un kvalitātes pazīmes Jogevas Augu Selekcijas institūta izmēģinājumos laikā no 2004. līdz 2007. gadam. Ziemas kviešu raža un 1000 graudu masa pārsniedza vasaras kviešu rādītājus katru gadu. Vasaras kviešiem bija augstāks proteīna saturs un tilpummasa. Graudu raža un 1000 graudu masa bija atkarīgas no kviešu sezonālā tipa, bet citas pazīmes vairāk ietekmēja attiecīgo gadu meteoroloģiskie apstākļi. Gada ietekme abiem kviešu tipiem bija lielāka uz ražu, 1000 graudu masu, proteīna un lipekļa saturu, maizes kukuļa apjomu un mīklas stabilitāti. Gada ietekme uz krišanas skaitli vasaras kviešiem bija lielāka nekā šķirnes ietekme, bet ziemas kviešiem – otrādi. Tilpummasa vasaras kviešiem bija vairāk atkarīga no gada, bet ziemas kviešiem - no šķirnes.

SELECTION CRITERIA IN TRITICALE BREEDING FOR ORGANIC FARMING

Kronberga A.
State Priekuli Plant Breeding Institute, Zinatnes str. 1a, Priekuli, Cesis distr., Latvia, LV-4126,
phone +371 4130162, e-mail: artakron@navigator.lv

Abstract
For creating varieties suitable for organic farming a special breeding programme has been started in Priekuli Plant Breeding Institute. The evaluation of triticale genotypes in organic farming was done in Priekuli during 2005 - 2007. The aims of research are:
Estimating possibility for selecting genotypes desirable for organic farming in conventional fields.
To find desired traits for the organic triticale varieties breeding programme.
There were included 25 different winter triticale (*xTriticosecale Wittm.*) breeding lines in our trials, selected from the conventional breeding programme. The different traits were tested for each genotype. The influence of different traits on yield and grain quality was analyzed. Every year the best 25 different triticale breeding lines from the organic and conventional growing conditions were compared.
The results showed that different breeding lines reacted differently to growing conditions. It is possible to select genotypes suitable for organic conditions in the conventional field. To select genotypes with better stability of the traits (especially in the years with unfavorable weather conditions) and suitability for organic farming, selected breeding lines must be tested in organic growing conditions.
For organic farming only genotypes with good winterhardiness and resistance to snow mould should be selected.
Triticale genotypes with different plant height, growth habit, leaf size would be suitable for organic growing conditions.

Key words: triticale, organic breeding, trait

Introduction
For the further development of organic agriculture, more attention is being focused on the creation of better adapted varieties. As organic conditions are less controllable and more variable, breeding should be aimed on improved yield stability and product quality by being adapted to organic soil fertility, sustainable weed, pest and disease management (Lammerts van Bueren., 2002; Lammerts van Bueren *et al.*, 2007). Therefore the traits required for the varieties in organic and conventional farming differ. Some breeding programmes were started in the last years with aim to evaluate genotypes adaptation to organic agriculture for characteristic traits required in organic farming systems and to elaborate the selection criteria that facilitate the breeding of proper varieties for organic agriculture (Schneider *et al.*, 2007; Legzdina and Skrabule, 2005).
The main objectives in the breeding programmes for small grains cultivars for organic farming are: to improve the nutrient efficiency, weed suppression ability (new ideotype of plant), as well as the resistance to leaf, spike and soil born diseases, the efficient use of manure, reducing risk of diseases (long stem, ear high above flag leaf, ear not too compact, last leaves green for the longest time possible), reducing risks at harvest, higher stress tolerance to abiotic causes (Ittu *et al.*, 2007, Legzdina and Skrabule, 2005; Lammerts van Bueren, 2002; Kopke, 2005; Goyer *et al*., 2005).

