



Original article

## High Yielding Triticale Lines With High Resistance to Powdery Mildew and Stem Rust

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### Abstract

Higher attacks by some fungal diseases are observed in triticale in the recent years. Together with yellow and brown rust, powdery mildew and stem rust are main economically important diseases on triticale. The breeding for resistant cultivars is economically the most efficient and environmentally friendly method for disease control. During 2015 – 2016, 43 triticale lines were selected, which had shown resistance to the causative agents of powdery mildew (*Blumeri graminis* f.sp. *tritici* = *Erysiphe graminis* f.sp. *tritici*) and stem rust *Puccinia graminis* f.sp. *tritici*, and which possessed very good economic parameters. The investigation was carried out in an artificial infection field at Dobrudzha Agricultural Institute. The lines were divided into two groups according to their resistance to the studied pathogens and their productivity. All lines were analyzed for production potential. Triticale lines 102/99-212, 211/05-107, 63/08-89, 218/08-97 and 93/08-87 demonstrated full resistance to the causative agents of powdery mildew and stem rust and possessed productivity exceeding the used standard with over 20 %. Lines 63/08-86, 63/01-293, 63/08-83, 100/08-93, 218/08-81, 100/08-87, 11/07-95, 195/05-120, 113/07-86, 111/07-102, 93/08-89, 63/08-88, 63/08-79, 157τ/9-4, 196/06-135, 195/05-148 combined high productivity with full resistance to powdery mildew and good resistance to stem rust.

**Keywords:** triticale, powdery mildew, stem rust, productivity.

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## INTRODUCTION

In parallel to its high production potential and nutrition value of the grain and green mass, triticale possesses other valuable properties as well. It has lower requirements to the soil and climatic conditions and higher disease resistance. In the recent years, however, greater attacking rates by some fungal diseases are observed. Together with yellow and brown rust, powdery mildew and stem rust are main economically important diseases on triticale. The breeding for resistant cultivars is economically the most efficient and environmentally friendly method for disease control because it reduces the expenses for growing of the crop and facilitates environmental protection and organic production. In triticale breeding, good results have been achieved in combining high disease resistance with very good productivity (Gospodinova and Kurzhin, 1984; Tsvetkov et al., 1986, 1987; Iliev et al., 1996; Stojanovic et al., 1996; Iliev and Baychev, 2007).

The aim of this study was to present results for the resistance determined in new triticale lines to the causative agents of powdery mildew and stem rust and of parameters for high productivity.

### Materials and Methods

During 2015 – 2016, 43 lines were selected from the 315 new breeding triticale lines, which demonstrated resistance to powdery mildew (pm) *Blumeri graminis* (DC) Speer f.sp. *tritici* (*Erysiphe graminis* f.sp. *tritici*) and stem rust *Puccinia graminis* Pers. f.sp. *tritici*. The investigation was carried out in an artificial infection field at Dobrudzha Agricultural Institute. The propagation of the pathogens, the inoculation of the plants and the reading of results was done according to methodologies described by Iliev (1989, 1992).

On the basis of the obtained results, corrected relative attacking rate was calculated by the formula of Zadoks (1972). The susceptible cultivars Sadovska ranozreika 4 (for powdery mildew) and Barbie (for stem rust) were used as standards. The lines were divided into three groups according to their resistance to the investigated pathogens and their productivity. The first group included all triticale lines with productivity exceeding with over 20 % the used standards and demonstrating full resistance to powdery mildew and stem rust (values of P – corrected relative attacking rate – 0). The second group involved lines with productivity 20 % above the standard, full resistance to the causative agent of powdery mildew and partial resistance to the causative agent of stem rust. They showed corrected relative attacking rate within the range from P = 10.0 to P = 30.0. The third group comprised of the breeding materials with productivity of up to 20 % above the standard which also possessed full resistance to the causative agent of powdery mildew and variable susceptibility to the causative agent of stem rust. All triticale lines were analyzed for their production potential.

The parameters grain yield (kg/dka) and relative yield (RY %) were read. The competitive varietal trials were designed by the Latin rectangle method in five replicates, the harvest plot area being 10 m<sup>2</sup>,

after previous crop grain pea and fertilization with N – 3.5 и P2O5 – 8 kg/dka. A mean standard was used for comparing the results in relation with productivity, which was calculated on the basis of the mean values of varieties Vihren and Rakita. The data obtained on productivity were processed by the descriptive statistics method.

