



## OWC 2020 Paper Submission - Science Forum

### *Topic 1 - Ecological approaches to systems' health*

OWC2020-SCI-331

#### **AGRONOMIC PERFORMANCE OF HETEROGENEOUS CEREAL POPULATIONS**

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**Full Paper Publication:** Yes

**Abstract:** Results from comparative field trials of heterogeneous winter wheat and maize populations marketed in Germany under the temporary experiment 2014/150 of the European Commission are presented. Winter wheat populations were tested across 16 environments (four locations x four years) and eight maize populations were tested in six environments (three locations x two years) under organic conditions. In terms of yield and quality parameters both the wheat and maize populations indicated good agronomic performance. The wheat populations demonstrated yield levels and baking quality characteristics comparable to pure line varieties ranked in the highest German quality category (E). The maize populations yielded up to 85% of the hybrid reference varieties. An important future perspective will be the design of field trials for populations in order to test and quantify their special characteristics, e.g. adaptive capacity and suitability for low input conditions.

**Introduction:** Heterogeneous populations offer benefits for farmers and ecosystems, especially under organic and low input conditions. Research indicates that such populations can contribute to better site-specific adaptation, resistance to leaf diseases, resilience to abiotic stresses and conservation of genetic resources. Assessments of the overall agronomic performance and yield stability of populations, however, often remain inconclusive due to their limited scope. In 2014 the European Commission set up a temporary experiment in order to collect more information on populations of the species wheat, barley, oats and maize with specific genetic structures. It is required that field trials of all populations marketed under the experiment should be carried out. In this paper, we present results of trials from Germany for winter wheat and maize populations. A specific focus of the paper looks to question whether the standard Value for Cultivation and Use protocols are suited for population testing.

**Material and methods:** Comparative field trials for winter wheat and maize populations registered in Germany within the temporary experiment of the European Commission (2018) were carried out in accordance with the Guidelines for Testing of Value for Cultivation and Use (VCU testing) of the German Federal Plant Variety Office (Bundessortenamt 2000). Only minor modifications were made to the testing protocols in order to account for the higher degree of variability of populations. For instance, in the case of maize, the trait plant height was assessed by measuring the height of ten plants per replication rather than five. Measurements of yield and quality parameters were carried out according to standard VCU testing protocols.

In this paper, results from three comparative field trials are presented – all of them carried out under organic management and best local agronomic practice with regard to sowing density, weed management and fertilization levels.

In the first trial, six registered winter wheat populations, two breeding populations (ER-F6, ER-F8) and four pure line reference varieties of the highest German quality category (E) were tested at four locations in Germany and Switzerland in 2019. A completely randomized block design was used with a plot size of 1.4 m<sup>2</sup> (Feldbach), 4.8 m<sup>2</sup> (Dottenfelderhof, Gladbacher Hof) and 13.3 m<sup>2</sup> (Forchheim), with three (Feldbach) and four replicates, respectively. The assessed parameters included grain yield and other agronomic and morphological parameters in accordance with standard VCU protocols (results not shown). For the evaluation of significant differences between the yield of the entries the LSD test was applied with  $\alpha=0.05$ .

A second winter wheat field trial was conducted with two registered populations and three pure line reference varieties in the E quality category across 16 environments (four locations x four years 2016-19). The trial was included in larger field trials with more test entries. A plot size of 4.8 m<sup>2</sup> with three replicates was used. In addition to grain yield and other agronomic parameters, the following baking quality parameters were assessed: Wet gluten content, gluten index, Zeleny sedimentation value and Hagberg falling number.

In the maize field trials, 11 entries were tested at three locations in different climatic regions in Germany in 2017 and 2018. Of the 11 entries, eight are maize populations developed from modern breeding material (in one case crossed with landrace germplasm) and three entries are hybrid reference varieties. Five populations were registered within the temporary experiment. The assessed parameters in the maize trial included grain yield (at 86 % dry matter content), dry matter content and other agronomic and morphological parameters in accordance with VCU protocols. The total fertilization level in the trial was set to 190 kg N/ha (including N min).

