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Correlation Coefficient, Path Analysis and Drought Tolerance Indices for Different Wheat Cultivars under Deficit Irrigation Conditions of Isfahan Region

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Introduction

Water crisis as a main factor of agronomy limitation exists in all over the arid and semiarid regions such as Isfahan province which is located in the central part of the Zayandehrud River Basin. This study aimed to use path analysis and indices of drought to evaluate the correlation coefficients between main physiological parameter (grain yield) with yield components and water use efficiency of winter wheat under three water conditions.

Materials and Methods

The experiment was carried out in Kaboutar Abad Agricultural Research Station, Isfahan in the central region of Iran (32º 31'N, 51º 51'E is located at the altitude of 1545 m above the sea level) with a split plot in a randomized complete block design (RCBD) with three replications in three cropping seasons on irrigated wheat cultivars. The treatments were included three levels of irrigation (60%FI, 80%FI and full irrigation) as main plots and six wheat cultivars (Pishtaz, Shiraz, Sepahan, Marvdasht, Mahdavi and BC-Roshan) as sub plots. Grain yield, straw and stubble, biological yield, harvest index (H.I.), productivity degree (P.D.), water use efficiency (WUE), plant height, grain number per spike, spike number per m^2 and TGW were determined. Winter wheat cultivars were sown at the beginning of November and harvested in mid-June of the following year. The seed rate was 400 seed m^{-2}, with a row spacing of 0.75 m. The first irrigation was by furrow method, implemented one day after seeding. Seeds emergence was observed about 5 days later. The N application was 250, 200 and 300 $kgha^{-1}$ of N (urea at 46% N) for each year divided into installments (10 days before planting, 30 days after planting, and every 30 days until the last irrigation). The P_2O_5 (phosphate ammonium and super-phosphate triple) application to soil was 200, 100 and 50 kg ha^{-1} during the 3 years, respectively. At this stage, cultivation was done to mix the fertilizers with top soil manually. Pests and weeds were controlled, following the recommendations given by Isfahan Pest Management Department. At harvest, the final total grain yield per plot was determined. The amount of evapotranspiration for irrigation scheduling was determined by using a crop coefficient (KC), ETpan from measured daily open Class A pan evaporation data, and pan coefficient values from FAO 24 (Doorenbos & Pruitt, 1977). Irrigation water requirement was calculated as the difference between ETc (=KC times ET0) and the effective rainfall amount. In this study, pan evaporation and rainfall amount data collected from the Kabutar Abad meteorological station located at the agricultural research center were used for calculating irrigation water application quantities. The irrigation schedule was timed to meet the crop water requirement. The depth of irrigation water and consequently the volume of water were applied weekly and irrigation amounts equaled the previous week's evapotranspiration (ETc) from the crop. Then, taking into consideration the discharge of the irrigation siphons, the relevant irrigation duration for each treatment was also determined. For path analysis and determining direct and indirect effects of yield components on grain yield, three years data were used (3 Irr * 6 cultivars * 3 years).

Results and Discussion

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Results showed significant correlations of grain yield with: productivity degree (r=0.798**), spike number per m^2 (r=0.71**), biological yield (r=0.629**), harvest index (r=0.538**), and plant height (r=0.284*), respectively, and there was not significant correlation between grain yield with water use efficiency, straw yield, TGW and grain number per spike. On based of indices of drought tolerance (Tolerance Index=TOL, Mean Productivity=MP, Geometric Mean Productivity=GMP, Stress Susceptibility Index=STI and Harmonic Mean=HM), %60 of full irrigation for Pishtaz wheat cultivar was substantially increased water productivity (WP). Amounts of TOL, MP, GMP, STI, HM and WP for Pishtaz cultivar were -0.71, 1.94, 1.92, 1.82, 1.06 and 2.26 kg mm^{-1} and for Sepahan cultivar were -0.63, 1.83, 1.79, 1.59, 0.92 and 2.17 kg mm^{-1}, respectively. Path analysis results showed that increase in grain yield was resulted from increase of spike number per square meter.

Conclusions

The results showed that there is positive and significant correlation between grain yield and productivity degree, the number of spikes per square meter, biomass, harvest index and plant height. The most direct effect is related to the grain number per spike per square meter.

The 60% of full irrigation treatment for Pishtaz and Sepahan cultivars in terms of indices of drought tolerance (Tolerance Index, Mean Productivity, Geometric Mean Productivity, Stress Susceptibility Index, and Harmonic Mean) was preferred. These results can be considered in future breeding studies.

Keywords: Full irrigation, Stress, Tolerance index, Water productivity, Yield components