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Evaluation and Comparison of Drought Tolerance Indices in Desi Chickpea Genotypes using Multivariate Analysis Methods

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ABSTRACT

In order to evaluate drought tolerance of chickpea genotypes and identifying the best indices of drought tolerance, 20 genotypes of Desi chickpea plus two improved cultivars (KAKA and PIROZ) were tested by using a randomized complete block design under two irrigated (non-stress) and (stress) conditions. Quantitative drought tolerance and susceptibility indices such as Stress Tolerance Index (STI), Stress Susceptibility Index (SSI), Mean Productivity (MP), Harmonic Mean (HM), Tolerance Index (TOL) and Geometric Mean Productivity (GMP) based on yield in stress and non- stress conditions were calculated. There were significant variations among the genotypes in their reaction to drought tolerance. There were positive and highly significant correlations among GMP and STI with yield in stress and non- stress conditions. Also, there were positive and high significant correlations for TOL and SSI with yield in stress. The correlation between seed yield, in stressed and non-stress conditions, and drought tolerance indices indicated that STI and GMP were the suitable indices for screening of Desi Chickpea genotypes for drought tolerance. Comparison of three dimension plot and bi-plot showed that in stress condition, genotypes KC-218625, KC-217667 and KC-218553 were more tolerant genotypes.

Keywords: Desi chickpea, drought stress, multivariate analysis, tolerance indices.

The Effect of Salinity Stress on Morphological and Physiological Traits of Recombinant Inbred Lines Population of Barley Derived from a Cross Between Arigashar×Igri

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ABSTRACT

In order to investigate effective morpho-physiological traits related to salinity resistance, and their relationship with grain yield as well as study of salinity tolerance and susceptibility indices in 169 barley recombinant inbred lines, a population of barley derived from a cross between Arigashar and Igri, this experiments were carried out using alpha lattice design with two replications during years 2011 to 2013 in Birjand station under non-stress and salinity stress conditions ($EC_{\text{water}}=10\text{ds/m}$ and $EC_{\text{soil}}=12\text{ds/m}$). During cropping seasons, lines were evaluated for morpho-physiological traits, day to heading, day to maturity, spike length, peduncle length, plant height, leaf chlorophyll content (SPAD), flag leaf Na^+ and K^+ content and K^+/Na^+ , flag leaf length, width and area, grains in spike, thousand kernel weight (TKW), biological yield (BY), grain yield (YLD), harvest index (HI) and salinity tolerance and susceptibility indices. Combined analysis of variance of studied traits in two conditions revealed significant difference among years, genotype and genotype \times years interaction. Under salinity stress conditions, biological yield, grains in spike, harvest index, flag leaf Na^+ content and K^+/Na^+ and thousand kernel weight (TKW) and under non-stress conditions, biological yield, harvest index and flag leaf area have high association with grain yield. With regard to grain yield under salinity and non-stress conditions (Y_s and Y_p) and tolerance and susceptibility indices (SSI, TOL, MP, GMP, STI and Harm), lines were grouped in four classes, including: a) semi-high-yielding and salinity tolerance, b) low-yielding and salinity susceptibility, c) high-yielding and salinity susceptibility, and d) high-yielding and salinity tolerance. GMP and STI indices had the highest correlation with grain yield under stress and non-stress conditions, and selected as the best salinity tolerance indices.

Keywords: barley, physiological traits, salinity stress, tolerance and susceptibility indices, yield, K^+/Na^+ .

Traits Related to Yield in Bread Wheat Genotypes under Normal Irrigation and Water Stress Conditions

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ABSTRACT

In order to study the yield component traits of grain in bread wheat genotypes, 200 lines of CIMMYT origin bread wheat were cultured and evaluated in augmented design by four control lines in ten blocks in 2010-2011 growing season. Using stepwise regression analysis, five and four traits entered to regression model under stress ($R^2 = 0.41$) and normal ($R^2 = 0.38$) conditions, respectively. Path analysis results showed that the traits day to stem ($P = -0.369$) and number of seed per spike ($P = 0.264$) had the highest direct effect on seed yield under stress and normal conditions, respectively. In normal conditions, the thousand seed weight (434/0) trait showed the most direct effect on yield that could be used as an index in wheat breeding programs for selecting superior genotypes. Factors analysis in stress and non-stress conditions indicated eight factors justifying 67.96% and 69.43% out of total variance, respectively. Based on the survey results, grain yield is strongly affected by yield component traits and these traits are considered as an important measure for improving bread wheat genotypes in order to achieve better performance and more favorable genotypes.