**Results:** In the winter wheat field trial carried out at four locations in 2019 under organic conditions the four highest yielding entries were populations (see Figure 1). The best performing population, registered as 'Brandex Population' within the temporary experiment, reached a grain yield of 4.7 t/ha, which was significantly higher in comparison to all pure line reference varieties with grain yields ranging between 3.8 – 4.3 t/ha. The yields of the populations in the 'Evolito'-family were not significantly different from the reference varieties.

Results of the second winter wheat trial with two registered populations and three pure line reference varieties in the highest baking quality category E carried out across 16 organic environments (four locations x four years) are presented in Table 1.

Table 1: Winter wheat populations 'Brandex Population' and 'Liocharls Population' and reference varieties (\*) under organic management at four locations (Dottenfelderhof, Alsfeld, Crailsheim, Gladbacher Hof) 2016-2019

	Grain yield	Wet gluten content	Gluten-index	Sedimentation value	Falling number
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Reference variety / population	rel.	rel.	rel.	rel.	rel.
Genius*	105	94	97	98	111
Aristaro*	103	101	101	101	102
Butaro*	93	105	101	102	88
<i>Mean of reference varieties (abs.)</i>	<i>4.6 t/ha</i>	<i>28.66 %</i>	<i>77.69</i>	<i>68.17 ml</i>	<i>342.8 s</i>
Brandex Population	105	98	100	99	92
Liocharls Population	105	99	102	99	90

Across all sixteen environments both populations reached a yield level of 105 % relative to the mean yield of the pure line reference varieties of 4.6 t/ha. The yield of the populations was higher (or comparable) to those of the reference varieties. With regard to baking quality parameters, depending on the growing conditions, the values of E-wheat varieties typically lie above 27 % for wet gluten content, above 50 ml for sedimentation value and above 270 s for the falling number. Results indicate that both populations attained baking quality values within this range (Table 1). For the baking parameters of wet gluten content, gluten-index and sedimentation value, the values of the populations were never less than 2 % relative to the mean of the E-wheat reference varieties. The falling number values for the two populations were well above 270 s and higher in comparison to the reference variety 'Butaro', which achieved both the highest wet gluten content and sedimentation value.

In the maize field trial, the mean grain yield of the hybrid reference varieties (at 86 % dry matter content) was 13.7 t/ha in 2017 and 9.3 t/ha in 2018. The populations yielded between 70 and 85 % of the mean of the reference varieties (see Figure 2). The best performing population over two years ('Evolino Population') reached a yield level of 82 % of the hybrid mean in 2017 and 78 % in 2018. For grain dry matter content, the (absolute) mean of the hybrid reference varieties was 64.7 % in 2017 and 74.9 % in 2018. The values of the populations lay within a range of 98 to 106 % relative to the hybrid mean in 2017 and 92 to 102 % in 2018.

**Discussion:** The results presented in this paper indicate the feasibility of comparative field trials for heterogeneous populations in order to fulfil the aims of the temporary experiment (European Commission 2018) and in accordance with (modified) VCU testing protocols. The results confirm the high agronomic potential of populations under organic management in line with findings of Weedon (2018) and Eder et al. (2017) obtained at single locations. The winter wheat populations in particular have shown comparable yield levels and baking quality characteristics to the E-wheat reference varieties.

In addition to the optimal and high input organic conditions of all trials, the seeds of the various populations also originated from single multiplication sites, which meant that the testing of their adaptive capacity was not possible. An interesting future perspective will be to test populations under varying input levels and to save seeds over the course of multi-year field trials.