Long years work experience with the newest small grains species - triticale (*xTriticosecale Wittm.*) shows that this crop is very suitable for growing in Latvian agroclimatic conditions. Such traits as high yield potential, good nutrient efficiency, resistance to diseases are advantages for growing triticale in Latvian organic and conventional fields. Triticale breeding for organic farming was started in Latvia at the same time as in some other countries – for example, Romania, Germany (Skrabule, 2005; Ittu *et al.*, 2007).

The winter triticale breeding programme for organic farming was initiated in the State Priekuli Plant Breeding Institute in 2004. The limited area allowed for organic agriculture as well as limited financing will be the bottleneck for the establishment of specific breeding programmes for organic farming systems (Lammerts van Bueren *et al.*, 2002). The financing of a special triticale breeding programme for organic farming is problematical in Latvia too. Due to this problem the first tasks of the breeding programme in Priekuli are: 1. Estimating possibility for selecting genotypes desirable for organic farming in conventional fields; 2. Determination of the most important traits for the selection criteria in plant breeding for organic farming.

Materials and Methods

The investigation was conducted at the State Priekuli Plant Breeding Institute experimental fields. The breeding material was evaluated over three years (2004-2005, 2005-2006 and 2006-2007) in a randomized block design with 4 replicates, plot size 12.6 m^2. The field was certified as being organic from 2003. Soil properties: sod-podzolic soil, soil type –sandy loam, organic matter content 19- g kg^{-1}, pH_{KCl} – 5.9- 6.0, P - 69-111 g kg^{-1}, K - 114-165 g kg^{-1}, preecrop– peas for green manure. No agrochemicals and fertilizers were used. Trial varieties were sown on 26 September 2005, 14 September 2006 and 16 September 2007. The seeding rate was 450 germinating seeds per m^2.

The following field trials were performed:

1. The breeding lines according traits assessment which are significant for organic farming (stable yield, disease resistance a.o.) were selected in the conventional field and tested in the organic field, with the aim to establish the efficiency of the organic breeding if the first steps are done in conventional field. Every year the best 25 different triticale breeding lines from the organic and conventional growing conditions were compared. Soil properties in conventional field: sod podzolic soil, soil type –sandy loam, organic matter content 19-23 g kg^{-1}, pH_{KCl} – 5.9- 6.0, P - 79-84 g kg^{-1}, K - 110-160 g kg^{-1}, preecrop – white clover for seed. Basic fertilizer (N:P:K 6:26:30) 300 kg ha^{-1}, additional fertilizing (N 60+30) as well as herbicide, was applied in the conventional field in every ear of the investigation. The trial varieties in the conventional field were sown on 24 September 2005, 14 September 2006 and 15 September 2007. The seeding rate was 400 germinating seeds per m^2.
2. With the aim to find the most desirable traits for the triticale organic crop ideotype for Latvian growing conditions 25 different winter triticale breeding lines in the organic field were tested and about 30 different traits were evaluated: yield, heading, maturity, winter hardiness, lodging, growth habit, infection with leaf diseases (*Septoria* spp., *Puccinia* spp., *Rhynchosporium* spp. a.s.o), infection with snow mould (*Microdochium nivale*), weed amount in the plot, grain quality parameters (1000 kernel weight, protein, starch content, volume weight, falling number). Five plants from every replication were planted and such morphological traits as plant height, ear length, spike density were measured. The importance of the influence of different traits on yield and quality traits (protein content) was tested. The correlation analysis was used to find out the most acceptable traits for organic crop ideotype of triticale. Descriptive statistics and correlation analysis were used for analyzing the obtained results.

During the study years, the meteorological conditions were significantly different. Due to a cold and dry autumn in 2004 the tillering of triticale was delayed. The spring of 2005 was cold and the vegetation renewed itself comparatively late and the infection of plants with snow mould was very strong. Triticale flowering in 2005 was very late – from 20 of June (about 10 days later than usually). July was warm and dry, but the beginning of August was very rainy – as a result of these conditions triticale grains sprouted in the ears.