Keywords: bread wheat, path analysis and factor analysis, water stress.

Proteome Analysis of Wheat Seed Embryo (*Triticum aestivum*) in Tolerant and Susceptible Cultivars under Drought Stress during Early Germination Phase

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ABSTRACT

Germination is one the most important growth phases in plants that is sensitive to drought stress extremely. Germination divided in to three phases although before third phases, many activities (radicle protrusion) initiated. Many of metabolical activity occurred specially in the first phase since seed embryo is an alive organ, although differences in protein patterns happen in this phase. This study was carried out to evaluate the effect of drought stress on protein patterns in the first phase of germination. In order to analyze the effects of drought stress (-12 bar) on wheat embryo proteome (Sardari and Qods respectively tolerant and susceptible cultivar), factorial experiment was conducted in a randomized completely block design with three replications. Drought stress diminished germination percentage and caused adverse effects on the proteins pattern. Two-dimensional gel electrophoresis analysis of wheat embryo axis showed 1000 spots were reproducible that 25 spots between treatments indicated significant differences at 5% level. By comparing tolerant and susceptible cultivar, in control condition, , 22 and 6 spots, and in stress condition, 21 and 10 spots were down and up regulated, respectively. The results indicated that frequency of protein under drought stress depends on severity, amount of stress, and imbibition time.

Keywords: embryo seed, germination, proteomics, wheat.

Effect of Drought Stress on Photoassimilate Allocation of Pinto Bean (*Phaseolus vulgaris* L.)

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ABSTRACT

In order to estimate the effects of drought stress on dry matter allocation of pinto bean (*Phaseolus vulgaris* L.), an experiment was carried out as split plot based on a complete randomized block design with four replications at Zanzan university research farm. In this experiment, two irrigation levels (optimum irrigation during growth season and post flowering drought stress) were set at main plots and six pinto bean cultivars (Khomein, COS16, sadri, KS21193, KS21191, KS21189) were set at sub plots. Results showed that drought stress had significant effects on stem weight ratio and pod weight ratio. Also, KS21191 genotype had the highest grain yield under drought stress because of less allocation of photoassimilates to leaves and higher pod weight and higher biomass. Generally, cultivars that allocate less photoassimilates to leaves and stems and higher photoassimilates to pods had the priority under drought stress.

Keywords: biomass, grain yield, pod dry weight, pod weight ratio, stem weight ratio.

Putrescine Induces Drought Tolerance and Alters the Activities of Antioxidant Enzymes in Growing Chamomile Plants (*Matricaria Chamomilla* L.)

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ABSTRACT

The present study focused on the influence of Put treatment on antioxidant enzyme activity in chamomile seedlings under drought stress. Treatments were two moisture regimes (87 and 43% of field capacity), putrescine application (0 and 0.1 mM), and two chamomile cultivars (Bodgold and Hungary breed seed). The experiment was conducted in a factorial design based on a randomized complete blocks with three replications. Drought reduced soluble protein content, and increased the activities of antioxidant enzymes, including ascorbate peroxidase (APX), catalase (CAT), guaiacol peroxidase (GPX) glutathione reductase (GR). Put treatment caused a significant increase in the activity of antioxidant enzymes, as compared to control (26.6, 17, 26.56 and 8.88% for APX, CAT, GPX and GR, respectively), while no significant effect was recognized as long as the soluble proteins content was taken into account. A significant association was observed between moisture regimes and Put in terms of GR activity ($P<0.05$), while interaction between cultivar and moisture regimes was only significant as the variable of GPX was considered ($P<0.05$). Interestingly, between two cultivars, Bodgold was found to contain higher GR and GPX activities compared to Hungary breed seed. While Hungary breed seed exhibited higher soluble proteins content, APX and CAT activities than the other one.

Keywords: antioxidant enzymes, chamomile, drought stress, putrescine, soluble protein content.

