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Agroecological evaluation of Gonbad-e-Kavous township for rainfed wheat cultivation by spatial analysis of geographic information system (GIS)

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Abstract

Backgroun and objectives: Wheat is grown worldwide in agricultural lands under different cropping systems. About 66% of cultivetid area of wheat in Iran was belonged to ranifed cropping systems. Current estimation showed that Iran needs to approximately 25 billion ton of wheat in 2021. Land suitability for a particular agricultural crop such as wheat requires consideration of many criteria. Evaluation of the environmental components and understanding of local biophysical restraints can help to determine the suitable areas for agricultural landuse. Topographic characteristics, climatic conditions and the soil quality of an area are the most important parameters to evaluate land suitability. The objective of this research was evaluation of environmetal variables and agroecological zoning of Gonbad–e-Kavous township for rainfed wheat cultivation by potential and spatial analysis of geographic information system (GIS) and analytical hierarchy process (AHP).

Mterials and methods: At the fisrt agroecological requirements of crop identified according to scientific resources. Then, thematic requirement maps were provided. In this research, studied environmental variables were annual, autumn, spring and May precipitations, average, minimum and maximum temperatures, germination temperature, the maximum temperature in heading and grain filling stages, slope percent, elevation, slope aspect, OM, pH, and EC. Then, each layer was classified into four classes (high suitable, suitable, semi- suitable and unsuitable). The analytical hierarchy process (AHP) was used to determine the weight of criteria by using the questionnaires analysis sheet. In final, by weighted overlay technique in geographic information system (GIS) media, land suitability map was generated in 4 classes.

Results: In this study, the results showed that about 9.20% and 24.73% of agricultural lands in Gonbad–e-Kavous township were located in the high suitable and suitable zones for rainfed wheat cultivation, respectively. These regions were identified in the south of this township. In these zones, there are not limiting factors for wheat cultivation according to precipitation and temperatures variables, slope percent, elevation and soil characteristics. In this evaluation, the semi- suitable (39.92%) and unsuitable (26.15%) regions were located in the some areas of central, north, and east north of Gonbad–e-Kavous. In addition, these areas were faced by at least one limitation factors from environmental variable.

Conclusion: In this research, it was identified that 33.93% of studied area was suitable for wheat cultivation according to topography and climatic conditions and there is not limitation for these variables.The limiting factors in semi- suitable and unsuitable regions were including: low annual and spring precipitations, low content of organic matter and high soil salinity.

Keywords: Environmental variables, Geostatistical, Gonbad–e-Kavous, Land suitability, Rainfed wheat

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Comparison of two methods for fitting boundary line in yield gap analysis: Case study of rainfed wheat in Golestan province

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Abstract

Background and objectives: In the recent year, due to increasing concerns about the future food security, researches in this field are growing globally and it requires to use proper statistic methods for estimation the amount of yield gap and determination of its causes. In dryland management, optimization of vegetative growth before flowering in order to maximize the utilization of available water in the soil is a fundamental principle and consequently management factors such as planting date, seeding rate and amount of fertilizer nitrogen (N) use can determine the amount of vegetative growth before flowering. Boundary line analysis is a statistical method that can quantify the response of yield to an environmental or management factor in a situation in which other parameters are variable. The objectives of this study were to introduce, use and comparison of two methods for fitting boundary line to determine the best managements and simultaneously estimate potentials and calculate wheat yield gap in three county of the Golestan province include Aqqala, Gomishan and Kalaleh. One, the common method based on the least squares (LS) method and another method based on linear programming (LP) so that no point is fall above the drawn line.

Materials and methods: For this study, the required information were collected from 332 wheat field during two growing season of 2014 and 2015 in Aqqala, Gomishan and Kalaleh. The investigated management factors included planting date, seeding rate and amount of nitrogen fertilizer (N) use (at the base and the road). To fit a boundary line using LS method, a curve was fitted through the maximum yield points based on the least squares method. However in LP method, a curve was fitted on the top edge of the data so that any point is not fall above the drawn line. For this purpose, the parameters of the function were changed so that the total remaining was at the lowest level, in the condition that no single negative remaining was left. Then, the optimum of each specific management factor was recognized and finally with estimating potential yield and minus the average yield in each county, yield gap was calculated for each and all factors.

Results: The results show the optimum of each specific management factor to reach the potential yield and optimum planting date, seeding rate and optimum nitrogen (N) use in each county were determined. The average wheat yield in drylands of Aqqala, Gomishan and Kalaleh was about 2600 kg ha^{-1} and also potential yield was about 4700 kg ha^{-1} according to LS method and 4800 Kg ha^{-1} according to LP method. So there is a yield gap about 2000-2100 Kg ha^{-1} (44-45%). It should be noted that these results are not conclusive and it would be required to several years of testing to achieve the optimal range of each region.

