



OWC 2020 Paper Submission - Science Forum

Topic 1 - Ecological approaches to systems' health

OWC2020-SCI-774

HETEROGENEOUS POPULATIONS VS. PURE LINE VARIETIES FOR ORGANIC WINTER WHEAT PRODUCTION IN GERMANY - ECONOMIC PERFORMANCE

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Preferred Presentation Method: Oral or poster presentation

Full Paper Publication: Yes

Abstract: The economic performance of composite cross populations (CCP) of winter wheat were calculated and compared with pure line varieties using cost benefit accounting. An organic production system was modelled based on field trial data (yield, quality), market information (prices) and standard data (machinery and labor costs) to calculate the net return of the winter wheat production. This paper compares two CCPs created from both yield- and quality-oriented parent varieties (YQI and YQII) with ten reference varieties. Yield distributions were estimated from experimental data from the INSUSFAR project (harvest years 2016-2019). Simulations for one fertilization scenario (100 kg N) are presented here. At the field trial site, the CCPs were productively and economically similarly successful as or better than reference varieties from organic breeding, with the CCP YQII having the highest net return behind the hybrid and fodder varieties and two of the conventional E-varieties. As expected, these results fit in with previous studies on yield stability by Weedon and Finckh (2019). Our results suggest that the CCPs can also compete (e.g. 'Capo') and outperform (e.g. 'Kerubino') individual varieties from conventional breeding. However, these calculations are based on one trial location, so that further investigations are necessary in order to make general statements. An economic performance at the same level as or better than popular varieties from organic breeding indicates CCPs competitiveness under low-input conditions.

Introduction: Diversity is often seen as a key to stable yields and more resilient cropping systems (Brenda 2011; Finckh 2008). Evolutionary plant breeding and the cultivation of genetically heterogeneous composite cross-populations (CCPs) are an approach to increase diversity with the aim of achieving more stable yields (Döring et al. 2015). However, there is a trade-off between a high short-term yield potential for line varieties and the possible long-term yield stability of CCPs.

Material and methods: The economic performance and production risk of CCPs were calculated and compared with pure line varieties using cost benefit accounting. An organic production system was modelled based on 4 years (2016-2019) of field trial data (grain yield, straw yield, protein content) from Neu-Eichenberg/Germany, market information (ex-post prices from 2017-2019 for 3 quality classes) and standard data (machinery and labor costs) to calculate net returns of organic winter wheat production. This paper compares two CCPs created from both yield- and quality-oriented parent varieties (YQI and YQII) with ten reference varieties (Table 1).

Systematic differences between CCP and pure line variety cultivation were identified in field trials. For example, higher weed suppression was observed with CCP (Finckh et al. 2020), which affects machinery and labor costs. For risk analysis, stochastic simulation (Monte Carlo simulation) was performed using @Risk software. Probability distributions were used for various input parameters (yield, protein content, grain/straw ratio, weed mgmt. cost). Distributions were estimated directly from experimental data from the INSUSFAR project (harvest years 2016 - 2019). Simulations for the fertilization scenario '100 kg N' are presented here.

Table 1: Model entries

E-wheat (conv. bred)	hybrid-/ fodder wheat	E-wheat (org. bred)	CCP
Achat	Elixer	Butaro	YQI
Capo	Hybery	Poesie	YQII
Genius		Tobias	
Kerubino		Wiwa	

Results: As expected, the hybrid variety 'Hybery' and the fodder wheat 'Elixer' had the highest mean yields, but only low protein content. The economic performance of the conventional E-varieties differed greatly. While 'Genius' and 'Achat' showed good quantity *and* quality and therefore the best and third best expected net return, 'Capo' ranks only in the mid-field and 'Kerubino' due to low protein content has the lowest expected net return (Table 2). The best organic reference variety 'Tobias' has high expected returns due to high protein contents. The two populations showed small differences in yield and quality and in terms of economic output rank were better than most organic references (except 'Tobias') and the conventional variety 'Kerubino'. However, the populations differed greatly in variance of the simulated net returns. While OYQ II is among the most stable entries, OYQ I showed one of the greatest variabilities in net return of all entries.

Table 2:

net return of organic wheat		
entry	€/ha	CV
Genius	1668**	31%
Hybery	1592***	28%
Achat	1489**	35%
Elixer	1402***	47%
Tobias	1388*	35%
OYQ II	1374**	31%
Capo	1341**	40%
OYQ I	1328**	50%
Wiwa	1310*	45%
Poesie	1213**	50%
Butaro	1177**	46%
Kerubino	1165***	47%

*elite quality (430€/t); **baking wheat (400€/t);
***fodder wheat (350€/t); CV - coefficient of variance

Discussion: The cultivation methods of CCP and varieties in organic agriculture hardly differ. Although higher weed suppression of CCPs reduces the need for mechanical weeding, significant cost savings by a conversion to CCP cannot be expected. Therefore, revenues are the main influence for economic performance. Revenue is influenced, apart from yield quantity, also by quality. Whether a variety/population gains excellence through differences in protein content depends on the yield difference and the price margin of the quality levels.

At the field trial sites, the CCPs were productively and economically at least at the same level as E-varieties from organic breeding, with the CCP YQII having the highest net return behind the high-yielding conventional varieties. As expected, these results fit in with previous studies on yield stability by Weedon and Finckh (2019). Results suggest that the CCPs can also compete with varieties from conventional breeding that are popular in organic farming (e.g. 'Capo'). However, these calculations are based on only one trial location, so that further investigations are necessary in order to make more general statements. An economic performance at the same level as or better than popular varieties from organic breeding indicates CCPs competitiveness under low-input conditions. Especially since the tested populations were created from relatively old genetic material (all parents from before 2001) and therefore do not reflect recent breeding progress.

References:

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Disclosure of Interest: None Declared

Keywords: net return, organic agriculture, production economics, *Triticum aestivum*, yield stability