Genetic Diversity of *Aegilops triuncialis* L. Accessions of Iran Revealed by Microsatellite Markers

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ABSTRACT

In order to study the genetic diversity among 35 accessions of *Ae. triuncialis* L. 17 SSR loci of 56 primer pairs originated from A and D genomes of bread wheat were used. Seventy one fragments amplified totally and 68 of them were polymorph between genotypes. Allele number ranged from 1 to 8 with average of 4.18 per locus. PIC value of markers was from 0.593 (Xgwm-30-2D, Xgwm-383-3D, Xgwm-654-5D) to 0.861 (Xgwm-156-5A) and marker index varied from 1.779 to 6.888. Average genetic distance of genotypes was 0.859. Two accessions from Lorestan and Khoozestan with least genetic distance (0.231) was the most similar genotypes. Cluster analysis was not able to separate accessions from each other. No relationships between genetic and geographic variation indicates high amount of genetic diversity among genotypes. All molecular variation was from within groups which indicate no specific SSR alleles for accessions. This genetic diversity and transferability of known SSRs in cultivated could be assigned as useful tools for management of wild wheat genetic resources.

Keywords: *Aegilops triuncialis* L., cluster analysis, genetic diversity, SSR marker.

Post-dispersal Seed Predation of Four Weed Species in Maize Fields

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ABSTRACT

To evaluate post-dispersal seed predation of weeds in maize fields, factorial experiments with four replications were conducted in 2007 in Mashhad and Chenaran, NE of Iran using four common weed species in maize field. Treatments were weed species, sampling periods and cages. Removal of *Amaranthus retroflexus*, *Chenopodium album*, *Sorghum halepense* and *Datura stramonium* were measured during seven sequential weeks in two maize fields from August until October 2007. Wire mesh cages were used to determine the predation by avian predators. Invertebrate seed predator activity-density was monitored using pitfall traps. Seed removal was significantly different between fields and among species. Post-dispersal seed predation was higher in Chenaran maize field (55%) than Mashhad field (47%) that could be resulted from difference in irrigation method and the number of invertebrate predators. Except some fluctuations during the predation period, seed removal decreased toward the end of experiments in both places. Cage exclusion had no significant effect on predation in both places, showing no significant removal of seeds by birds. Invertebrates were the most important predators in both fields and ants were the main invertebrate seed predators but other seed eater invertebrates like crickets and different seed eater carabid beetles were also caught in to pitfalls.

Keywords: cage, invertebrate, maize, pitfall, seed dispersal, weed seed predation.

Effects of Foliar Application of Ordinary and Nano-Particles of Zinc Oxide on the Antioxidant Enzyme Activity and Proline Content of Two *Zea Mays* L. Cultivars under Salt Stress

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ABSTRACT

This experiment was conducted in order to evaluate the effects of foliar application of ordinary and nano-particles of zinc oxide on the response of corn to salinity. Treatments included two corn genotypes (seed mass and Sc 704), three spray levels (zinc oxide, nano-sized zinc oxide, and a spray of water treatment) and three salinity levels (0, 75 and 150 mM NaCl). Shoot dry weight was decreased as the level of salinity was increased and the reduction was greater in seed mass than in Sc 704 cultivar. However, the enzyme activity of superoxide dismutase (SOD), catalase (CAT) and ascorbat peroxidase (APX), and also the concentration of MDA and proline in leaves were increased under saline conditions. The extent of increases in proline content and the antioxidant enzyme activities was larger in seed mass than in Sc 704. Foliar application of zinc oxide had significant positive effects on shoot dry weight and on the activity of SOD in leaves. Regardless of cultivars, the extent of increase in the activity of APX under saline condition was smaller when plants were sprayed with nano-sized zinc oxide compared to the ordinary bulk form. The results from this experiment showed that there were positive correlations between the increase in proline content and the enhanced antioxidant enzyme under saline condition and the salt tolerance of cultivar. Although, there were no significant differences between the two tested cultivars in response to zinc oxide foliar application, positive effects of nano-sized was more than ordinary form.

Keywords: catalase, foliar application, nano-sized, peroxides, single cross704, superoxide dismutase,

Evaluation of Different Combinations of Nitrogen and Zinc on Maize by Path Analysis of Yield and Grain Filling Rate

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ABSTRACT

This research was conducted to evaluate the effect of different nitrogen and zinc combination on grain yield and its component in maize by path analysis. This experiment was carried out through split plot based on a RCBD, varieties as main plot and fertilizers as sub plot, with three replications at Badjgah (experimental farm of Shiraz University). Nitrogen fertilizer (120,260 and 400 kg/ha) and Zinc fertilizer (0, 15 and 30 kg/ha) were applied in soil. According to the path analysis, 1000 grain weight showed the highest direct and indirect effects on grain yield (0.96). Also, the number of row was positive and significant while the number of grain per row was negative. Therefore, as breeding point, the weight of 1000 grain has the highest potential for increasing the yield, means it can be significant under the effect of nitrogen and zinc. Grain filling rate due to its effective role on grain yield can be good criteria for assessing of produced grain yield in different genotypes. Based on the obtained results, intermediate mature hybrid 540 has the better grain filling rate comparing to 704. Meanwhile, grain filling rate at 120 kg/ha urea and 15 kg/ha zinc sulphate gave the highest rate, as 3.19 gr/m² per day. According to the experiment and assessment of grain filling rate and using path analysis, it is clear that different combinations of nitrogen and zinc had a positive effect on grain yield and it is projected to evaluate more related researches in future.

