Int. Agrophysics, 2004, 18,

INTERNATIONAL
Agrophysics
www.ipan.lublin.pl/int-agrophysics

Evaluation of grain technological quality of X *Triticosecale* Wittmack with *Aegilops* sp. hybrids

D. Gruszecka[1], *D.Kulpa*[2], *and E. Makarska*[3]

[1]Institute of Genetics and Plant Breeding, University of Agriculture, Akademicka 15, 20-934 Lublin
[2]Department of Food Technology and Storage, University of Agriculture, Skromna 8, 20-704 Lublin
[3]Department of Chemistry, University of Agriculture, Akademicka 15, 20-934 Lublin

Received August 18, 2003; accepted September 23, 2003

A b s t r a c t. Technological value of grain of new hybrid triticale lines achieved due to crossbreeding X *Triticosecale* Wittmack with *Aegilops* sp. was studied as compared to standard triticale varieties to select lines with the best technological value. It was found that the new triticale lines under evaluation were characterized by usually higher 1000-kernel weight than standard Bogo cv., but this value depended on the year of the study when compared to Presto cv. The hybrid strains were characterized by lower volume weight than Presto cv., but exceeded or were similar to Bogo cv. Grain shapeliness and uniformity for the lines studied were usually significantly lower than for standard triticale varieties. Great differentiation of vitreousness within the lines was found; vitreousness of strain 3 and 6 grain even exceeded that for both standard varieties. Total protein content was also higher for both strains than for Presto cv. The hybrid triticale strains were distinguished with lower wet gluten content than the standard varieties. Flour extract from triticale with Aegilops cross-combination grain was significantly lower than from Presto cv., but similar to Bogo cv. Among the strains studied, No 4 and 5 were characterized by the highest value of that trait and the best rheological properties of dough. Evaluation of baking and its organoleptic features revealed the superiority of strain 4 over standard Presto cv. Strain 4 deserves attention as a material for the baking industry.

K e y w o r d s: triticale, *Aegilops* sp., hybrids, technological value

INTRODUCTION

Cereals of good technological value can broaden the assortment of bakery products for consumers. Introduction of genes responsible for the improvement of their breeding and technological traits through inter-genus crossbreeding of triticale (X *Triticosecale* Wittmack) with *Aegilops* (*Aegilops* sp.) is one of the methods of quality improvement of triticale (Gruszecka, 1998; Gruszecka and Kowalczyk, 2000). Triticale is a fodder cereal which can also be utilized in flour milling, baking, dough cooking and as a component of breakfast mixtures and even for noodle production (Błażewicz, 1993; Beglińska and Cacak-Pietrzak, 1996, Haber, 1989; Haber *et al*., 1993; Tambros and Briggs, 1984). Species of the *Aegilops* genus are characterized by resistance to disease-forming factors, pests, unfavorable environmental conditions, as well as by a high content and good quality of protein (Berzensky and Kimber, 1987; Frauenstein and Hammer, 1985; Hammer, 1985; Rivoal *et al*., 1993). Remote hybridization and selection may facilitate accumulation of genes responsible for good technological quality of hybrids better than in triticale.

The aim of the study was to assess the technological value of seeds of new hybrid triticale lines achieved due to the crossbreeding of X *Triticosecale* Wittmack with *Aegilops* sp., as well as the selection of the best lines as compared to standard triticale varieties.

MATERIAL AND METHODS

Four hybrid lines of three crossbred combinations of triticale with *Aegilops* constituted the material for the study: *Ae. crassa* 4x Boiss × CZR 1125/90 (strain 3), *Ae. juvenalis* 6x (Thell.) Eig × 1125/90 (strains 4 and 5), CZR 1421/89 × *Ae. juvenalis* 6x (Thell.) Eig (strain 6), and two standard triticale varieties: Bogo and Presto (strains 1 and 2) (Table 1). The material originated from a comparative experiment set in four replications along with standards and performed for

*Corresponding author's e-mail:gruszdan@agros.ar.lublin.pl

two vegetation seasons (1997/1998 and 1998/1999) at the Experimental Station Czesławice on a dust soil of loess origin.

The following determinations were made: 1000-kernel weight, volume weight, shapeliness and uniformity, share of vitreous grains, grain humidity and total protein content (N × 6.25). Trial grinding was performed using a QC 109/2 laboratory grinder, and the flour obtained was subjected to technological and farinographic analysis. Trial laboratory baking of chosen strains was performed. Analyses were made in 2 or 3 replications according to standards for cereal products (Jakubczyk and Haber, 1983).