Conclusion: LP method doesn't require dividing independent factor and determining the boundary point, and also the fitted curve done with participate of all the data. In other words, all points have their impacts on the drawn curve and this is the advantage of this method. However the lack of involvement of user experience to choice the ideal points for fitting the curve would be the weakness of this method, it seems that each of these methods in certain situations-depend on the type and distribution of data- can be useful. So user after drawing the scatter plot of data should choice the best method to fit line to the data.

Keywords: Food security; Dryland management; Boundary line analysis; Least square; Liner programming.

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Evaluation of salinity tolerance of the fifth generation (M5) of bread wheat lines using some indices of stress tolerance

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Abstract

Background and Objectives: The basis of breeding programs is the presence of genetic diversity. The role of nuclear radiation to create genetic diversity has been well documented. Mutations induced by irradiation with gamma rays has had a significant role in improving the lot of important agronomic traits in plants. Salinity stress every year affects crops in large areas of the country. Since crops' yield is reduced due to the salt toxicity, hence the production and introduction of high yielding salinity tolerant varieties can minimize the phenomenon effect.

Materials and Methods: In order to determine some stability indices related to wheat grain yield the fifth generation (M5) under salinity conditions, 15 selected lines from the fourth generation (M4) with two parents' genotypes (‘Arg’ and ‘Bam’) and two genotypes produced in Yazd region (‘Sivand’ and ‘Narin’) were planted under both conditions of non-stress (2 dS m^{-1}) and salinity stress (10 dS m^{-1}) in research field of the National Salinity Research Center (NSRC) in Yazd province. Each plot included two rows in 1 m long with a row spacing of 20 cm. During the growing season, to determine the soil salinity in the root growth zone the soil sampling was carried out to a depth of 0-90 cm. The average salinity under conditions of non-stress and stress was obtained 2.3 and 9.7 dS m^{-1}, respectively. Analysis of variance for a complete random block design was performed on grain yield, yield components and sodium and potassium ions traits and the Comparison of means was conducted by least significant difference (LSD) test. Tolerant indices of mean productivity (MP), geometric mean productivity (GMP), stress tolerance index (STI), Stress stability index (SSI), Tolerance index (TOL) were calculated to investigation salinity. Also, Pearson correlation, stability analysis and cluster analysis was performed

Results: The results of analysis of variance for grain yield and yield components showed the genetic diversity among lines. Line two (Arg-200 gray, 246.67 g m^{-1}) and one (Bam-150 gray, 165.55g m^{-1}) had the highest grain yield, K^+ and K^+/Na^+ ratio and the lowest and Na^+ ions under both conditions. Also, lines tolerant to salinity had a lower level of Na^+, high level of K^+ and a higher K^+/Na^+ ratio under salinity stress conditions to sensitive lines. Regarding the positive and significant correlation between grain yield in both conditions and indices of MP, GMP and STI, the indices were selected as the most desirable tolerance indices. According to three-dimensional graph Fernandez were introduced that lines one, two and eight as the most tolerant lines to salinity stress.

Conclusion: The experiment results showed, indices of MP, GMP and STI are the most suitable indices for selection of lines tolerant to salinity. Lines one, two and eight had high grain yield under both conditions. So, according to the results lines one, two and eight can be introduced as stable lines and with high yield under salinity stress conditions and the fifth generation and it is recommended to introduce these three lines for cultivation in the sixth generation.

Keywords: Wheat, Grain yield, Salt stress, K^+/Na^+, Tolerance indices

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Effect of Different Salinity Levels on Yield and Yield Components of Two Wheat Cultivars in Birjand Plain

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Abstract

Background and objectives: Indiscriminate harvesting water from underground resources (in the recent two decades) phenomenon intrusion (interference saline aquifer in fresh water) in most of South Khorasan plains and the every day the volume of brackish water area will be added. The aim of this study was to investigate the effects of salinity on yield, yield components and protein content of two varieties of Ghods and Roshan, and determination the efficiency of water use and the effect of changes in irrigation water quality on economic indicators and net income.

Materials and methods: The experiment was split plot in a randomized complete block design with a factorial arrangement of two wheat varieties as main plots and salinity of irrigation water at three levels (1.4, 4.5, and 9.6 dS m^{-1}) as subplots in three replications.

Results: Variety and salinity stress factors had a significant effect on grain yield, thousand seed weight, harvest index and biological yield, increasing salinity, increased the protein content of two varieties. Roshan variety had 26% higher seed yield and 5% higher protein content than Ghods. Salinity decreased relative water use efficiency (WUE), but the value of all treatments, for Roshan was more than Ghods. The effects of salinity on yield indices of two wheat varieties showed that based on absolute value of final production (VMP_{ECw}) and final production (MP_{ECw}) indexes, Ghods was more sensetive than Roshan. At S1, S2 salinity level (1.4 and 4.5 dS m^{-1}) net income in Roshan was1.4 and at S3 level was 2 times more than Ghods.