The weather conditions in autumn and winter months of 2005/2006 were favorable for triticale tillering and for over wintering. However April was very cold and the triticale plants began to

wither away. Snow mould was spread widely. July was dry and warm. Such weather conditions significantly influenced yield – yield level was lower than in another years.
Some days of January 2007 had very low air temperature (-22.5°C), without a mantle of snow on the soil. These conditions negatively influenced triticale overwintering. Vegetation renewed comparatively early in spring 2007. Triticale flowered earlier than in other years. The weather conditions in June, July, August was typical for the Latvian climate and the triticale yield level was high. The weather conditions in 2007 were very favorable for leaf disease development - septoria (*Septoria tritici*), leaf rust (*Puccinia recondita f.sp. tritic)i*, powder mildew (*Erysiphe graminis*).

Results and Discussion

The obtained results show very similar triticale genotypes traits average yield value and their variance in organic and conventional fields. Triticale adapted oneself good to conventional and to organic conditions (Table 1). The mean and maximum yield of triticale genotypes was slightly higher in the organic field in the two years of the investigation (2005 and 2007). Only in the year with unfavorable weather conditions (cold winter and dry and hot summer) the triticale yield in organic field was lower.

Table 1. Characteristics of triticale genotypes yield in organic and conventional fields

Year	Growing conditions	Mean, t ha^{-1}	Standart deviation	Coefficient of variation, %	Minimum, t ha^{-1}	Maximum, t ha^{-1}
2005	Org. field	4.6	0.8	17.0	3.1	6.4
	Conv.field	4.3	0.7	16.3	2.5	5.7
2006	Org. field	2.9	0.6	20.6	1.5	3.8
	Conv.field	4.7	0.7	14.8	3.5	5.8
2007	Org. field	5.6	0.8	14.2	4.1	7.6
	Conv.field	5.7	0.7	12.2	5.0	7.5

Although many investigations point out that triticale samples are characterized by a high amount of crude protein in grains, this was not proved in Latvia agroclimatic conditions (Kronberga, 2001), therefore it is necessary by breeding to increase protein content in triticale grains, especially in the organic field where the mean protein content was lower than in the conventional field (Table 2). Mean protein level was higher in the organic field only in 2005, nonetheless in all three years in the organic field maximum protein level in grains was similar to them on conventional field.

Table 2. Characteristics of protein content (in %) in grains in organic and conventional fields

Year	Growing conditions	Mean, % in grains	Standart deviation	Coefficient of variation, %	Minimum, % in grains	Maximum, % in grains
2005	Org. field	11.3	0.8	7.1	9.9	12.9
	Conv.field	10.1	0.7	6.9	8.5	11.5
2006	Org. field	13.2	0.7	5.3	12.1	15.3
	Conv.field	14.0	0.7	5.0	12.7	15.1
2007	Org. field	10.4	0.8	7.6	9.1	11.7
	Conv.field	10.9	0.6	5.5	9.8	11.9

Each year of the testing the genotypes with a high starch or protein content in the grains, good winterhardiness, resistance to snow mould, 1000 kernel weight and other tested traits were in the organic field. This verifies that it is possible to select genotypes in conventional field, which would have good testing results in the organic field.
Triticale traits were influenced by weather conditions also. So the triticale in the organic field owerwintered better that in the conventional field however the yield level in organic field was lower in 2006. Very hot and dry weather conditions during ripening may disturbed effective utilizing of nutrients in the organic field. This shows the mean and maximum value of 1000 kernel weight was lower in organic field (Table 3).
The mean protein content in grains in 2006 was higher that in the other years of investigation in both fields due too warm and dry summer, however, trait variance in the organic and the conventional field was very similar. Therefore it is necessary especially evaluate genotype stability

in the organic field in the years with unfavorable weather conditions with aim the to find genotypes which have stable trait values in these conditions.