The results of the study were statistically processed; verification of differences among mean values for particular strains and standard triticale varieties was performed using variance analysis and multiple T-Tukey's intervals.

RESULTS AND DISCUSSION

On the basis of the study, it was found that the new triticale strains were usually characterized by a higher 1000-kernel weight (48.2 g in 1997 and 42.3 g in 1998) than the standard Bogo cv. (38.3 and 43.3 g, respectively). As compared to Presto cv. (42.1 and 51.8 g, respectively), this value depended on the year of the study (Table 2). The results achieved are similar to those obtained for triticale varieties (Ciglińska *et al*., 2000): 34.1-49.5 g. Gil (2001), when testing triticale grain in the same years, achieved lower mean values for that trait (37.3 g in 1997 and 33.2 g in 1998). The high 1000 kernel weight for the hybrids of triticale with *Aegilops* proves their good shapeliness and high sowing potential.

Although the hybrid strains were characterized by a lower density (64.2 kg hl^{-1} in 1997 and 65 kg hl^{-1} in 1998)

T a b l e 1. Material for study

Strain	Variety/Cross combination	Generation 1996/1997	Generation 1997/1998
1	Bogo	-	-
2	Presto	-	-
3	*Ae. crassa* 4x Boiss x CZR 1125/90	B_3/F_2	B_3/F_3
4	*Ae. juvenalis* 6x (Thell.) Eig x CZR 1125/90 (1)	B_2/F_3	B_2/F_4
5	*Ae. juvenalis* 6x (Thell.) Eig x CZR 1125/90 (2)	B_2/F_3	B_2/F_4
6	CZR 1421/89 x *Ae. juvenalis* 6x (Thell.) Eig	B_2/F_2	B_2/F_3

T a b l e 2. Characteristics of physical and chemical traits of grain of hybrid triticale varieties and strains (mean values)

Strain	Harvest year	1000 kernel weight (g)	Density (kg hl^{-1})	Shapeliness	Uniformity	Vitreousness	Total protein (Nx6.25)
				(%)			
1	1997	38.3_{**}	60.9_{**}	91.8	91.8	31	15.1
	1998	43.3	66.4	96.0	96.0	24	13.8
2	1997	42.1^{*}	68.2^{*}	95.2	95.2	28	13.5
	1998	51.8^{*}	72.9^{*}	97.9	97.9	27	11.9^{*}
$\bar{x}$	1997	40.2	64.5	93.5	93.5	29.5	14.3
	1998	47.5	69.6	97.0	97.0	25.5	12.9
3	1997	45.2^{*}	63.5^{*}_{**}	76.2^{*}_{**}	76.2^{*}_{**}	39^{*}_{**}	14.1
	1998	43.5_{**}	65.8_{**}	89.5^{*}_{**}	89.5^{*}_{**}	37^{*}_{**}	12.3^{*}
4	1997	51.6^{*}_{**}	66.7^{*}_{**}	88.9	88.9	23^{*}	13.3
	1998	38.8^{*}_{**}	63.5^{*}_{**}	75.3^{*}_{**}	75.3^{*}_{**}	19	12.0^{*}
5	1997	51.7^{*}_{**}	66.6^{*}_{**}	88.4	88.4	25	11.9^{*}
	1998	40.5^{*}_{**}	64.4^{*}_{**}	79.7^{*}_{**}	79.7^{*}_{**}	22	12.4^{*}
6	1997	44.2^{*}	59.8^{*}_{**}	76.3^{*}_{**}	76.3^{*}_{**}	36_{**}	14.9
	1998	46.6^{*}_{**}	66.3_{**}	92.3^{*}_{**}	92.3^{*}_{**}	36^{*}_{**}	12.4^{*}
$\bar{x}$	1997	48.2	64.2	74.9	74.9	30.8	13.5
	1998	42.3	65.0	84.2	84.2	28.5	12.2

Statistically significant difference as compared to: *Bogo cv. at P=0.01, $_{**}$ Presto cv. at P=0.01.

than Presto cv. (68.2 and 72.9 kg hl^{-1}, respectively), they exceeded or were almost the same as the Bogo cv. (60.9 and 66.4 kg hl^{-1}, respectively) (Table 2), which indicates similar endosperm to fruit-seed cover ratio and shapeliness. Biskupski *et al*. (1992) observed similar values for triticale, and Haber *et al*. (1993) as well asCeglińska *et al*. (2000) (67.2-78.8 kg hl^{-1}) and Gil (2001) (71-71.4 kg hl^{-1}) proved higher grain density at the strewed state.