Conclusions: Due to the increasing yield and protein content higher than 26 and 5 per cent in Roshan in comparison to Ghods variety, Roshan recommended in saline condition. Relative reduction in water use efficiency with increasing salinity in Roshan was higher than Ghods. The evaluation of economic indicators, performance and revenue showed that Roshan was more salt tolerance than Ghods and in higher salinity net income was higher than Ghods, then cultivation of Roshan with unsuitable water was more cost-effective.

Keywords: Salinity stress, Water use efficiency, Grain protein, Economic evaluation, South Khorasan

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Soybean Yield Prediction as Function of Nitrogen Fertilizer and Plant Density Using Artificial Neural Network (ANN)

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Abstract

Background and objectives: Many factors, including climatic conditions, planting date, planting pattern, plant populations, and nutrition can cause a variety of yield through the impacts on the plant. Also, since Iran is located in arid and semi-arid regions, the amount of organic matter in its soils is low, for this reason, it has low levels of nitrogen. Most plants are faced with a lack of nitrogen in these regions, which are compensated through organic and chemical fertilizers; in this regard, nitrogen fertilizers play an important role in plant production. Also, the increasing demand for agricultural products and problems of access to field data, reveals the necessary of using the appropriate models to predict crop yield. The aim of this research was to study the effect of nitrogen fertilizer and plant density on yield and yield components of soybean (Variety Gorgan 3) and also prediction this parameter by using the artificial neural network.

Materials and methods: Two major factors in randomized complete block design were investigated in this research in three replications on soybean (variety Gorgan 3); nitrogen fertilizer in three levels (100, 200 and 300 Kg ha^{-1}) and plant density in three levels (100,000, 150,000 and 200,000 plants ha^{-1}). Ten plants were randomly selected from the middle row in each plot to measure traits such as plant height, pods number per plant, pods weight per plant, plant weight, the number of branches and shoot diameter. Data analysis was conducted using SAS software and LSD test as a factorial experiment. For prediction yield and yield components in the artificial neural network, the Levenberg-Marquardt algorithm was used to train the ANN. In order to develop ANN's models, plant density and nitrogen fertilizer were used as input vectors and yield and yield components were used as the output.

Results: Shoot height increased by increasing the amount of nitrogen fertilizer and plant density, but increased pod number, plant weight, the number of branches and shoot diameter were a result of increased nitrogen and reduced density. Pods weight increased by reducing the density. Plant weight reduced with increasing applied nitrogen and plant density. With increasing nitrogen fertilizer and soybean plant population plant stem increased. Network with 2-20-7 topology could predict the parameters with R^2 of 0.99987 and MSE of 0.2497.

Conclusion: Pod weight was significantly higher with the density of 100,000 plants per hectare, while these amounts were similar statistically in 150,000 to 200,000 plants per hectare. Soybean yield is greatly influenced by the weight and pod number, although the pod weight was much more of low density; but this problem may be resolved in a high density due to the larger number of plants. No significant difference was statistically observed in shoot diameter between 100 and 200 Kg N per ha. Accordingly, 100 Kg N per ha is suitable for bring down the cost and using fewer fertilizers. Network with 2-20-7 topology had the most performance in soybean yield prediction and had the least performance in a number of branch prediction.

Keywords: Soybean Yield, Yield Components, Levenberg-Marquardt algorithm, Gorgan 3

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The effect of irrigation interval and iron and zinc foliar application on some morpho-physiological characteristics and yield of sunflower

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Abstract

Background and objectives: Sunflower is one of the five important oil plants in Iran that because of the relative resistance to drought stress and high oil quality (absence of cholesterol) had a wide range of country land that devoted to the cultivation of this crop. Drought stress is one of the most important factors that limiting the growth and yield of many crops, especially in the arid and semi-arid region in the world. The use of micro-nutrients is one of the ways to reduce the negative effects of water stress on crops. This research was carried out to investigate the response of sunflower to the foliar application of iron (Fe) and zinc (Zn) micro fertilizers under drought stress conditions and to evaluate the role of these nutrients for reducing drought stress damages and plant tolerance to the drought stress.

Material and methods: This experiment was carried out as a split-plot based on randomized complete block design with three replications in Zarghan Agricultural Research Station, Fars province in spring and summer of 2014. The irrigation interval in three levels (irrigation after 60, 120 and 180 mm evaporation from A-class pan evaporation) were used as the main plot and foliar application of micronutrients in four levels (foliar application with water (control), ferrous sulfate (3 g L^{-1}) zinc sulfate (3 g L^{-1}) and the combination of ferrous sulfate and zinc sulfate each one at a rate of (3 g L^{-1})) served as the subplot. In this experiment, physiological traits (chlorophyll content, proline, soluble carbohydrates, relative water content and electrolyte leakage percent of leaf), morphological traits (leaf area index and height) as well as grain yield were evaluated.

