Organic World Congress 2020 | FRANCE

SEPTEMBER 21ST TO 27TH, 2020 IN RENNES
AT THE COUVENT DES JACOBINS • RENNES MÉTROPOLE CONFERENCE CENTRE
www.owc.ifoam.bio/2020

OWC 2020 Paper Submission - Science Forum

OWC2020-SCI-656

COMPARING YIELD AND YIELD STABILITY OF ORGANIC BRED AND CONVENTIONAL BRED WINTER WHEAT VARIETIES ON ORGANIC VARIETY TRIALS IN LUXEMBOURG

Hanna Heidt[1], Kerstin Struwe[1], Sabine Kessler[1], Evelyne Stoll[1], Serge Heuchling[2] and Stéphanie Zimmer [1]

[1]Institute for organic agriculture a.s.b.l. (IBLA), 27, Op der Schanz, 6225 Altrier, Luxembourg; www.ibla.lu; heidt@ibla.lu
[2]Lycée Techinque Agricole (LTA)

Abstract: Weather conditions in Luxembourg became more instable, therefore varieties with more stable yields were need in organic farming in Luxembourg. Data of 4 winter wheat varieties (2 organic and 2 conventional), pooled data of all organic and all conventional varieties and total varieties through 2015-2019 were used for analyses. Results show no significant differences in grain yield between organic and conventional bred varieties. One organic and one conventional variety could be selected based on their yield stability. Therefor yield stability could be a useful tool for analysing variety trials.

Introduction: In organic farming the main criteria for choosing the right varieties are mostly yield and other quality parameters such as health and weed suppression. Additionally, the stability of these parameters could be useful because the environmental effects have greater impact on organic farming since the use of mineral fertilizer and pesticides were permitted. Normally, the stability parameters were not taken for account, because it requires data over a long period. In the last years the weather variability in Luxembourg increased and varieties with more stable yields were need in organic farming in Luxembourg. Therefore, the aim of the study was to analyse the differences of organic and conventional varieties of winter wheat in yield and yield stability in the winter cereal variety trials on organic farming sites in Luxemburg.

Material and methods: Since 2010, the winter cereal variety trials in organic farming were conducted on two sites ("Gutland" and "Oesling") in Luxembourg, which represents the important regions for organic farming in Luxemburg. The test fields are on two organically managed farms as IBLA does not own an agricultural experimental station. The exact trials are done in a randomized block design in three repetitions. For the analyse, data from 2015 to 2019 were used. As described in the papers of Finck et al. (2000), Mundt etr al. (1995) and Reid et al. (2011) each year and location was treated as separate environment, which makes a total number of 8 environments.

For the study 4 winter wheat varieties, Jularo and Govelino (organic bred varieties) and Elixer and Florian (conventional bred varieties) and pooled data of all organic bred varieties, all conventional bred varieties and overall varieties were used.

The data were analysed using the package “agricolae” (de Mendiburu, 2019) in R. Data were tested for normality using Shapiro test. Least square mean values for yield were compared by t-test and p-values were adjusted by the Tukey–Kramer correction. Yield stability were calculated using Shukla`s stability variance and Kang`s Yield stability statistics analysis (Kang, 1993). Kang`s yield-stability-statistic (Ysi), which is a modified Kang`s modified rank-sum (KMR) (1991) method, is able to determine type I and type II error rates relative to select for both yield and stability. Additionally, the stability component in Ysi is based on the stability-variance statistics (δi2) of Shukla (1972) which were also calculated in the study.

Results: The analysis showed a difference in yield between the pooled organic bred varieties and the pooled conventional bred varieties in the organic variety trials in Luxembourg of 3.49 t/ha and 3.67 t/ha, but the difference in yield was not significant (p-value >0.05) (see Table1).

For the four varieties Elixer and Florian (conventional bred varieties), Govelino and Jularo (organic bred varieties), Elixer showed the highest yield 4.02 t/ha but had also the highest standard deviation (Std) of 1.49 t/ha. Florian had a lower yield as well as a lower Std (3.69 t/ha and 1.04 t/ha). In comparison to the two conventional varieties, Govelino and Jularo had similar yield of 3.77 t/ha and 3.62 t/ha with low respectively medium Std of 0.9 t/ha and 1.15 t/ha. Nevertheless, significant differences between the organic bred varieties (Govelino and Jularo) and the conventional bred varieties (Elixer and Florian) could not be observed (see Table 1).

The Shukla`s stability variance for all four varieties and for both pooled data of organic bred and conventional bred varieties were highly significant (p<0.01) and ranged between 115.51 and 6.80, only the stability variance of all varieties (-1.11) were not significant. Kang`s yield stability statistics show that only Elixer and Govelino had a stable yield in comparison to the other varieties Florian and Jularo as well as the pooled data (see Table 1).