Strains 4 and 5, in which *Ae. juvenalis* was the maternal form, had higher 1000-kernel weight and density than strain 6 with Ae. juvenalis as the paternal form.

Grain shapeliness and uniformity for the strains under study (75.3-92.3%) were usually significantly lower than for the standard triticale varieties (91.8-97.9%) (Table 2). Haber *et al*. (1993) presented similar results (65.5-91%).

Evaluation of the kernel vitreousness indicates a great influence of the genetic factor on the trait development, and less of the weather conditions (Table 2). Strains 3 and 6 were characterized by significantly higher vitreousness (37-39 and 36%, respectively) than the other two strains (19-25%) and even the standard triticale varieties (24-31%). Vitreousness differences between two years reached only 4%. However, other conclusions were drawn by Gil (2001), who found the that triticale grain vitreousness and, to a lesser extent, inter-variety traits, were affected by the weather. Results of a study performed upon triticale by Achremowicz and Podgórska (1989), as well as that by Biskupski *et al.* (1992), showed higher vitreousness than the values achieved in the present study. Ceglińska *et al*. (2000) observed a much lower value of that trait. High grain vitreousness that proves a high protein content was also confirmed in the present paper. Strains with high vitreousness (3 and 6) were characterized by a higher total protein content.

Most of the hybrid triticale strains were characterized by a significantly lower total protein content (11.9-14.9%) than the standard Bogo cv. (13.8-15.1%), and by a similar level to that of Presto cv. (11.9-13.5%). Similar values for triticale were achieved by Ceglińska *et al*. (2000) (10.2-12%), and by Biskupski *et al*. (1992) (11.1-17.7%). Lower values (9.7-10.8%) were obtained by Ceglińska and Haber (1997), as well as by Achremowicz *et al*. (1998) (9.1%, on average). Moreover, a decrease of protein content for all the studied forms was observed in the second year, which can be explained by worse weather conditions. Gil (2001) also observed a similar phenomenon when comparing the total protein content in triticale grains in 1997 (13.4%) and 1998 (12.7%).

It was found that flour extract from the hybrid triticale with *Aegilops* combinations was significantly less than that from Presto cv., and similar to Bogo cv. (Table 3). Among the strains studied, No. 5 and 4 were characterized by the highest values of that trait (46.5 and 49.5%, at the first, and 42.7 and 49.2%, respectively at the second year). Cacak-Pietrzak *et al*. (1995) achieved higher flour extracts (65.7-75.3%), but Achremowicz and Podgórska (1989) lower ones (40.8-47%).

Ash content in flour made from the hybrid strains was 0.64-0.97% and thus it was higher then in flour prepared

T a b l e 3. Characteristics of trial grain grinding from hybrid triticale varieties and strains (mean values)

Strain	Harvest year	Flour extract	Bran efficiency	Losses
		(%)		
1	1997	44.49**	54.31**	1.20
	1998	48.41	50.90	0.69
2	1997	51.48*	47.49*	1.03
	1998	52.17*	46.91*	0.92
$\bar{x}$	1997	47.98	50.80	1.11
	1998	50.29	48.9	0.80
3	1997	41.45**	57.99**	0.56
	1998	45.77***	53.56**	0.66
4	1997	42.73**	55.77**	1.50
	1998	49.20**	50.02**	0.77
5	1997	46.49	53.13	0.38
	1998	49.45**	49.61	0.94
6	1997	42.63**	56.19**	1.18
	1998	42.35***	56.75***	0.90
$\bar{x}$	1997	43.32	55.77	0.80
	1998	46.7	52.48	0.81

Statistically significant difference as compared to: *Bogo cv. at P=0.01, **Presto cv. at P=0.01.

from Presto cv. (0.63-0.73%). The high level of ash in the material studied proves large amounts of minerals. Ash content in flour from the hybrid forms was comparable to that achieved for triticale by Ceglińska and Haber *et al.* (2001) (0.73-0.98%).

