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Study of Ecotype and Sowing Date Interaction in Cumin (*Cuminum cyminum* L.) using Different Univariate Stability Parameters

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Introduction

Cumin is one of the most important medicinal plants in Iran and today, it is in the second level of popularity between spices in the world after black pepper. Cumin is an aromatic plant used as flavoring and seasoning agent in foods. Cumin seeds have been found to possess significant biological and have been used for treatment of toothache, dyspepsia, diarrhoea, epilepsy and jaundice. Knowledge of GEI is advantageous to have a cultivar that gives consistently high yield in a broad range of environments and to increase efficiency of breeding program and selection of best genotypes. A genotype that has stable trait expression across environments contributes little to GEI and its performance should be more predictable from the main several statistical methods have been proposed for stability analysis, with the aim of explaining the information contained in the GEI. Regression technique was proposed by Finlay and Wilkinson (1963) and was improved by Eberhart and Russell (1966). Generally, genotype stability was estimated by the slope of and deviation from the regression line for each of the genotypes. This is a popular method in stability analysis and has been applied in many crops. Non-parametric methods (rank mean (R), standard deviation rank (SDR) and yield index ratio (YIR)), environmental variance (S^2_i) and genotypic variation coefficient (CV_i) Wricke's ecovalence and Shukla's stability variance (Shukla, 1972) have been used to determine genotype-by-environment interaction in many studies. This study was aimed to evaluate the ecotype × sowing date interaction in cumin and to evaluation of genotypic response of cumin to different sowing dates using univariate stability parameters.

Materials and Methods

In order to study of ecotype × sowing date interaction, different cumin ecotypes: Semnan, Fars, Yazd, Golestan, Khorasan-Razavi, Khorasan-Shomali, Khorasan-Jonoubi, Isfahan and Kerman in 5 different sowing dates (26th December, 10th January, 25th January, 9th February and 24th February) were studied. The experiment was conducted during growing season of 2011-2012 in Agricultural Research field of Shahid Bahonar University of Kerman, Iran; and grain yield was measured in the end of the growing season. Combined ANOVA, Bartlett test and mean comparison (Duncan's multiple range test) was performed using SAS 9.1 software. Considering the significant interaction between ecotypes and sowing dates, non-parametric methods (rank mean (R), standard deviation rank (SDR) and yield index ratio (YIR)), and different methods of univariate stability parameters include: environmental variance (S^2_i), genotypic variation coefficient (CV_i), Wricke's ecovalence, Shukla's stability variance, and Regression technique (Eberhart and Russell parameters) was applied to study Ecotype × Sowing date interaction. Calculation of different stability parameters were done by S116 and Excel softwares. In order to investigate the relationship between stability statistics, the Spearman's rank correlation coefficient was calculated by using SPSS 17.0 software.

Results and Discussion

Combined ANOVA revealed that significant differences among sowing dates, ecotypes and ecotype by sowing date interaction. More than 46 percent of variation in yield was devoted to the ecotype by sowing date interaction; on this basis, stability and adaptability studies were performed based on non-parametric methods,

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Eberhart and Russell regression method and univariate parameters. Based on non-parametric methods (rank mean (R), standard deviation rank (SDR) and yield index ratio (YIR)) Kerman and Khorasan-Shomali were identified as stable ecotypes, and based on environmental variance (S^2_i) and genotypic variation coefficient (CV_i) parameters Khorasan-Razavi and Semnan ecotypes were diagnosed as stable while Kerman and Yazd ecotypes were categorized as unstable ecotypes. According to the results from Eberhart and Russell, Wricke's ecovalence and Shukla's stability variance parameters Isfahan and Golestan ecotypes were categorized as relatively stable ecotypes. Kerman ecotype showed specific adaptability to 24th February sowing date (favorable environment) while Semnan had specific adaptability reaction to 26th December sowing date (unfavorable environment). Khorasan-Shomali showed highest sensitivity reaction to different environments (sowing dates). According to the Spearman correlation the regression coefficient (b_i) showed moderate correlation coefficient with W_i and σ^2_i statistics (r_s = 0.567) and with other statistics in this study showed little correlation. Similar results in the study of Becker and Leon (1988) have been reported. Correlation between the deviation from regression (S^2d_i) with W_i, σ^2_i, S^2_i and CV_i statistics was positive and significant at 5% probability level. YIR and R statistics showed negative rank correlation and coefficient of determination (r^2_i) and SDR don't show any significant correlation coefficient with other parametric statistics. Therefore, in this study, the results of these statistics did not match with parametric methods to introduce stable ecotypes.

Conclusions

Isfahan and Golestan ecotypes were categorized as relatively stable ecotypes. Kerman and Semnan ecotype showed specific adaptability reaction to 24th February sowing date (favorable environment) and 26th December sowing date (unfavorable environment) respectively. Khorasan-Shomali showed highest sensitivity reaction to different sowing dates.

Keywords: Adaptability, Cumin, Ecotype, Rank correlation, Stability