2023 MULTIDISCIPLINARY CONFERENCE ON SUSTAINABLE DEVELOPMENT

Timisoara, 25-26 May

Inheritance Pattern and Combining Ability of Proline Content in a Half Diallel Population of Wheat

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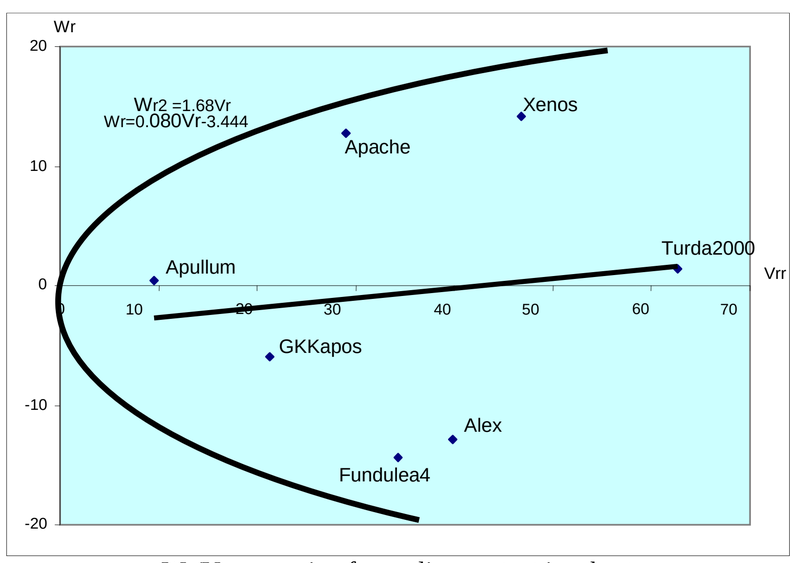
Abstract: The development of desirable tolerant genotypes to drought requires a good understanding of the genetic background of drought responsive traits. The present research was undertaken to analyze the inheritance type, nature of gene action, and different components of genetic variance in order to identify the suitable parents and combinations for future use in wheat improvement for tolerance to drought, using proline content as a criterion for selection. The large dominance effects for proline content make it preferable for selection of lines in later generations, when the heterozygosity level has decreased to a negligible value. Due to the presence of non-additive variance selection for this trait in early generations will be difficult. Thus it is suggested that bulk population breeding could be a more efficient method for obtaining desirable genotypes than the pedigree system for early segregating generations. The significant SCA effects of the cross 'Xenos' x 'Turda 2000' between parents with positive GCA, indicated that the proline content in the offspring can be higher than the sum of parent's GCA effects. In the case of the Fundulea 4 x Alex obtained from parents with divergent GCA, in order to obtain genotypes with high proline content intermating followed by selection can be effective.

Introduction

Under the climate change from last decades, in order to ensure food security at a large scale it is necessary to intensify the breeding of wheat for tolerance to different levels of drought. Generally, the reaction of plants to water stress is manifested by the production of different types of organic solutes, which include small molecules like the proline. Under stress-free conditions the proline is involved in normal plant development, whereas, dehydration events set off an increase in its biosynthesis. The positive association between grain yield of wheat and proline quantity under-drought stress conditions offer evidence that proline accumulation could be eventually considered as an important tool for an effective selection of wheat genotypes tolerant to different drought levels.

Material and Method

Seven varieties of wheat ('Fundulea 4'; 'Alex'; 'Apullum'; 'Turda 2000'; 'GKKapos'; 'Apache'; Xenos) having different genetically and ecologically origin, and their 21 half-diallel crosses, were studied using a randomized block design in three replications. The proline content (µg/mg) was determined in flag leaves according to the method of Pesci and Beffagna (1984). Data were evaluated using the Hayman's (1954) diallel cross methods, regarding: the analysis of variance, estimation of variance (Vr) and covariance (Wr), and the achievement of the graph Wr-Vr. Combining ability analysis was performed according to method 2 (*p* parents and *p(p-1)/2* hybrids), model I of Griffing.



Wr/Vr regression for proline content in wheat

Results and Discussions

According to the position of the seven parents to the regression line, the additive effects are involved only in the inheritance of proline content for 'Turda 2000' and 'Appulum' varieties, which are relatively grouped near the regression line. For rest of the varieties the phenotypic expression of this trait is under the influence of non-allelic gene interactions or under the effect of environmental conditions. The regression line cut the Wr axis below the origin point (a=-3,444), showing the presence of non-additive type of gene action with over dominance.

Components of variance and genetic parameters for proline content in wheat

Variance component / ratio	Estimated values
D- additive effects of genes	1.684
H_1- dominance effects of genes	143.387***
H_2 – corrected dominance effects of genes	125.21***
F- covariance of additive and dominance effects	5.955***
h^2- cumulative dominance effects	16.829***
E- environmental variance	8.716***
$(H_1/D)^{1/2}$ – average level of dominance	9.225
kD/(kD+kR) – proportion of dominance genes	0.551
$\overline{F_1} - \overline{P}$ - average direction of dominance	-2.66
D-H_1 – average direction of genes effects	141.69
$H_2/4H_1$ – average frequency of positive and negative alleles	0.218
h^2/H_2 – number of genes groups or effective factors	0.157
Hb – broad sense heritability	0.814
Hn – narrow sense heritability	0.148

The dominance effects of genes (*H1*) and corrected dominance effects of genes (*H2*) were found to be significant and play an important role in the inheritance of this trait, while the influence of additive effects of genes (*D*) were low and non-significant. The high level of broad sense heritability (0.814) and also the low level of narrow sense heritability (0.148) certify that a considerable part of the variability for this trait is due to dominance effects under a significant influence of environmental conditions.

Conclusions

The predominance of dominant gene action in the inheritance of proline content associated with low narrow sense heritability suggesting the importance of heterosis for improvement of this trait in wheat. The large dominance effects for proline content make it preferable for lines selection in subsequent generations, when the heterozygosity decreased to a very low level. Due to the presence of non-additive variance selection for this trait in early generations will be difficult.