Keywords: grain filling rate, nitrogen, path analysis, zinc.

Effects of Irrigation Levels and Macro and Micro Fertilizers on Morpho-Physiological Traits of Summer Annual Savory (*Satureja hortensis* L.)

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ABSTRACT

To investigate the effect of irrigation treatment and macro and micro fertilizers on morpho-physiological characteristics of *Satureja* a field experiment was conducted in Agricultural Research Station of Haji-Abad (Hormozghan province-Iran) using a split plot randomized complete block design with three replications during the growing season of 2012-2014. Irrigation treatments consisted of normal, moderate and severe water stress (with 70, 100 and 130 mm evaporation from open pan class A) as main plots and nine fertilizer allocated to sub-plots including triple superphosphate, low and high levels (100 and 200 kg per ha) of ammonium nitrate each at low and high levels (100 and 200 kg. ha⁻¹), foliar application of zinc sulfate and iron sulfate each at low and high levels (0 and 0.5 kg. ha⁻¹), and a control (no fertilizer). The experimental results showed that irrigation treatments and fertilizer application had significant effects on plant height and number of secondary branches. Interaction effects showed that moderate water stress and micro fertilizer application increased proline and soluble sugar content in savory plant. The highest chlorophyll content (2.66 mg. gr⁻¹ on plant fresh weight basis) and leaf relative water content (62.7%) was related to normal irrigation treatment. The irrigation regime increased levels of proline, and essential oil contents. Also the micronutrients spraying increased the savory plant tolerance to water deficit stress.

Keywords: essential oil, irrigation deficit, macro and micronutrients, proline, savory.

Leaf Morpho-Physiological Characteristics of Common Bean under Contrasting Moisture Regimes

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ABSTRACT

Some of the morpho-physiological characteristics related to the leaf growth and development of *Phaseolus vulgaris* L. genotypes have been studied in the field conditions at the Seed and Plant Improvement Institute (SPII). The study was performed as split plot experiment in a randomized complete block design with four replications in well-watered and water deficit conditions with eight genotypes of white, red and Chitti beans. Results indicated that water deficit reduced the number of trifoliolate leaves and the reduction in the vegetative stage was greater than the flowering stage. Due to water stress, MCD4011 had the least reduction and COS16 showed significant reduction in leaf numbers in both stages. Leaf angle was affected by irrigation regimes and increased under water deficit condition. White beans showed more than average in leaf angle. Drought also increased leaf temperature of all genotypes. Genotypes WA4531-17 and KS21486 had the highest specific leaf weight (SLW) and succulence index (SucI) in both irrigation conditions, respectively. Water shortage caused significant decreases in leaf area index (LAI) and relative water content (RWC) in all genotypes. In this condition, AND1007 had higher LAI than other genotypes. The white lines had mean RWC higher than other two groups. Reduction percentages of RWC in genotypes were between 3-10%. Drought stress reduced quantum yield (Fv/Fm) of PSII photochemistry, the lowest decrease was observed in MCD4011 line. Whereas the white lines had the greatest mean proline content in well-watered treatments, but showed the least values of it under stress conditions. Overall, water deficit caused reductions in the most evaluated traits, and increased leaf temperature, leaf angle and proline content of all genotypes up to 2°C, 59% ($\alpha=24^\circ$) and 105%, respectively.

Keywords: drought, leaf angle, quantum yield, relative water content, succulence index.