Table 3. Characteristics of triticale genotypes 1000 kernel weight (g) in organic and conventional fields

Trait	Growing conditions	Mean, g	Standart deviation	Coefficient of variation, %	Minimum, g	Maximum, g
2005	Org. field	46.1	3.4	7.3	40.0	52.9
	Conv.field	43.0	3.5	8.1	36.8	49.1
2006	Org. field	38.1	2.7	7.1	33.2	43.7
	Conv.field	40.8	4.4	10.8	35.6	51.4
2007	Org. field	44.2	3.1	7.0	39.6	51.0
	Conv.field	41.6	4.4	10.6	33.1	51.2

Different triticale genotypes varied differently according to their response to organic and conventional growing conditions. The correlation between yield of the same genotypes in the organic and conventional field was positive and significant only in 2007. This trial year had suitable weather conditions for winter cereal development (r_{2005}=0.0.217<$r_{0.05}$=0.396; r_{2006}=-0.077<$r_{0.05}$=0.396, r_{2007}=0.675<$r_{0.05}$=0.396). It was possible to select lines with a higher yield and grain quality in organic growing conditions. For example, line 9402-32 had lower yield, protein content in grains, 1000 kernel weight in the organic field in the all years of investigation (Table 4). But line 9540-1 was better in organic conditions. However in 2006, when weather conditions were unfavorable for triticale growing, the yield of line 9540-1 in the organic field decreased significantly. There were some cultivars that had high yield performances in both types of testing conditions (for example, 9405-23).

Table 4. Results of some triticale lines testing in organic and conventional growing conditions

Genotype	Year	Yield, t ha^{-1}		Protein, %		1000 kernel weight, g	
		org.cond.	conv. cond.	org.cond.	conv. cond.	org.cond.	conv. cond.
9402-32	2005	3.11	4.89	10.8	11.2	49.7	52.3
	2006	3.22	4.56	12.8	14.6	43.7	48.0
	2007	5.89	6.11	10.8	11.4	51.0	49.3
9540-1	2005	5.49	4.74	11.1	9.7	42.1	39.3
	2006	2.73	5.48	13.1	13.7	34.4	35.6
	2007	5.62	5.44	10.4	10.4	42.7	37.1

To find the most desirable traits for organic farming, the correlation between all the tested traits and the yield as well as quality traits (protein) was calculated. Winterhardiness is one of most important trait for organic varieties. There was a positive and significant correlation between yield and winterhardiness in all years of the investigation (Table 5).

Table 5. Correlation between traits in organic field

Traits	Year		
	2005	2006	2007
Yield-winterhardiness	0.504*	0.605**	0.529**
Yield –resistance to snow mould	-0.300	-0.655**	-0.646**
Winterhardiness –resistance to snow mould	0.634**	0.604**	0.467*
Yield-plant height	0.041	0.063	0.153
Yield-weed amount in the plot	-0.639**	-0.849**	-0.563**
Yield-protein content in grains	-0.153	-0.086	-0.458*
Leaf area -1000 kernel weight	0.674**	0.104	0.218
Growth habit-weed amount in the plot	0.354	-	-0.244

*, ** - significant at the 0.05 and 0.01 probability level respectively

A significant correlation between winterhardiness and resistance to snow mould in all the years of the investigations prove, that good resistance to snow mould is one of most important components of good overwintering of triticale in Latvia. Genotypes with better winterhardiness have a larger amount of ears on the 1 m^2 and as result – better weed competitiveness and a higher yield. This shows that for organic farming only genotypes with good winterhardiness and resistance to snow mould should be selected.