Wet gluten content in the strains analyzed varied within the range of 15.7 to 21.3% (Table 4). Those values were significantly lower than for the standard triticale varieties (24.2-28.1%), which points out to the opportunity of using flour made from triticale with *Aegilops* hybrids in the baking industry, for baking cakes and cookies that do not require high levels of gluten. Clear differences in the gluten content were observed between strain 3 (20% in 1997 and 21.3% in 1998) and strain 6 (15.8 and 17.7%, respectively), which in the case of strain 3 was associated with a high total protein content. Slightly less gluten in triticale flour was found by Achremowicz and Podgórska (1989) (10-24%). Biskupski *et al*. (1992) and Czubaszek (1995) determined a wider variability range for that trait (7.5-39 and 8.2-32.3%, respectively).

On the basis of farinographic studies, it was found that mean water absorption of the hybrids tested was higher (59.9% in 1997 and 64.1% in 1998) than the mean water absorption of the standards (53.0 and 62.1%, respectively) (Table 4). Strains 4 and 5 were positively distinguished in this respect (61-65.4%).

Although mean development time of dough made of the triticale with *Aegilops* hybrid strains (1.1 min in 1997 and 0.9 min in 1998) did not differ from the mean values for this trait in the standard triticale varieties (1 min in both years), oscillations between particular samples were significant (strain 6: 0.4-0.8 min, strain 4: 1.2-1.3 min). Similar differences among the strains and varieties studied also referred to dough stability time, but the influence of harvest year was accentuated: mean dough stability was 1.3 min for the hybrids, 1.4 min for triticale in 1997; and 1.9 min for the hybrids, 2 min for triticale varieties in 1998. These two traits form dough resistance whose values oscillated within 1.3-3.1 min in 1997 and 2.7-3.1 min in 1998 for the hybrids, and 2.1-2.6 min in 1997 and 2.9-3.3 min in 1998 for triticale. From these analyses it follows that dough development and stability times, therefore dough resistance, are a factor that differentiates the breeding material, although they also depend on the weather and soil conditions during the vegetation and harvest.

Dough softening varied at the level from 140 jB (strain 4) up to 275 jB (strain 6). The much lower value of dough softening for strain 4 in 1997 than for triticale dough (205-250 jB) indicates probable usefulness of that hybrid for baking purposes. Also dough elasticity was at the highest level (80-90 jB) among all the studied strains.

T a b l e 4. Technological and farinographic analysis of flour made from grains of hybrid triticale varieties and strains

Strain	Harvest year	Ash	Wet gluten	Water absorption	Dough develop-ment	Dough stability	Dough softening	Elasticity	Resistance
		(%)			(min)		(jB)		(min)
1	1997	0.76	25.9	61.1	1.1	1.5	205	95	2.6
	1998	0.76	28.1	64.2	1.3	1.6	240	90	2.9
2	1997	0.63	24.2	56.6	0.9	1.2	250	85	2.1
	1998	0.73	28.1	60.0	0.8	2.5	220	90	3.3
$\bar{x}$	1997	0.69	25.1	53.0	1.0	1.4	228	90	2.4
	1998	0.74	28.1	62.1	1.0	2.0	230	90	3.1
3	1997	0.80	20.0***	60.4	0.8	1.2	180	50	2.0
	1998	0.77	21.3***	65.2	1.0	1.8	220	60	2.8
4	1997	0.64	19.6***	61.0	1.2	1.7	140	80	2.9
	1998	0.80	15.7***	65.4	1.3	1.8	210	90	3.1
5	1997	0.83	18.4***	62.0	1.6	1.5	200	90	3.1
	1998	0.85	19.6***	63.8	0.9	1.9	210	80	2.8
6	1997	0.97	17.7***	56.2	0.8	0.8	275	75	1.7
	1998	0.66	15.8***	62.0	0.4	2.3	230	90	2.7
$\bar{x}$	1997	0.81	18.9	59.9	1.1	1.3	199	74	2.4
	1998	0.77	18.1	64.1	0.9	1.9	217	80	2.8

Statistically significant difference as compared to: * Bogo cv. at P=0.01, ** Presto cv. at P=0.01.

