

AGRONOMIC PERFORMANCE OF SOME WHEAT VARIETIES UNDER CONVENTIONAL AND ORGANIC FIELD CONDITIONS

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Abstract

In this study we tested an assortment of eight Romanian wheat varieties in conventional and organic field conditions at Agricultural Research and Development Station Șimnic, Craiova. The results for the yield showed that the varieties exhibited a significant interaction only with the organic field conditions. In these conditions of the organic field, the Litera variety was significantly inferior to the control (Glosa variety) in terms of yield. Overall, the varieties grown under organic field conditions had a lower yield (-42.6%), with a lower thousand grains weight (-6.8%) and a lower hectoliter weight (-1.6%) compared to conventional field conditions. The varieties of wheat that showed minimal loss under organic field conditions were Glosa for yield; Glosa and Ursita for thousand grains weight, and Ursita and Zamfira for hectoliter weight, hence these varieties could be used as parents for organic breeding programs in this region. Only in conventional field conditions, the correlation between yield and hectoliter weight was significant, 64.5% of the yield variability being associated with the variability of this character.

Key words: conventional, organic, hectoliter weight, thousand grains weight, yield, wheat.

INTRODUCTION

Most wheat production is produced using the conventional crop system, a system that contributes substantially to ensuring global food security.

In 2020, global wheat production was 760 million tons (FAO, 2020). According to Grote et al. (2021), more than two-thirds of global wheat is used for food and one fifth is used for livestock feed.

In recent years, organic wheat production has increased significantly in many countries due to consumer demand.

Organic farming is accepted as an effective alternative to overcome the effects of chemical pollution in conventional agriculture (Gevrek & Atasoy, 2012).

An organic farming system is based on the use of organic fertilizers and non-chemical crop protection strategies, which often involves a reduction in yields compared to a conventional system, but this reduction can be offset by higher prices for organic products (Tamis & Van den Brink, 1999).

To overcome concerns about limiting production in organic farming systems, better

adapted genotypes that use nitrogen efficiently are needed (Kubota et al; 2018; Chen et al., 2020). Also, a major constraint factor for organic farming is weed infestation, so competitive genotypes are needed. A competitive genotype for organically grown wheat must have agronomic traits: rapid growth at the beginning of the season, taller plants, early maturity and elevated fertile tillers number (Mason et al., 2007).

In addition to the crop system, the yield of wheat is also influenced by the interaction of other factors: cultivar, soil, climate (Jonczuk & Stalenga, 2016).

Wheat is a crop sensitive to prevailing weather conditions, such as rainfall during grain filling and temperatures in July (during the ripening period of cereals) (Jansone & Gaile, 2013).

In many previous studies, it is mentioned that Oltenia is a region of agricultural crop where drought and heat frequently occur limiting the yield of agricultural crops (Bonea, 2016; 2020a, 2020b; 2020c; Urechean & Bonea, 2012; Urechean et al., 2019; Bonea & Urechean, 2020; Dunăreanu et al., 2021), therefore organic agriculture needs varieties that can cope with different levels of abiotic

stress and have a stable yield over the years (Dunăreanu & Bonea, 2022).

This feature, respectively drought tolerance is another important issue for both conventional and organic farming. Organic farmers can give higher priority to this feature because they want an organic system that is less dependent on inputs (Lammerts van Bueren et al., 2011).

The main objective of the study is to evaluate the performance of an assortment of wheat varieties in conventional and organic field conditions to identify the most suitable varieties.

MATERIALS AND METHODS

The study was conducted in the agricultural year 2020-2021 in two field conditions: conventional and organic (Figure1, Figure 2).

Conventional cultivated plots were fertilized in autumn with doses of NPK 18-46-0 and in spring ammonium nitrate in two doses: 200 kg/ha in February and 150 kg/ha in April. No organic pesticides were used in the organically grown plots and no weed control was performed.

The analyzed wheat assortment was represented by 8 Romanian varieties obtained at NARDI Fundulea. This assortment was analyzed in terms of average yield, as well as thousand grains weight (TGW) and hectoliter weight (HW).



Figure 1. View from the organic field

TGW and HW was determinate with Seed counter - Sadkiewicz instruments and Perten AM 5200-A. The data provided in this study is the average of three replicates.

ANOVA to analyze all data for randomized block design was used.

The differences between the varieties were compared based on the least significant difference (LSD $P \leq 0.05$; 0.01 and 0.001).

Relationships between studied characters were examined using Pearson correlation coefficients ($p \leq 0.05$). Use Microsoft Excel 2010 for data calculations.