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Image:

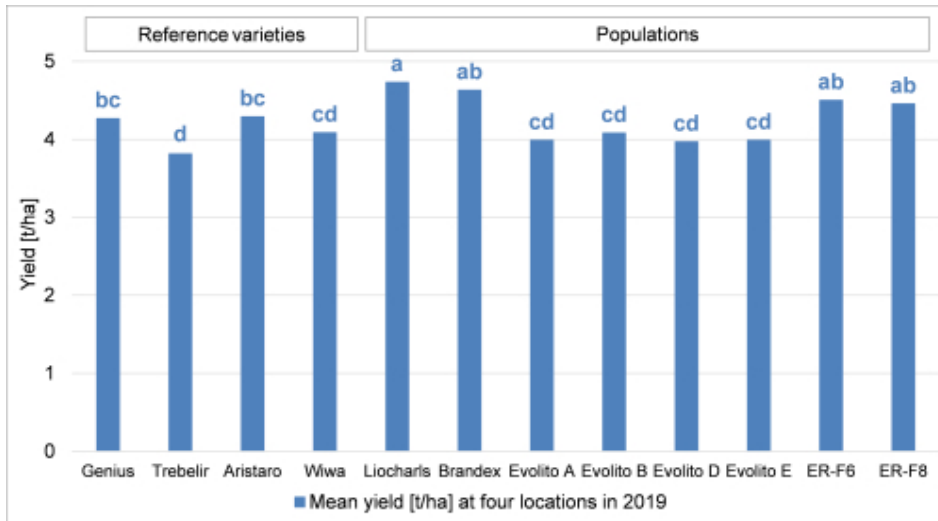
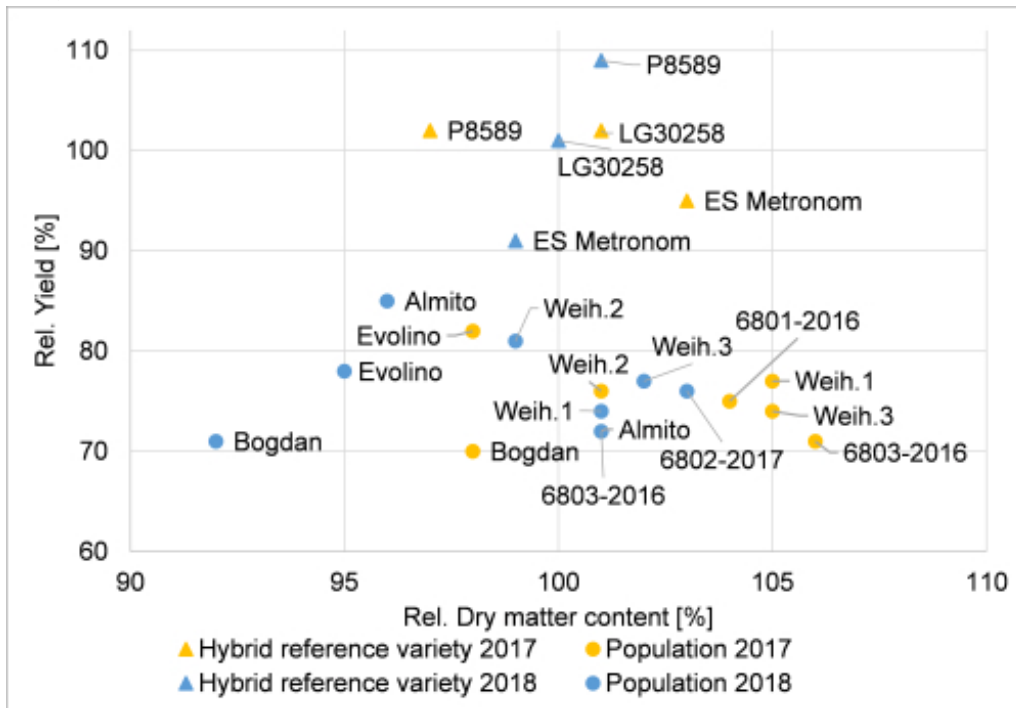


Image 2:



Disclosure of Interest: None Declared

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