## Comparison of composite cross winter wheat populations under conventional and organic management with differing N levels

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### Introduction

Due to their increased intra-specific within-crop diversity, diverse populations of wheat are expected to buffer against biotic and abiotic stresses and thus show increased stability compared to standard monogenetic crop stands. However, their level of yield and quality should still be comparable to common wheat cultivars to make them attractive for farmers. In order to better understand the performance of such populations, it is important to gain insights into the effects between neighboring plants, i.e. intra-specific or inter-genotypic effects. Furthermore, if diverse populations evolve under different environmental conditions, it is expected that natural selection will favor better adapted genotypes and the genetic contributions of the populations should change over generations, providing a population better adapted to prevailing conditions.

### Material and Methods

In order to answer such questions we compared 8 composite cross populations (CCPs) of the same genetic origin, but with differing evolutionary history to 10 lines extracted from one population, 6 varieties popular in organic farming (all class E), and 4 conventional varieties (2 class E, 1 class B, and 1 class C) in four trials across Germany in the season 2015/16. Two trials were managed conventionally and two organically, all following local practices. In all trials two nitrogen treatments (conventional: full and half nitrogen rates, organic: 100 kg N/ha and no applied nitrogen) were applied as the main plot factor, and in the organic trials an additional living mulch (white clover in one trial and subterranean clover in the other trial) treatment was included. The number of replicates was 4 in three trials and 3 in one trial.

### Results and discussion

Yield levels averaged 78 dt/ha and 36 dt/ha for conventional and organic trials, respectively. The additional nitrogen applied, led to an increase in yield between 2 and 5.7 dt/ha and was significant in all trials.
While the conventional varieties showed the highest yields in all trials (overall mean yield 65.5 dt/ha), the organic varieties and the populations had lower, but similar yields (55.3 dt/ha and 55.8 dt/ha respectively), and the extracted lines had the lowest yield (49.9 dt/ha). Assuming that the extracted lines experienced no selection and are thus a representative sample of the genetic diversity of the populations, it can be suggested, that the increased yield of the populations compared to the extracted lines is due to intra-crop or inter-genotypic interactions and effects, resulting in higher yields in the CCPs.
Following a Finlay-Wilkinson regression approach, where the performance of each genotype is regressed on the mean yield of each trial, the conventional varieties are better adapted to higher yielding environments (b=1.12), while the organic varieties are better adapted to lower yielding environments (b=0.90). The populations and extracted lines rank in-between (b=0.98 and b=1.03 respectively). According to the dynamic stability parameters, the deviation mean square (deviation from Finlay-Wilkinson regression),

Wricke’s ecovalence, Shukla’s stability variance and Hühn’s rank variance, the populations show the highest stability, the organic varieties and the extracted lines rank in the middle and the conventional varieties show to be the least stable (Table 1).

*Table 1: Mean yield and stability parameters across 9 environments (combination of trial and nitrogen/living mulch treatments) from the season 2015/2016.*

| **Genotype groups** | **Mean yield (dt/ha)** | **Slope (Finlay-Wilkinson)** | **Deviation Mean Square** | **Wricke's ecovalence** | **Shuklas stability variance** | **Hühn's rank variance** |
|---|---|---|---|---|---|---|
| Populations | 55.8 | 0.98 | 6.4 | 60.9 | 7.5 | 53.7 |
| Extracted Lines | 49.9 | 1.03 | 13.1 | 123.2 | 15.9 | 72.8 |
| Organic varieties | 55.3 | 0.90 | 11.8 | 163.1 | 21.3 | 63.5 |
| Conventional varieties | 65.5 | 1.12 | 24.7 | 292.8 | 38.7 | 116.0 |

While the CCPs overall showed significant yield differences in comparison to the commercial varieties and the extracted lines, no significant ($P>0.05$) differences (measured by yield) could be identified between the 8 tested populations, both over all trials and within each trial. The populations were harvested and resown under differing environmental and management conditions (e.g. conventional vs organic) over the last 10 years. The absence of significant difference between the populations could indicate that either differences in environmental conditions were not sufficiently great enough to lead to genetic differentiation between populations or that year-to-year differences in biotic and abiotic stresses were greater than differences between management and thus did not allow for adaptation to certain environmental conditions.