Figure 2. View from the conventional field

RESULTS AND DISCUSSIONS

Yield is the main determinant of the economic value of wheat.

In our study, under conventional field conditions, all tested varieties performed at the control variety (Glosa), the differences being statistically non-significant.

The maximum yield was recorded for the Pitar variety (8929 kg/ha), and the minimum yield for the Litera variety (6911 kg/ha).

Favorable climatic conditions in the study year led to an average production of 7489 kg/ha (Tables 1 and 3).

Table 1. Yield of wheat in conventional field conditions

Variety	Yield (kg/ha)	Differences to control (kg/ha)	Signif.
Glosa (Ct)	7396	Control	-
Pitar	8929	+1533	ns
Boema 1	5955	-1441	ns
Litera	6911	-485	ns
Ursita	7827	+431	ns
Semnal	7942	+546	ns
Voinic	7880	+484	ns
Zamfira	7071	-325	ns

LSD 5% = 2267.7 kg/ha; LSD 1% = 3112.8 kg/ha;
LSD 0.1% = 4300.2 kg/ha; ns = non-significant

In organic field conditions, ANOVA showed significant differences between varieties, but only Litera variety recorded a significant decrease in production compared to the control variety (-1698 kg/ha). For the rest of the varieties, the differences from the control were non-significant; the average production obtained being of 4295 kg/ha (Tables 2 and 3).

Table 2. Yield of wheat in organic field conditions

Variety	Yield (Kg/ha)	Differences to control (Kg/ha)	Signif.
Glosa (Ct)	4573	Control	-
Pitar	4235	-338	ns
Boema 1	4147	-426	ns
Litera	2875	-1698	0
Ursita	4649	-76	ns
Semnal	4836	+263	ns
Voinic	5437	+864	ns
Zamfira	3605	-968	ns

LSD 5%= 1336.6 kg/ha; LSD 1%=1840.9 kg/ha; LSD 0.1% = 2534.5 kg/ha; 0 or ns = significant or non-significant at LSD 5%

The classification of the varieties (ranking) based on the studied characters (yield, thousand grains weight and hectoliter weight) was made according to the minimum and maximum differences between the organic and the conventional field conditions (Tables 3-5).

Because nutrient intake in organic field conditions is a limiting factor in production, all varieties tested had lower yields in organic field compared to conventional field condition.

On average, the difference was -3194 kg/ha or -42.6% (Table 3).

Thus, the difference in yield between the two types of cropping systems is largely determined by the rainfall in the year of study.

According to Urechean & Bonea (2017), the Oltenia area is often affected by drought and heat only two years out of ten are favorable to agricultural crops.

Table 3. Ranking of the varieties for yield based on the differences between the conventional and organic management systems (a-b=c)

Variety	CONV ^a	ORG ^b	Difference ^c	Rank
Boema 1	5955	4147	1808	1
Voinic	7880	5437	2443	2
Glosa	7396	4573	2823	3
Ursita	7827	4649	3178	4
Semnal	7942	4836	3293	5
Zamfira	7071	3605	3466	6
Litera	6911	2875	4036	7
Pitar	8929	4235	4694	8
Mean	7489	4295	3194 (42.6%)	-

COV - conventional; ORG - organic

Compared to conventional field conditions, the smallest decrease in organic yield was recorded in the Boema 1 variety (-1808 kg/ha) which ranked first, and a maximum decrease in yield was recorded in the Pitar variety (-4694 kg/ha) which ranked last (eighth place) (Table 3).

The grains weight is a highly heritable trait and has made significant contributions to yield potential in modern wheat breeding.

Thousand grains weight (TGW) and yield has proved to be the preferable criteria to screen for heat-tolerant wheat in field (Cheng et al., 2015).

Wheat varieties capable of making a TGW higher under thermal stress, it has a higher tolerance to warm environment (Mohtasham, 2012).

In our study, with one exception (Zamfira variety in organic conditions) all varieties had TGW values of over 40 g.

The Glosa variety was the only variety that recorded a higher TGW value (49.6 g), respectively an increase of value (+2.9 g) in organic culture compared to conventional culture (46.7 g). On average, the difference between the fields was -3.1 g or -6.8% (Table 4).

The smallest decrease in TGW in organic conditions was recorded in the Ursita variety (0.5 g) and a maximum decrease was recorded in the Boema 1 variety (8.7 g) compared to conventional conditions (Table 4).