### Results and Discussion

The results from the investigation showed that triticale lines 102/99-212, 211/05-107, 63/08-89, 218/08-97 and 93/08-87 had productivity with 20 % above the standard used. Furthermore, these lines demonstrated full resistance to the causative agents of powdery mildew and stem rust. The data from Table 1 reveal that during the time of the investigation the results for yield and resistance in these lines were unidirectional, implying a stable breeding achievement in combining high productivity with high resistance to economically important diseases. The yield from these lines, averaged for the years of investigation, varied from 730 to 866 kg/dka, and the exceeding of the yield was from 23.7 to 40.0 % according to the mean standard, while the differences were with high degree of statistical significance. In this group, lines 63/08-89 and 93/08-87 were with the highest productivity. Averaged for the period of investigation, the yields obtained from these lines were 866 and 827 kg/dka, respectively, the differences with the mean standard over years being highly significant. Besides high productivity, the lines from this group possessed medium high, strong and lodging-resistant stem, and by dates to heading and maturation were equal to the standard cultivar Rakita.

**Table 1.** Triticale lines with productivity over 20 %, and full resistance to pm and stem rust during 2015 – 2016.

Breeding №	2015				2016				mean			
	Kg/dka	RY, %*	Pm	Sr	Kg/dka	RY, %*	Pm	Sr	Kg/dka	RY, %*	Pm	Sr
102/99-212	876	125.4	0	0	624	122.1	0	0	750	123.7	0	0
211/05-107	698	144.8	0	0	722	116.6	0	0	710	130.7	0	0
63/08-89	917	144.5	0	0	815	135.6	0	0	866	140.0	0	0
218/08-97	867	143.7	0	0	730	136.8	0	0	796	139.4	0	0
93/08-87	802	126.3	0	0	853	142.7	0	0	827	134.5	0	0

Pm - powdery mildew; Sr - stem rust

A very good combination of disease resistance and high productivity was observed in the lines from the second group. The lines from this group possessed productivity with over 20 % higher than the productivity of the standard used (Table 2). In these lines there was full resistance to the causative agent of powdery mildew and good resistance to the causative agent of stem rust, the corrected relative attacking rate being within P = 10.0 - P = 30.0. Averaged for the period of investigation, the yield from the lines of the second group varied within 746 - 868 kg/dka, which was equal to an exceeding of 20.8 to 46.8 % from the mean standard.

**Table 2.** Triticale lines with productivity over 20 %, full resistance to powdery mildew and certain susceptibility to stem rust during 2015 – 2016.

Breeding №	2015				2016				Mean			
	Kg/dka	RY, %*	Pm	Sr	Kg/dka	RY, %*	Pm	Sr	Kg/dka	RY, %*	Pm	Sr.
63/08-86	889	140.0	0	0	792	148.8	0	10	840	144.4	0	10
63/01-293	905	129.6	0	0	719	140.8	0	10	812	135.2	0	10
63/08-83	857	135.0	0	0	782	146.6	0	10	819	140.8	0	10
100/08-93	965	152.0	0	0	774	129.4	0	10	868	140.7	0	10
218/08-81	865	143.4	0	0	722	135.4	0	10	793	139.4	0	10
100/08-87	959	151.0	0	0	764	127.4	0	10	861	139.3	0	10
11/07-95	892	150.5	0	0	685	128.5	0	10	788	139.2	0	10
195/05-120	755	148.0	0	0	739	119.4	0	10	747	133.7	0	10
113/07-86	854	142.3	0	0	640	119.9	0	10	747	131.1	0	10
129/06-101	804	113.0	0	0	805	129.6	0	10	804	121.3	0	10
111/07-102	852	142.1	0	0	703	131.8	0	20	777	136.9	0	20
93/08-89	886	139.5	0	0	795	149.1	0	20	840	144.3	0	20
63/08-88	900	141.8	0	0	811	152.0	0	20	855	146.8	0	20
63/08-79	810	127.5	0	0	811	135.6	0	20	810	131.5	0	20
28/04-110	877	117.3	0	0	743	127.5	0	20	810	122.4	0	20
157Т/9-4	907	127.6	0	0	829	133.4	0	20	868	130.5	0	20
196/06-135	851	143.7	0	0	701	117.1	0	20	776	130.4	0	20
195/05-148	907	127.6	0	0	815	131.2	0	20	867	129.4	0	20
4/04-141	849	118.3	0	0	753	129.2	0	20	801	123.7	0	20
4/04-128	830	115.6	0	0	735	126.1	0	20	782	120.8	0	20
6/99-270	864	123.6	0	0	677	132.6	0	30	770	128.1	0	30
137/09-55	865	151.4	0	30	628	117.7	0	10	746	134.5	0	30
66/05-132	918	125.5	0	30	747	120.6	0	20	832	123.0	0	30
161Т/4-2	940	132.2	0	0	782	125.9	0	30	861	129.0	0	30