Results: The results showed that the main effects of irrigation interval and foliar application were significant for all traits, but their interactions only were significant for proline and soluble carbohydrates. Delaying in irrigation from 60 to 180 mm evaporation significantly decreased 5.6, 31.2, 37.5, 17 and 37 percent relative water content (RWC), chlorophyll content, plant height, leaf area index (LAI) and grain yield, respectively. With the delaying in irrigation also, leaf electrolyte leakage increased by 20 percent. In foliar application treatments, compared to the control, the foliar application of Fe and Zn caused to increase the RWC, chlorophyll content, proline and soluble sugars content of leaves, plant height, LAI and grain yield and oil as well as reduced electrolyte leakage in leaf significantly. The interactions mean comparison of irrigation and foliar application on proline and soluble carbohydrates showed that in all three levels of irrigation use of Fe and Zinc together increased these traits.

Conclusion: Foliar application of Fe and Zn improved physiological traits under drought stress condition. Hence, the increase in metabolites particularly soluble carbohydrates and reducing lipid peroxidation, by foliar application of these two elements, could have a positive effect on the mechanisms of drought tolerance and increased sunflower grain yield and oil.

Keywords: Grain yield, Membrane stability, Leaf area index, Proline, Soluble carbohydrates.

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The effect of some oils on optimizing nicosulfurun efficacy herbicide in corn

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Abstract
Background and objectives: Adjuvants through improving the performance of foliar-applied herbicides aim to optimize herbicide rates and minimize their cost and adverse effects. Enhancement in the efficacy of herbicides for effective weed control is important, especially at lower dosage and it could be considered as an approach to reduce application rates of herbicides.Vegetable oils, as one of the adjuvants, have aroused a point of interest because of their less toxicity and risk, eco- compatibility and, natural renewability and biodegradability. The effect of adjuvant types to increase or decrease herbicides efficacy depend on type, characteristics, and formulation of herbicides, weed species, and environmental conditions; therefore to detect appropriate adjuvant for each herbicide, field experiments are required. Thus, the effects of petroleum (volck) and some vegetative oils in combination with nicosulfuron (Cruz) were investigated in this study.
Materials and methods: In order to evaluate nicosulfuron efficacy for weed control and the effects on corn yield characteristics when it was applied alone and tank-mixed with petroleum (volck), olive, castor, sesame, bitter almond, and sweet almond comparing to weedfree and weed infested condition, this field experiment was conducted in a randomized complete block design with three replications at a field located at Mahi-dasht, Kermanshah province.
Results: The addition of olive, castor and volck oils were able to decrease density of redroot pigweed, green foxtail and groundcherry, and dry weight of total weeds to the extent of weedfree control. None of chemical management treatments could control orange nightshade and total weeds density as much as weed-free treatment. Orange nightshade showed a high level of tolerance to nicosulfuron. Plant height, biological and grain yield, harvest index, and thousand-seed weight of corn compared to weedfree condition was 22, 41, 59, 30, and 5% for weed infested, and 13, 8, 10, 2, and 1% for nicosulfuron applied alone, respectively. Tank mixing of all oils wanes height reduction to 7%, olive and castor oils decreased biological and grain yield reduction to 2.5%; although none of them could produce the same as weed free treatment. Corn harvest index and thousand-seed weight, when nicosulfuron applied in combination with olive, castor and sesame oils did not differed significantly from weed free control.
Conclusion: Weed species control improved when nicosulfuron applied with petroleum and vegetable oil adjuvants. Herbicide efficacy enhancement for weed species were different by utilizing various oils. In general, olive and castor oils showed the best results for nicosulfuron efficacy on weeds and corn yield related traits.

***Keywords*:** Tank-mixed adjuvants, Vegetable oils, Volck oil, Weed management

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Effect of salicylic acid and jasmonic acid on induction of oxidative stress, increasing resistance and yield of *Echinacea purpurea* L.

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Abstract

Background and objectives: The production of metabolites in medicinal plants farming is very important. Therefore, the application of some materials for increasing growth and production of secondary metabolites has driven attention. Elicitors are efficiently applied for increasing secondary metabolites production in medicinal plants. Elicitors can induce physiological changes in plant. Exogenous application of the compounds like jasmonic acid and salicylic acid causes induction of virtual stress in plant and triggers defensive responses. In response to created oxidative stress, plant increases the expression of antioxidant genes followed by an increase in activity of enzymatic and non-enzymatic antioxidants (mostly have medicinal properties). Accordingly, this experiment was aimed at studying the jasmonic acid and salicylic acid effects on induction of oxidative stress and increasing resistance and yield of Echinacea.

