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Yield stability of hybrids versus lines in wheat, barley, and triticale

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Abstract

Hybrid breeding in the self-pollinating crops wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), and triticale (×*Triticosecale* Wittmack) has the potential to lead to higher yield and enhanced yield stability. Yield stability can be assessed by the genotype-specific genotype by environment interaction (GEI) variance, which is termed stability variance. Small stability variance indicated high dynamic yield stability. A genotype that possesses high dynamic yield stability has changes in yield performance across environments, which correspond to the average changes in yield performance of all genotypes across environments.

Precise estimation of stability variance of individual genotypes requires intensive testing of genotypes. A recent study investigating barley registration trials suggested a minimum of 40 test environments. For group-specific estimates the required number of test environments is expected to be lower due to the larger sample of GEI effects.

We investigated three published experiments of the three crops. The wheat experiment comprised 1606 single-cross hybrids and 143 inbred lines, the barley experiment 45 single-cross hybrids, 15 three-way hybrids, and 36 inbred lines, and the triticale experiment 80 single-cross hybrids and 50 inbred lines. Each experiment was conducted at always five European locations. Single-cross hybrids, three-way hybrids and inbred lines were considered as separate genotypic groups.

The stability variance of each genotypic group was calculated for the three different crops. We found in all three crops a significant ($P<0.05$) smaller stability variance of hybrids compared to inbred lines, indicating higher dynamic yield stability of hybrids. In the barley experiment, stability variance of three-way hybrids was smaller than for the single-cross hybrids, but the difference was not significant. Our results agreed well with previous studies measuring dynamic yield stability with the stability variance. But several studies investigating dynamic yield stability with the deviation variance of the regression approach reported no advantage of hybrids in yield stability.

In the regression approach, for each genotype a linear regression of the genotypic yields in the individual environments on corresponding environmental indices is performed. The environmental indices should describe the yield level of the environments. The variance of the deviations of observed yield from the expected yields based on the regression line can be calculated and used as dynamic stability measure in analogy to the stability variance. In experimental studies comparing different yield stability measures, the deviation variance was closely related with the stability variance. Therefore, we were surprised about the contrasting results in literature and reviewed the studies using the regression approach thoroughly. In at least two of the four studies, the environmental indices were calculated based on yield performance of inbred lines only. We expected that this definition favours a smaller deviation variance of inbred lines, in case hybrids and lines react different across environments.

We analyzed the triticale experiment with the linear regression approach and found that inbred lines showed a lower deviation variance than hybrids when the mean performance of inbred lines was used as environmental index. But when the mean performance of all genotypes or the mean performance of hybrids was used as environmental index, hybrids showed a smaller deviation variance. We concluded that also the studies investigating yield stability with the regression approach would have found a higher dynamic yield stability of hybrids, when they would have used the mean yield of all genotypes as environmental index.

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Reference

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