Lines 100/08-93, 157Т/9-4, 100/08-87, 161Т/4-2 and 63/08-88 had the highest productivity in the second group. Averaged for the time of investigation, the yields from these lines were 868, 868, 861, 861 and 855 kg/dka, respectively, the variations according to the mean standard over years being highly significant. Besides a good combination of high yield with resistance to the causative agents of powdery mildew and stem rust, the lines from this group possessed normal plant height and their dates to heading and maturation were simultaneous with the standard Rakita.

The third group included breeding materials with productivity from 10 to 20 %, higher than the standard used (Table 3). All lines from this group were fully resistant to the powdery mildew causative agent and were to a certain degree susceptible to the causative agent of stem rust. The susceptibility of the lines to the causative agent of stem rust was within 10-50 % of corrected relative attacking rate. Line

54/03-204 had the highest susceptibility to the causative agent of stem rust ( $P = 50$ ), and therefore this line is not recommended for growing on production areas since this would lead to yield decrease and deteriorated grain quality. Moderate susceptibility to the causative agent of stem rust was demonstrated by lines 102/99-491, 246/06-72 and 3/01-173, in these lines the corrected relative attacking rate reached  $P=50$ .

**Table 3.** Triticale lines with productivity from 10 to 20 %, full resistance to powdery mildew and certain susceptibility to stem rust during 2015 – 2016.

Breeding №	2015				2016				Mean			
	Kg/dka	RY, %*	Pm	Sr	Kg/dka	RY, %*	Pm	Sr	Kg/dka	RY, %*	Pm	Sr
10/04-138	800	111.4	0	0	700	120.1	0	10	750	115.7	0	10
90/05-114	817	115.0	0	0	693	111.6	0	10	755	115.5	0	10
30/06-095	750	105.6	0	0	751	121.0	0	10	750	113.0	0	10
158/05-56	803	107.4	0	0	668	114.6	0	10	735	111	0	10
22/04-204	778	108.3	0	0	652	111.8	0	10	715	110.1	0	10
215/05-76	921	113.3	0	0	721	123.7	0	20	821	118.5	0	20
66/05-146	858	120.7	0	0	714	115.0	0	20	786	117.8	0	20
73/01-250	839	120.1	0	0	574	112.4	0	20	706	116.2	0	20
25/03-283	852	119.9	0	0	675	108.7	0	20	763	114.3	0	20
113/00-444	828	110.7	0	0	673	115.4	0	20	750	113.0	0	20
102/99-491	861	123.2	0	0	577	113.0	0	30	719	118.1	0	30
246/06-72	809	113.9	0	0	684	110.2	0	30	746	112.0	0	30
3/01-173	789	113.0	0	0	567	111.1	0	30	678	112.0	0	30
54/03-204	837	119.8	0	0	572	112.0	0	50	704	115.9	0	50

The rest of the lines from this group demonstrated resistant and moderately resistant reaction to the causative agent of stem rust, with corrected relative attacking rate of  $P = 10$  and  $P = 20$ , respectively. Averaged for the period of investigation, the yield from the lines from the third group varied within 678 - 821 kg/dka, which amounted to an exceeding from 10.1 to 18.5 % according to the mean standard. Lines 215/05-76, 102/99-491 and 66/05-146 were with the highest productivity in the third group. The yields from these lines, averaged for the testing period, were 821, 719 and 786 kg/dka.

### Conclusions

Interesting for breeding are lines 102/99-212, 211/05-107, 63/08-89, 218/08-97 and 93/08-87, which possess productivity over 20 % higher than the standard used. These lines have excellent combination of high productivity and full resistance to the causative agents of powdery mildew and stem rust.

The lines from the second group 63/08-86, 63/01-293, 63/08-83, 100/08-93, 218/08-81, 100/08-87, 11/07-95, 195/05-120, 113/07-86, 111/07-102, 93/08-89, 63/08-88, 63/08-79, 157T/9-4, 196/06-135, 195/05-148 are also promising because they combine high productivity with full resistance to the causative agent of powdery mildew and good resistance to the causative agent of stem rust.

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