Materials and methods: The present experiment was conducted as randomized complete blocks design with 12 treatments and three replications in Agriculture Faculty of Shahrood University of Technology in 2015-2016. Experimental treatments were spraying the jasmonic acid with 4 concentrations (0, 5, 20 and 50 micro molar), the salicylic acid with 3 concentrations (0, 5.0 and 1 milimolar) and spraying both of them [(5ja-0.5 sa, 20 ja-0.5 sa and 50 ja- 0.5 sa) and (5ja-1 sa, 20 ja-1 sa and 50 ja- 1sa)] three times with ten-day intervals, starting from reproductive stage initiation. The induced oxidative stress was presented by measuring NADPH oxidase activity and oxygen peroxide concentration, increasing resistance measured by antioxidant enzymes activity including catalase, guaiacol peroxidase, poly phenol oxidase, ascorbate peroxidase, and non-enzymatic antioxidant activity including total phenol and petal ascorbic acid; finally, the reaction of leaf soluble protein, chlorophyll a and b, leaf dry weight and dry flower yield to spraying was measured.

Results: The analysis of variance results indicated that spraying affected significantly all studied traits. The highest amount of NADPH oxidase was observed for treatment 20ja-1sa which was 1.6 times of control. The highest concentration of oxygen peroxide was seen for treatments 5 micromolar jasmonic acid and 0.5 milimolar salicylic acid. The highest amount of catalase enzyme activity was found for 20 micromolar jasmonic acid treatment with an average of 0.021 micromole per minute per gram fresh tissue. The highest and the lowest activity of leaf guaiacol peroxidase were observed for 20 micromolar jasmonic acid^{-1} milimolar salicylic acid and control treatments, with average of 0.205, and 0.038 micromole per minute per gram tissue, respectively. The top value of ascorbate peroxidase activity was found for 20 micromolar jasmonic acid^{-1} milimolar salicylic acid treatment with an average of 0.29 micromole per minute per gram fresh leaf tissue, which was almost twofold of control. The greatest amount of total phenol was obtained for 0.5 milimolar salicylic acid which appeared to be 3.68 times of control. The greatest amount of ascorbic acid was observed for five micromolar jasmonic acid-0.5 milimolar salicylic acid treatment which appeared to be 4.68 times of control.

Conclusion: Elicitors induce the transduction signal network. Following that, cytoplasm acidification and increase in amount of extra cellular pH take place. The NADPH oxidase activity, responsible for production of reactive oxygen species, increased and production of H_2O_2, one of the reactive oxygen species, got enhanced. The activity of enzymatic and non-enzymatic antioxidants such as phenols and acid ascorbic concentrations promoted. Increasing the activity of defense systems in plant causes the creation of favorable conditions for construction activities such as enhancing the amount of chlorophyll a and b, and soaring soluble protein content and finally increasing the weight of leaf and flower of plant.

Keywords: Enzymatic antioxidant and non-enzymatic antioxidants, soluble protein, chlorophyll.

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Study on effects of foliar spraying and soil application of humic acid on vegetative characteristics and flower yield of saffron (*Crocus sativus* L.)

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Abstract

Background and objectives: Saffron (*Crocus sativus* L.) is one of the most valuable indigenous plants, herbs and spice in the world. Saffron is cultivated in most part of Iran, because of low water requirement and well adaptation to diverse environmental condition. Application of organic material is one of the most important factors for acheiving maximum yield of saffron plants. The aim of this study was to investigate effects of soil and foliar application of humic acid on vegetative and reproductive characteristics of saffron.

Materials and methods: This experiment was carried out as a factorial based on randomized completely block design (RCBD) with three replications in research farm of University of Birjand, Iran, during 2015 - 2016 growing season. Treatments were usage type of humic acid (soil and foliar application) and different amounts of this fertilizer (0, 5, 10 and 15 Kg ha^{-1}). The measured indices were included of leaf characteristics (leaf length, fresh and dry weight), corm characteristics (corm number, total weight, cormel weight and diameter) and flower characteristics (flower number and fresh total yield, average stigma length, stigma fresh and dry yield).

