and after ripening under different temperature conditions.

Materials and Methods: This research was carried out as two separate experiments on freshly harvested and after-ripened milk thistle seeds with combined analysis based on a Completely Random Design, with the aim of investigating the effects of various concentrations of gibberellic acid on seed dormancy release and germination of this plant under different temperatures in 2018. After-ripening treatment was carried out for five months storage at $7\pm 1^{\circ}\text{C}$. In each experiment, the germination test was carried out on seeds incubated at 5, 10, 15, 20, 25, 30 and 35°C and supplied with different levels of gibberellic acid at five (0, 500, 1000, 1500 and 2000 ppm) levels. In each experiment, traits such as percentage, rate and uniformity of germination, along with time to germination, were determined. The response of these traits to after-ripening treatment, temperature and gibberellic acid were then investigated.

Results: The results showed that freshly harvested and after-ripened seeds of milk thistle could not germinate at any temperature; however, using gibberellic acid they germinated at varying temperatures. In spite of this, the responses of freshly harvested and after-ripened seeds to gibberellic acid were different. In freshly harvested seeds, percentage, rate, and uniformity of germination were less than those in the after-ripened ones. Also the time to start germination in the after-ripened seeds was less than the figure for freshly harvested seeds. In other words, it can be said that although after-ripening did not remove the seed dormancy of milk thistle, but it increased seed sensitivity to gibberellic acid, so that maximum percentage

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and rate of germination occurred at lower concentrations (500 ppm) of gibberellic acid. After-ripening also increased the optimum and ceiling temperatures for germination of this plant as compared to freshly harvested ones. The optimum temperatures for the freshly harvested and after-ripened seeds were 10 ° C and 25 ° C, and the corresponding ceiling temperatures were 30 ° C and 35 ° C, respectively. However, there was no significant difference in base temperature between the freshly harvested and after ripened seeds. In other words, it can be said that the after-ripening increases temperature ranges of germination in milk thistle seeds treated with gibberellic acid.

Conclusion: In general, the results of this study showed that milk thistle seeds have non-deep physiological dormancy, which can be removed by gibberellic acid. After-ripening treatment did not release seed dormancy, but increased the sensitivity of seeds to gibberellic acid. Also, after-ripening treatment increased the ranges of temperatures suitable for germination of milk thistle seeds treated with gibberellic acid.

Keywords: Cardinal temperatures; Sensitivity to gibberellic acid; Physiological [dormancy](#); Medicinal plants.