T a b l e 5. Characteristics of trial baking of baking from flour of Presto cv. and hybrid triticale strains

Strain	Harvest year	Dough efficiency	Stove loss	Total baking loss	Bread efficiency	Baking volume	Baking volume made from 100 g of flour
		(%)				(cm^3)	
2	1997	138.0	14.1	14.6	117.8	530	292.5
	1998	163.6	11.3	13.0	142.4	550	360.0
3	1997	-	-	-	-	-	-
	1998	161.7	9.5	12.2	141.3	500	323.4
4	1997	140.6	12.9	14.0	120.9	570	320.6
	1998	164.5	12.2	14.4	140.8	650	427.8

T a b l e 6. Organoleptic evaluation of baking made from flour of Presto cv. and hybrid triticale strains

Strain	Harvest year	Baking shape	Crust			Crumb					Baking flavour	Baking taste
			Colour	Surface	Thickness (mm)	Colour	Elasticity	Porosity	Bulkiness	Humidity and viscosity		
2	1997	proper	brown	smooth	3	cream-grey	sufficient	uniform	crumby	wet and viscous	proper	proper
	1998	flat	brown	smooth	3	cream-grey	sufficient	uniform	crumby	wet and viscous	proper	proper
3	1997	-	-	-	-	-	-	-	-	-	-	-
	1998	flat	brown	porous	2	cream-grey	sufficient	uniform	crumby	wet and viscous	nasty	insipid
4	1997	proper	golden	porous	3	cream	good	fine uniform	dense cracking	dry	proper	proper
	1998	proper spherical	golden	smooth	3	cream	good	fine uniform	dense	dry	proper	proper

tu będzie kolorowa fotografia (do wmontowania w drukarni)

Fig. 1. Intersection of bread baked using flour of Presto cv. (No. 2) and strain *Ae. juvenalis* 6x (Thell.) Eig × 1125/90 (No. 4).

It can be stated on the basis of the analyses made that grain of the triticale with *Aegilops* hybrids does not differ from standard material (Bogo and Presto cv.) with respect to farinographic traits, and flour made of strain 4 was distinguished by even better properties. Haber *et al*. (1993), Gil (1997) and Achremowicz *et al.* (1998) observed similar values when evaluating triticale flour.

Strain 4 was characterized by the best farinographic traits of flour in both study years (the longest dough development and stability times, the highest dough elasticity and resistance as well as the lowest softening), and Presto cv. was chosen for trial baking. In the second year, strain 3 was additionally taken into account due to its high vitreousness, total protein and wet gluten contents (Tables 5 and 6). Organoleptic assessment of baking produced from strain 4 was the confirmation of its positive grain and flour features. The bread was of spherical shape, smooth skin of golden color and 3 mm thickness (Fig. 1). Its crumb was bright and cream-coloured, with good elasticity, fine and uniform pores, nice flavour and proper taste. This strain appeared to be better than standard Presto cv. Strain 3, despite its high total protein and wet gluten contents, high dough and bakery efficiency as well as low stove and baking loss, had less favourable features during organoleptic assessment (flat shape, brown skin, crumb elastic only to some extent, nasty flavor and insipid taste).

CONCLUSIONS

1. Grain of the triticale with *Aegilops* hybrids was characterized by good technological quality.

2. Strains 4 and 5, in which *Ae. juvenalis* was the maternal form, had more favourable technological features than strain 6 with *Ae. juvenalis* as the paternal form.

3. Strain 4 (*Ae. juvenalis* 6x (Thell.) Eig × 1125/90) deserves attention as a material for utilization in the baking industry.

References: w całości wymagają zmiany. Powinny być napisane ściśle wg załączonej instrukcji.

REFERENCES

Achremowicz B., Mazurkiewicz J., and Tarkowski C., 1998. Ocena wybranych cech technologicznych ziarna nowych rodów pszenżyta (in Polish). Biul. IHAR, 208, 79-87.

Achremowicz B. and Podgórska E., 1989. Fizyczna i technologiczna ocena nowych rodów Triticale (in Polish). Zesz. Probl. Post. Nauk Roln., 354, 9-14.

Berzensky W.A. and Kimber G., 1987. The tolerance to aluminium of Triticum N - genome amphiploides. Plant Breeding, 103, 37-42.

Biskupski A., Bogdanowicz M., and Subda H., 1992. Wartość technologiczna ziarna pszenżyta (in Polish). Część I. Charakterystyka biochemiczna i technologiczna. Hod. Rośl. Aklim. i Nas., 36, 3-4, 73-89.