Yield Stability Assesment of Primary Tritipyrum as a new cereal in Comparison with Triticale and Bread Wheat using AMMI Method

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ABSTRACT

Yield stability of 17 genotypes including eight of tritipyrum lines, five promising triticale lines and four Iranian bread wheat varieties were studied in a randomized completely block design with three replications in seven environmental conditions during growing seasons of 2001-2002, 2002-2003, 2005-2006 and 2010-2011 in three locations. Analysis of additive main effects and multiplicative interaction effects (AMMI) showed that environmental main effects and genotype \times environment interaction were highly significant, so 89.49 percent of its sum of squares explained by the first three principal components (IPCI). Biplot results of genotypic and environmental components of interaction in the first, second and third principal components and mean yield of genotypes and environments, stability parameters of SIPC3 and EV3 in AMMI3 model and pattern analysis showed bread wheat cultivars had the unstable reaction to weak stability, triticale lines {4115, 4108} and Kavir wheat cultivar showed the specific adaptation to the sixth environment (Kerman) but, tritipyrum lines had the most stable reaction in different environments and combined primary line {(Ka/b)(Cr/b)-6} showed the specific adaptation to the Neyriz area. Combined primary tritipyrum line (Ka/b)(Cr/b)-5 with the higher yield than the mean yield and good general adaptability was known the best genotype that can be used as a pasture line for further study forage and grain production

Keywords: AMMI analysis, genotype \times environment interaction, pattern analysis.

Effects of Two Irrigation Regimes and Application of Barley Residue, Zeolite and Superabsorbent Polymer on Forage Yield and some Physiological Traits of Maize and Sorghum

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ABSTRACT

To study the effects of two irrigation regimes and application of barley residue, zeolite and superabsorbent polymer on forage yield and some physiological traits of maize and sorghum, an experiment was conducted over two years in Kerman, Iran. A randomized complete block design arranged in a factorial split was used with three replications. Two irrigation regimes of normal irrigation and water deficit stress based on 70 mm and 140 mm cumulative pan evaporation, respectively, and two plant species (maize and sorghum) as factorial combinations were compared in main plots. Five combination treatments of barley residue, zeolite, and superabsorbent polymer, (I) -10 t ha⁻¹ zeolite plus 4.5 t ha⁻¹ residue (ZR), (II) - 60 kg ha⁻¹ superabsorbent plus 4.5 t ha⁻¹ residue (SR), (III) - 5 t ha⁻¹ zeolite plus 30 kg ha⁻¹ superabsorbent plus 4.5 t ha⁻¹ residue (ZSR), (IV) - 4.5 t ha⁻¹ residue (R), and (V) – control (C), were compared in subplots. In maize, forage yield, maximum quantum yield (F_v/F_m) and chlorophyll concentration and in sorghum forage yield and F_v/F_m decreased significantly under water deficit stress. Maize produced higher forage yield (62.8 t ha⁻¹) than sorghum (49.3 t ha⁻¹). The application of 10 t ha⁻¹ zeolite plus 4.5 t ha⁻¹ residues (ZR) had the highest forage yield, and the control treatment had the lowest forage yield, soil water content and F_v/F_m . In most traits, there were no significant differences between the residue treatment (R) and the combination treatments of residue with the zeolite and super absorbent polymer. Maize planting associated with the application of 10 t ha⁻¹ of zeolite plus 4.5 t ha⁻¹ residues is recommended in a double-cropping system in Kerman.

Keywords: crop residue, drought stress, maize, sorghum, superabsorbent polymer, yield, zeolite,

Evaluation of Iranian Sainfoin Ecotypes (*Onobrychis viciifolia* Scop.) under Non-stress and Drought Stress Conditions

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ABSTRACT

Drought stress is the main limiting factor in the arid and semi-arid region of the world. This research was conducted to evaluate drought tolerance in different accessions of Sainfoin for yield, morphological and agronomic traits in 2010. Twenty one accessions (landraces and varieties) were evaluated in two environments including drought stress and non-stress conditions for four harvests according to a split plot design in time. Results showed that drought stress significantly decreased forage yield and yield components, while increased percentage of dry matter yield and leaf to stem ratio. The effects of drought, however, varied for different harvests. Drought stress decreased genetic variability for most of the measured traits. In both moisture environments forage yield had the highest genetic variation. Plant height and panicle length had the highest value of heritability (85 and 82% respectively) and may be improved by direct recurrent selection. The results of mean comparison for non-stress condition showed that accessions Kabotarabad, Fereidonshahr and Khansar 2 had the highest forage yield while in drought stress condition accessions Kabotarabad, Fereidonshahr 2 and Janatabad had better performance. Accessions Arak and Semirom in non-stress condition and Arak, Khansar, Semirom and Fereidoonshahr in the stress condition had the highest leaf to stem ratio. Cluster analysis on the studied traits produced several genetically distant accessions. Accessions with more genetic distance may be used as appropriate candidates for developing new varieties in future breeding programs.

Keywords: drought, forage yield, genetic distance, Sainfoin.