Table1: Mean Yield, standard deviation of yield (Std), Minimum yield (Min) and maximum yield (Max), Shukla`s stability variation (Stab.var) and Kang`s yield stability statistics (YSi) calculated for all four varieties, both pooled data sets and over all data set during the seasons 2015-2019

Variety	Mean Yield*	Std	Min	Max	Stab.var**	Ysi***
Elixer	4.02[a]	1.49	2.54	6.40	115.51**	0*
Florian	3.69[a]	1.04	2.25	5.15	17.11**	-4
Govelino	3.77[a]	0.90	2.59	5.42	58.47**	1*
Jularo	3.63[a]	1.15	2.09	5.32	34.73**	-8
Pooled organic varieties	3.49[a]	1.03	2.16	5.12	6.80**	-10
Pooled conventional varieties	3.67[a]	1.22	2.00	5.43	16.56**	-5
Total varieties	3.60[a]	1.14	2.06	5.23	-1.11	-1

* Tukey-Kramer Test with p-value <0.05, different letters show significant difference of the results

** Shukla`s stability variance: with significance levels of p <0.1, p<0.05 *, p<0.01**

***Kang`s stability statistics with mean YSi: -3.57, varieties > mean YSi were selected: * selected varieties on the basis of Ysi

Discussion: The results of this analysis show no significant difference in yield between organic bred varieties and conventional bred varieties in the organic winter wheat variety trials in Luxemburg. One reason is that conventional bred varieties could not fulfil their high yield potential, because of the lack of mineral fertilizers of the low-input system in organic farming and the involved environmental effects (Urbatzka et al., 2019a, 2019b). Another reason is that organically bred varieties are better adapted to the low-input conditions and the higher environmental effects in organic farming, since they were already bred in these conditions and could fulfil their whole potential in variable environments with higher stress potential (Spiess, 2019). However, it is important to perform variety trials in organic farming at different environments, in order to choose the right variety, because not all varieties were adapted for all environmental conditions and they should only be performed on organic farm sides (Reid et al., 2011).

Additionally, the yield stability could be an important selection tool for organic farming for the choice of appropriate varieties, since selection on yield stability could achieve a more uniform yield increase (Reid et al., 2011). Therefore, research should emphasis more on yield stability in the selection process, which would also benefit the growers, because growers could suffer yield loss, if the varieties are selected based only of the mean yield. The stability component of in Ysi is a useful tool to decrease the probability of disastrous type II errors (Kang, 1993)

Consequently, calculation of yield stability should be included in variety trial performance in Luxembourg, but still further analyses are needed.

Keywords: Organic bred varieties, conventional bred varieties, winter wheat, yield, yield stability, organic farming

References

Finckh, M.R., Gacek, E.S., Goyeau, H., Lannou, C., Merz, U., Mundt, C.C., Munk, L., Nadziak, J., Newton, A.C., de Vallavieille-Pope, C., et al. (2000). Cereal variety and species mixtures in practice, with emphasis on disease resistance. Agronomie 20, 813–837.

Kang, M.S. (1991). MODIFIED RANK-SUM METHOD FOR SELECTING HIGH YIELDING, STABLE CROP GENOTYPES. Cereal Res. Commun. 19, 361–364.

Kang, M.S. (1993). Simultaneous Selection for Yield and Stability in Crop Performance Trials: Consequences for Growers. Agron. J. 85, 754.

de Mendiburu, F. (2019). Package 'agricolae' Statistical Procedures for Agricultural Research.

Mundt, C., Brophy, L., and Schmitt, M. (1995). Disease severity and yield of pure-line wheat cultivars and mixtures in the presence of eyespot, yellow rust, and their combination. Plant Pathol. 44, 173–182.

Reid, T.A., Yang, R.-C., Salmon, D.F., Navabi, A., and Spaner, D. (2011). Realized gains from selection for spring wheat grain yield are different in conventional and organically managed systems. Euphytica 177, 253–266.

Shukla, G.K. (1972). Some statistical aspects of partitioning genotype-environmental components of variability. Heredity 237–245.

Spiess, H. (2019). Populationssorten im Getreide (Heinerscheid).

Urbatzka, P., Scherm, P., Viehbacher, W., and Uhl, J. (2019a). Stabilität verschiedener Sorten von Sommergerste. In Innovatives Denken Für Eine Nachhaltige Land- Und Ernährungswirtschaft., (Kassel: Verlag Dr. Köster, Berlin), p.

Urbatzka, P., Uhl, J., Urgibl, A., and Zott, S. (2019b). Vergleich der Ertragsstabilität von Hybrid- und Populationsroggen. In Innovatives Denken Für Eine Nachhaltige Land- Und Ernährungswirtschaft., (Kassel: Verlag Dr. Köster, Berlin), p.

Acknowledgement

The organic variety trials in Luxembourg were financed by the ministry of agriculture, viticulture and rural development. We thank Marc Reinig und Georges Schmit of Lycée Technique Agricole Ettelbruck for their technical support, the ASTA laboratory for the analyses and all the participating farmers.