Table 4. Ranking of the varieties for thousand grains weight based on the differences between the conventional and organic field conditions (a-b=c)

Variety	CONV ^a	ORG ^b	Difference ^c	Rank
Glosa	46.7	49.6	+2.9	1
Ursita	46.0	45.5	0.5	2
Voinic	42.9	41.5	1.4	3
Semnal	42.7	41.0	1.7	4
Zamfira	40.9	38.1	2.8	5
Pitar	48.0	43.0	5.0	6
Litera	47.1	40.1	7.0	7
Boema 1	49.3	40.6	8.7	8
Mean	45.5	42.4	3.1 (6.8%)	-

COV - conventional; ORG – organic

Hectoliter weight (HW) is another determining factor in the economic value of wheat. The grading manual for consumption seeds in Romania, establishes for wheat a minimum value of 78 kg/hl for Grade 1 quality, 75 kg/hl for Grade 2 and 72 kg/hl for Grade 3 quality (Dunăreanu & Bonea, 2022).

In our study, in conventional conditions, Pitar and Voinic varieties met the requirements for Grade 1 quality and the rest of the varieties for Grade 2 and 3 of quality.

In organic conditions only Voinic variety was classified in Grade 1 of quality. Also, only

Glosa variety registered values below the limit of 72 kg/hl, respectively 70.2 kg/hl (with non-bakery value) in organic conditions. Thus, the largest decrease for HW in organic conditions compared to conventional conditions was recorded in the Glosa variety (4.1 kg/hl) which ranked last, and the smallest decrease of 0.3 kg/hl in the Ursita and Zamfira varieties who took the first places (Table 5).

Table 5. Ranking of the varieties for hectoliter weight based on the differences between the conventional and organic field conditions (a-b=c)

Variety	CONV ^a	ORG ^b	Differences ^c	Rank
Ursita	77.4	77.1	0.3	1
Zamfira	75.1	74.8	0.3	2
Boema 1	73.1	72.7	0.4	3
Voinic	79.7	79.0	0.7	4
Semnal	76.9	75.9	1.0	5
Litera	74.9	73.8	1.1	6
Pitar	78.0	76.6	1.4	7
Glosa	74.3	70.2	4.1	8
Mean	76.2	75.0	1.2 (1.6%)	-

COV - conventional; ORG - organic

Under conventional field conditions, the only significant correlation was observed between yield (Y) and HW ($r = 0.803^*$), indicating that 64.5% of the wheat yield variability could be explained by the variability of this character (Figure 3). The rest of the correlations were non-significant (Table 6).

Table 6. Pearson's correlation coefficients between studied characters under conventional field conditions

Characters studied	Yield	Thousand grains weight	Hectoliter weight
Yield	1	0.191 ^{ns}	0.803 [*]
Thousand grains weight		1	-0.378 ^{ns}
Hectoliter weight			1

*; ^{ns} - significant; non-significant at 0.05 level of probability

In organic field conditions, all correlations between the studied characters were non-significant (Table 7), probably due to the small number of variants tested, the correlations studied were mostly non-significant.

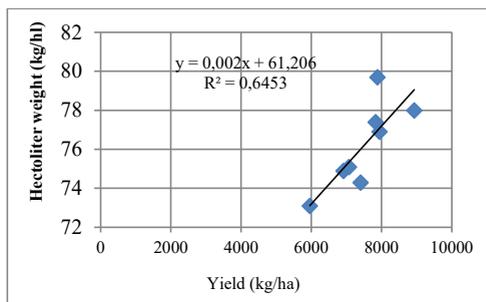


Figure 3. Dependence between yield and hectoliter weight in conventional field conditions

Table 7. Pearson's correlation coefficients between studied characters under organic field conditions

Characters studied	Yield	Thousand grains weight	Hectoliter weight
Yield	1	0.381 ^{ns}	0.431 ^{ns}
Thousand grains weight		1	-0.345 ^{ns}
Hectoliter weight			1

ns – non-significant at 0.05 level of probability

CONCLUSIONS

The yield of the varieties tested in the organic system was, on average, by 42.6% lower than in the conventional system. Also, thousand grains weight was smaller by 6.8% and hectoliter weight by 1.6%.

The wheat varieties that registered a minimal decrease in the value of the characters studied in organic conditions compared to the conventional conditions were: Glosa for yield; Glosa and Ursita for thousand grains weight, and Ursita and Zamfira for hectoliter weight.

These varieties are recommended for organic farming in the study area, depending on the purpose of the farmers (production or quality), but can also be used as parents in the breeding program for organic farming.

In general, all correlations between the characters studied were insignificant in both field conditions, except for the correlation between yield and hectoliter weight in organic field conditions.

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