Results: Results showed that, application of humic acid improved the leaf growth indices (leaf length, fresh and dry weight) and corm growth indices (cormel weight and diameter). The highest these indices were obtained in the soil application of humic acid. Also, results showed that flower reproductive characteristics (flower number and total fresh yield, stigma fresh and dry yield) were influenced by type of applied humic acid.The highest stigma fresh (0.781 g m^{-2}) and dry (0.147 g m^{-2}) yield were obtained in soil application. Humic acid concentration improved the leaf growth indices (leaf length, fresh and dry weight) and corm growth indices (cormel weight and diameter) and flower reproductive characteristics (flower number and fresh total yield and stigma fresh and dry yield).The highest total fresh yield of flower (18.201 g m^{-2}) were obtained in plants treated with 10 Kg ha^{-1} humic acid, while the lowest values was recorded in the control. Interaction effects of these factors were effective on leaf length, flower number and stigma dry yield.The highest stigma dry yield (0.158 g m^{-2}) and flower number (48.833 Flower m^{-2}) were obtained in plants treated with 10 Kg ha^{-1} soil application of humic acid.

Conclusion: Thus, humic acid increased saffron vegetative and reproductive characteristics and soil application than the spray was more effective in these characteristics, altogether 10 Kg ha^{-1} humic acid as soil application increased stigma yield of saffron.

Keywords: Organic fertilizers, Medicinal plant, Cormel, Stigma yield

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Evaluation of alternative series of Tepary bean (*Phaseolus acutifolus*) and two millet variety (*Panicum miliaceum*) intercropping effects on some quantitative and quality traits and forage yield

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Abstract

Background and objective: Intercropping is one of the most effective methods to achieve sustainable production with low input to increase the diversity in agro ecosystems. In these systems two or more plants are cultivated at a same time and place in order to increase the efficiency of the resources usage. Based on results, the intercropping bring about the improvement of qualitative and quality characteristics and forage yield. In order to Evaluation of Tepary bean and millet intercropping effects on some quantitative and quality traits and forage yield, this study was done in Jiroft area.

Materials and methods: The field experiment was done in a randomized complete blocks design with three replications in Jiroft during 2015-2016. The treatments included combination of Tepary bean and two cultivars of millet (Bastan and Pishahang) and replacement intercropping ratio (75:25, 50:50, 25:75 Tepary bean- millet, sole cropping of Bastan millet, Pishahang millet and Tepary bean with 300000 plants/ha. Planting date was on 27th April. Millet and Tepary bean harvested on May and June, respectively. Traits such as Plant height of bean, Number of secondary branch of bean, Leaf dry weight of bean, Plant height of millet, Leaf dry weight of millet, Steam dry weight of millet, Dry forage yield of bean, Dry forage of millet, Total dry forage NDF, ADF, crude protein yield and LER were measured. Data analyses were conducted using SAS ver. 12 and analysis of means was done with the LSD's test.

Results: The results showed that interaction of millet cultivars and intercropping ratio was affected dry forage of Tepary bean. The highest amount of Tepary bean dry forage was obtained from 50: 50 Tepary bean-millet cultivars percentage. Despite the lack of significant mutual effect of these two treatments on millet dry forage, the effect of millet cultivars in mixture and the mixing ratio on this trait was significant at 1% level. The highest amount was obtained from the presence of millet cultivars increasing by 87.8% with 25:75 treatment of Tepary bean-millet cultivar. Statistically, there was not a great difference between this ratio and 50: 50 mixing ratio. The highest amount of dry forage was obtained from 50:50 Tepary bean-millet cultivar with 12.59% and 87.57% increase compared to the single cropping of Tepary bean and millet cultivars percentage. Statistically, there was not a great difference between the performance of this treatment and 50: 50 treatment of Tepary bean-millet cultivar and saw the least ADF, NDF and the most crude protein yield in intercropping treatment. In all treatments, the land equivalent ratio (LER) was more than one and the highest amount (2.162) was observed in the mixture of 50: 50 treatment of Tepary bean- Bastan cultivar.

Conclusion: According to this results, the intercropping of Tepary bean and millet was much better than their pure cropping so that the highest amount of dry forage was obtained from 50: 50 of Tepary bean-millet cultivars compared to the sole cropping of Tepary bean with 12.59% dry forage and millet cultivar with 87.57% dry forage. The LER also indicates the superiority of this mixing ratio compared to single cropping of these two plants. Therefore, in general, the intercropping treatment of these two plants with 50:50 ratio is an appropriate method to replace the pure culture of these plants.

Keywords: Diversity, Intercropping Ratio, Land Equivalent Ratio, Sole cropping

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Modeling the interaction of herbicide doses and nitrogen fertilizer on crop and weed biomass production in multiple weed species–wheat interference

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Abstract

Background and objectives: Understanding the interaction between crop-weed competition and herbicide doses may, in many cases, result in a recommendation to reduce the consumption of the herbicide, which is both environmentally and economically important. Nitrogen fertilizer also influences the competitive balance through changes in weed density and biomass, and also contributes to environmental pollution. Hence, the evaluation of the interaction of herbicide doses and nitrogen fertilizer application is necessary for proper management of weeds and achieving acceptable economic yield along with minimizing environmental negative impacts.