Błażewicz J., 1993. Estimation of the usability of Triticale malts in brewing industry. Pol. J. Food Nutr. Sci., 43, 2, 1, 39-45.

Cacak-Pietrzak G., Haber T., Duszyńska R., and Sitkowski T., 1995. Wartość przemiałowa nowych krajowych odmian pszenżyta (in Polish). Przegl. Zboż. Młyn. 8, 23-24.

Cieglińska A. and Cacak-Pietrzak G., 1996. Charakterystyka technologiczna wybranych krajowych odmian pszenżyta w zależności od miejsca uprawy (in Polish). Przegl. Zboż.-Młyn., 7, 26-28.

Ceglińska A., Cacak-Pietrzak G., Haber T., Jóźwiak J., and Czerwińska E., 2000. Cechy fizykochemiczne ziarna rodów pszenżyta ozimego (in Polish). Przegl. Zboż.-Młyn., 7, 27-28.

Ceglińska A. and Haber T., 1997. Wpływ ilości i jakości glutenu mokrego na wartość wypiekową mąki pszenżytniej (in Polish). Biul. Kat. Technol. Zbóż, Nasion Oleistych i Koncentratów Spoż. SGGW Warszawa, 5. Dodatek do Przegl. Piek. I Cukierniczego, 7, 35-36.

Ceglińska A. and Haber T., 2001. Wartość technologiczna wybranych odmian pszenżyta ozimego (in Polish). Biul. IHAR, 218/219, 315-321.

Czubaszek A., 1995. Charakterystyka technologiczna pszenżyta hodowli polskiej na podstawie metod pośrednich i wypieku laboratoryjnego. Cz. III. Wartość wypiekowa odmian pszenżyta (in Polish). Hod. Rośl. Aklim. i Nas., 3, 95-109.

Frauenstein K. and Hammer K., 1985. Pruefung von Aegilops-Arten auf Resistenz gegen Echten Mehltau, Erysiphe graminis D. C., Braunrost, Puccinia recondita Rob. Ex Desm. und Spelzenbraeune, Septoria nodorum Berk. Kulturpflanze, 33, 37-42.

Gil Z., 1997. Współzależność pomiędzy niektórymi cechami jakościowymi ziarna i mąki pszenżyta jarego i ozimego (in Polish). Biul. IHAR, 201, 123-131.

Gil Z., 2001. Charakterystyka cech fizycznych, chemicznych i przemiałowych ziarna pszenżyta jarego i ozimego (in Polish). Biul. IHAR, 220, 139-146.

Gruszecka D., 1998. Charakterystyka niektórych cech mieszańców X Triticosecale Wittmack z Aegilops sp. generacji B2/F1 i F2 (in Polish). Biul. IHAR, 205/206, 163-174.

Gruszecka D. and Kowalczyk K., 2000. Charakterystyka wybranych cech ilościowych mieszańców pszenżyta (X Triticosecale Wittmack) z kozieńcami (Aegilops sp.) (in Polish). Folia Univ. Agric. Stetin., 201, 82, 83-88.

Haber T., 1989. Pszenżyto - nowa roślina zbożowa. Charakterystyka technologiczna i możliwości wykorzystania (in Polish). Biul. Central. Labor. Techn. Przetwórstwa i Przechow. Zbóż w Warszawie, 6. Dodatek do Przegl. Zboż.-Młyn., 11-12, 17-21.

Haber T., Lewczuk J., and Pachelska A., 1993. Charakterystyka technologiczna nowych, krajowych odmian pszenżyta (in Polish). Biul. Kat. Technol. Zbóż, Nasion Oleistych i Koncentr. Spoż., 2. Dodatek do Przegl. Zboż-Młyn., 8, 13-17.

Hammer K., 1985. Vorarbeiten zur Monographischen Darstellung von Wildpflanzensortimenten: Aegilops L. Resistenzuntersuchungen. Kulturpflanze, 33, 123-131.

Jakubczyk T. and Haber T., 1983. Analiza zbóż i przetworów zbożowych (in Polish). Skrypt SGGW Warszawa.

Rivoal R., Jahier J., and Hulle H., 1993. Partial resistance to Heterodera avenae in wheat lines with the 6 Mv chromosome from Aegilops ventricosa. Soc. Of Nematologiste, J. Nematel., 25, 2, 265-269.

Tambros S. and Briggs D. B., 1984. Micromalting triticale. J. Inst. Brew. 90, 4, 263-265.