The obtained results do not prove the necessity to select for organic farming triticale genotypes with long stems. There was not found a significant correlation between yield and plant height ($r_{2005}=0.041<r_{0.05}=0.396$; $r_{2006}=0.063<r_{0.05}=0.396$, $r_{2007}=0.153<r_{0.05}=0.396$, n=25). It was observed, that genotypes with longer stems were less infected with leaf diseases, however in our trials there was a significant negative correlation between infection with leaf diseases and plant height only in the year 2005 ($r_{2005}=-0.409>r_{0.05}=0.396$; $r_{2006}=-0.363<r_{0.05}=0.396$, $r_{2007}=0.271<r_{0.05}=0.396$, n=25). The obtained results were similar with triticale testing results in Rumania, with the conclusion, that both tall and short straw genotypes are between genotypes suitable for organic farming (Ittu *et al*., 2007).

According to the obtained results, the yield was not significantly influenced by leaf size or growth habits. Triticale resistance to diseases decreased in the last years (Arseniuk *et al*, 2006) but the influence of diseases on the yield was not found. There was not a significant correlation between yield and infection with leaf diseases *(Septoria* spp., *Puccinia* spp., *Rhynchosporium* spp), powder mildew (*Erysiphe graminis*). Good resistance to these diseases make triticale very suitable as an organic field cropfor the present, and by selecting genotypes it should not be lost.

There were negative correlation between the yield and protein content in the grains; however only in 2006 this correlation was significant. It indicates possibility to find genotypes with high yield and protein content in grains.

No stable and significant influence of the tested traits was found on the protein content in the grains. There was not proved influence of growth habit on the weed competitiveness.

The obtained results indicated that it is possible to find triticale genotypes suitable for organic farming with different traits as plant height, growth habit, maturity time, leaf size. However these genotypes have to be with good winterhardiness and resistance to snow mould, as well as resistance to other diseases.

Conclusions

It is possible to select triticale genotypes suitable for organic conditions in the conventional field. However the testing of selected breeding lines have to be done in organic growing conditions. Genotypes with better stability traits must be selected (especially in the years with unfavorable weather conditions).

For organic farming only genotypes with good winterhardiness and resistance to snow mould should be selected.

Triticale genotypes with different plant heights, growth habits, leaf size would be suitable for organic growing conditions.

References

1. Arseniuk E., Oleksiak T., Strzembicka A., Reszka E., Poznan W. (2006) Occurrence and relative importance of triticale diseases in Poland. Proceedings of the 6th International Triticale Symposium 3-7 September 2006, Stellenbosh, 28-32.
2. Goyer, S., Al Rifai, M., Bataillon, P., Gardet, O., Outy, F.X., Rolland, B. (2005) Selection index for winter wheat cultivars suitable in organic farming. Proceedings of the COST SUSVAR/ECO-PB Workshop on Organic Plant Breeding Strategies and the Use of Molecular Markers, 84.
3. Ittu Gh., Săulescu N.N., Ittu M, I Toncea. (2007) Performances of winter wheat and triticale cultivars under low input technology. Østergård, H. and Fontaine, L., Eds. (2006) Cereal crop diversity: Implications for production and products. Proceedings of COST SUSVAR workshop, La Besse, Paris (FR), 12-15 Jun 2006, 95-96.
4. Kopke, U. (2005) Crop ideotypes for organic cereal cropping systems. Proceedings of the COST SUSVAR/ECO-PB Workshop on Organic Plant Breeding Strategies and the Use of Molecular Markers, 13-16.

5. Kronberga A (2001) Tritikāles selekcijas izejmateriāla raksturojums un Latvijas agroekoloģiskajiem apstākļiem piemērota šķirnes modeļa izstrāde. Disertācijas kopsavilkums. Jelgava, 48.
6. Lammerts van Bueren E. T. (2002) Organic plant breeding and propagation: concepts and strategies PhD Thesis Wageningen University. The Netherlands. -196.
7. Lammerts van Bueren E.T., Wilbois K.P., Ostergard H. (2007) European perspectives of organic plant breeding and seed production in a genomics era In: Journal of Agriculture and Rural development in the Tropics and Subtropics, Supplement 89, 101.-120.
8. Legzdina L., Skrabule I. (2005) Plant breeding for organic farming: current status and problems in Europe. Report, Seminar ENVIRFOOD, http://orgprints.org/5703/01/EnvirfoodCompendiumOrgPlBreed.pdf , accessed on 05.02.2008.
9. Skrabule, I. (2005) Crop breeding for organic farming – current situation in Latvia. Proceedings of the seminar Environmental friendly food production system: requirements for plant breeding and seed production, Talsi, Latvia, 54-58.
10. Schneider D., Fossati D. and Mascher F. (2007) Breeding for varieties adapted to low-input conditions: Should we use old varieties? Østergård, H. and Fontaine, L., Eds. (2006) Cereal crop diversity: Implications for production and products. Proceedings of COST SUSVAR workshop, La Besse, Paris, 112-114.