Materials and methods: A field experiment was conducted as split plots in a randomized complete block design with four replications at Ramin Agriculture and Natural Resources University of Khuzestan. Nitrogen fertilizer included five levels of 0, 50, 100, 200 and 350 Kg ha^{-1} of urea was considered as the main plot and the herbicide dose of "iodosulfuron-methyl sodium + mesosulfuron methyl + mefenpyr-diethyl" in six levels of 0, 0.2, 0.4, 0.6, 0.8 and 1 times the recommended dose (1.5 L ha^{-1}) was considered as the sub plot. Half of the nitrogen fertilizer was distributed before sowing and the other half was distributed in mid-tillering stage of wheat. Four weeks after spraying (late of wheat tillering stage), destructive sampling was done using a quadrate with a surface area of 0.25 m^2 from four points of each experimental plot. Total biomass of weeds and wheat were weighed in each plot after three days of placement in an oven at 80 °C.

Results: The response of weed and wheat biomass to herbicide doses was described, respectively, with dose-response and sigmoid models, and developed in response to an increase in nitrogen fertilizer consumption. Based on the combined model, the dosage required for reducing the weed biomass to less than 50 g m^{-2} with consuming of 140, 210 and 300 Kg ha^{-1} of urea fertilizer was predicted to be 100, 85 and 60% of the recommended dose, respectively. Also, to achieve about 700 g m^{-2} of wheat biomass, using 230 kg ha^{-1} of nitrogen fertilizer plus 100% of the recommended herbicide dose, or applying 270 kg ha^{-1} of nitrogen fertilizer and 60% of herbicide recommended dose or applying 350 kg ha^{-1} of nitrogen fertilizer and 40% of the recommended dose of herbicide. Also, application of 230 kg ha^{-1} of nitrogen fertilizer plus 100% of the recommended herbicide dose or application of 270 kg ha^{-1} of nitrogen fertilizer and 60% of the recommended herbicide dose or application of 350 kg ha^{-1} of nitrogen fertilizer with 40% of the recommended herbicide dose led to the achievement of about 700 g m^{-2} of wheat biomass.

Conclusion: Increasing the competitive ability of weeds in response to increasing nitrogen use led to a higher loss of wheat biomass at higher levels of fertilizer application. Application of herbicide at higher levels of fertilizer application, which the competitive ability of weeds in these conditions was much higher than that of low fertilizer levels, led to a greater increase in wheat biomass. Increasing environmental concerns has led to the development of low input systems (low fertilizer and herbicide use). However, our results showed that weeds grown in low nitrogen levels were much more tolerant to herbicide than plants grown at higher levels of fertilizer application.

Keywords: Atlantis OD, Dose-response, Sigmoid model, Exponential model

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Evaluation of yield stability of winter barley varieties (*Hordeum vulgare* L.) using additive main effects and multiplicative interaction method

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Abstract

Background and objectives: Accurate recognition of the genotype - environment interaction nature, provides the possibility of identification of stable genotypes for breeders and it is always one of the important issues in production and release of new cultivars in plant breeding projects. The existence of genotype - environment interaction influences the genotypes value in different locations. Aim to present study was identification of the cultivars responds to different regions based on the model of the additive main effects and multiplicative interactions (AMMI), better understanding of interaction between genotype and environment, determine the general and the specific stability.

Material and methods: Ten varieties of winter barley (*Hordeum vulgare* L.,) (Gorgan 4, Reihan, Kavir, Nosrat, Nimrooz, Valfajr, Makoei, Zarjo, Gorgan, Strain) evaluated during 2015-2016 in 5 regions including Karaj, Birjand, Kashmar, Sanandaj and Shiraz in a randomized complete block design (RCBD) with three replications. First, Bartlett's test carried out on the data, suggesting the uniformity of errors in the various experiments. The additive main effects and multiplicative interactions method (AMMI) used to investigation of the genotype and genotype - environment interaction and find out of the adaptability and stability of genotypes.

Results: The highest grain yield belonged to strain cultivar with 602.87 g m^{-2}, the lowest grain yield reveal for Reyhan and Zarjo cultivars was 306.73 and 3338.33 g m^{-2} respectively. AMMI results showed the main genotype effect, genotype - environment interaction and the first principal component interaction were significant at the 1% likelihood level and the first interaction principal component of the genotype - environment interaction explains about 76% of sum of squares. The interaction of genotype and environment explain 25% of the total sum of squares. For studying of the varieties stability, AMMI stability value (ASV) used and Zarjo, Nosrat and Makuei genotypes, to rate 0.77, 2.48 and 2.74 respectively, assigned lowest amount ASV, but Nosrat variety with average yield upper known as stable varieties. Between environments, Kashmar with the lowest ASV (6.58) had the highest stability. Based on regression coefficient (b_i) Nimrooz, Makuei and Zarjo had the adequate stability. Based on coefficient of determination (R_i^2) and Hanson stability estimator, Nosrat, Makuei, Zarjou and Gorgan cultivares had the higher stability. Kavir and Nosrat genotypes based on AMMI1 graph, had the upper total yield average and the first component interacts was the lowest rate therefore known as the most stable genotype. Based on the first and second principal component biplot graph (AMMI2), Zarjo, Makuei and Nosrat, were the most stable genotypes. Based on this graph the Kavir, Valfajr, Gorgan and Strain cultivars had the lowest yield stability.

Conclusion: The results of this study showed the significant genetics variability among genotypes and genotype - environment interaction and base on AMMI method, Kavir and Nosrat were the most stable genotypes.

Keyword: AMMI, Adaptability, Barley, Genotype-environment interaction, Principal component

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Effect of plant growth promoting micro-organisms on some vegetative characteristics and grain yield of rice (*Oryza sativa* L.) under different levels of potassium fertilizer

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Abstract

Background and objectives: One of the aims of the country is self-sufficiency in rice production. To purpose this aim according to the sustainable agricultural laws, it is important to use an appropriate agronomic management such as improving use of chemical fertilizers and or application of biofertilizers in both method; alone and or along with declined chemical fertilizers. Also, use of renewable inputs such as plant growth promoting microorganisms (PGPM; with the ability of biological nitrogen fixation, solubilize insoluble minerals like phosphorus and potassium, phytohormone production and or production of enzymes and organic acids) with high ecological benefits and low environmental damages is necessary today. Therefore, this study aimed to evaluate the efficiency of two PGPM on some vegetative characteristics and grain yield (GY) of rice (cv. 'Tarom Mahali') at different amounts of potassium sulfate fertilizer (PSF).

Materials and methods: A field experiment was conducted in a paddy field of Mazandaran province (Juybar city) as a split plot based on a randomized complete block design with three replications in 2016. Four levels of PSF (zero, 60, 120 and 180 Kg ha^{-1}) were used as the main plot and four levels of inoculation with PGPM (*Pantoea ananatis* and *Piriformospora indica* were applied individually and a co-inoculation with *Pa. ananatis* and *Pi. indica* (50:50) and non-inoculated as control) served as the sub plots. Based on the results of soil test, 50 Kg $ha^{-1}$of triple super phosphate and all levels of PSF were used before transplanting time and 150 Kg ha^{-1} of urea was applied twice (100 and 50 Kg ha^{-1} at transplanting and heading stage, respectively). At anthesis stage, some vegetative characteristics including plant height (PH), total number leaves $hill^{-1}$ (TNL), leaf area index (LAI), total tillers numbers $hill^{-1}$ (TTN) and the time of beginning anthesis stage (BAS) were measured. GY was also determined at harvesting time by removing of 1 m^{-2} of rice plants from each plot.

Results: The results of this study indicate that all studied traits significantly affected by the simple effect of PSF and PGPM inoculations and also their interactions was significant at 0.01 and 0.05 probability level. As PSF increased from 0 to 120 kg ha^{-1}, the significant increase in PH (from 142.1 to 150 cm), TTN (from 9.2 to 11.0 count), TNL (from 64.2 to 65.4 count), LAI (from 3.9 to 5.6) and GY (from 448.8 to 585.7 gr m^{-2}) was 6, 20, 2, 41 and 30%, respectively, as compared to the control. In addition, BAS decreased significantly by 2.3% (from 57.6 to 56.2 days after transplanting), as compared to the control (without PSF). Although, an increasing of PSF from 120 to 180 kg ha^{-1} resulted in an increase in all studied traits, but differences were not statistically significant among treatments. In addition, single inoculations with *Pa. ananatis*, *Pi. indica* and co-inoculation treatment significantly increased PH by 4.4, 4.1 and 3.4%, TTN by 8.7, 8.7 and 22.7%, TNL by 2.8, 2.4 and 4.4%, LAI by 13.1, 15.0 and 27.2% and GY by 11.2, 11.2 and 19.4% and decreased significantly BAS by 2.0, 2.0 and 3.3%, as compared to the control (non-inoculation), respectively.

Conclusion: Based on our finding the co-inoculation with *Pa. ananatis* and *Pi. indica* as the best treatment, improved the values of all studied traits when compared with the control condition. In general, application of this treatment resulted in decreasing PSF about 55 kg ha^{-1} (40 % lower than the control) and increasing GY±confidence interval about 79±1.52 g m^{-2} (18.6% more than the control). Consequently, these PGPM can be used along with lower values of PSF as well as, particularly in sustainable rice cultivation systems.

Keywords: *Pantoea ananatis*, *Piriformospora indica*, Plant growth promoting micro-organisms, Potassium sulfate, Rice

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