IZLASES KRITĒRIJI TRITIKĀLES ŠĶIRŅU SELEKCIJĀ BIOLOĢISKAJAI LAUKSAIMNIECĪBAI

Kronberga A.

Priekuļu laukaugu selekcijas institūtā uzsākta bioloģiskajai lauksaimniecībai piemērotu šķirņu selekcija. Tās sākuma etapā tika veikta dažādu tritikāles genotipu izvērtēšana bioloģiskajā laukā ar mērķiem:
Novērtēt, vai iespējama bioloģiskajai lauksaimniecībai piemērotu genotipu izlase konvencionālās selekcijas laukā;
Atrast pazīmes, pēc kurām jāvērtē tritikāles genotipi, lai nodrošinātu to labu piemērotību bioloģiskajai lauksaimniecībai.
Izmēģinājums veikts trīs gadus (no 2005. līdz 2007.gadam). 25 dažādas tritikāles selekcijas līnijas atlasītas konvencionālās selekcijas laukā un izvērtētas bioloģiskajā laukā. Katram genotipam novērtētas 30 dažādas pazīmes, tai skaitā arī pazīmes, kas tiek uzskatītas kā nozīmīgas bioloģiskajai lauksaimniecībai (auga garums, cera forma u.c.). Novērtēta šo pazīmju korelācija ar ražu un kopproteīna saturu graudos. Katru gadu salīdzināti 25 genotipi bioloģiskajā un konvencionālajā laukā un novērtēta dažādu pazīmju variācija atkarībā no audzēšanas veida.
Iegūtie rezultāti liecina, ka dažādu genotipu reakcija uz bioloģiskajiem un konvencionālajiem audzēšanas apstākļiem atšķiras. Bioloģiskajai lauksaimniecībai piemērotu līniju atlasi iespējams veikt konvencionālās selekcijas laukā. Tomēr šīs līnijas pēc tam nepieciešams pārbaudīt bioloģiskajā laukā, lai novērtētu pazīmju stabilitāti un atlasītu bioloģiskajai lauksaimniecībai vispiemērotākās.
Pēc izmēģinājuma rezultātiem konstatēts, ka svarīgākie izlases kritēriji, veidojot bioloģiskajai lauksaimniecībai piemērotas ziemas tritikāles šķirnes ir to laba ziemcietība un izturība pret sniega pelējumu. Pētījumā netika pierādīts, ka bioloģiskajiem laukiem ir piemēroti genotipi tikai ar garu stiebru un klājenisku cera formu.

TESTING RESULTS OF THE SPRING BARLEY VARIETY 'RUBIOLA'

[1]Legzdiņa L., [1]Gaiķe M., [2]Gaile Z., [1]Bērziņa I.
[1]State Priekuli Plant Breeding Institute, Zinatnes str. 1a, Priekuli, Latvia, phone: +371-4130162, e-mail: lindaleg@navigator.lv
[2]RSF "Vecauce" of Latvia University of Agriculture, Akademijas str. 11a, Auce, Latvia

Abstract
One of problems for barley (*Hordeum vulgare* L.) in organic farming is its infection with seed born diseases, particularly with loose smut (*Ustilago nuda*). Currently in the Latvian Plant Variety