

PRODUCTIVITY AND QUALITY OF WINTER TRITICALE (*X Triticosecale* Wittmack) IN MULTIFACTORIAL EXPERIMENTS

Victor BURDUJAN, Mihail RURAC, Angela MELNIC

State Agrarian University of Moldova
44 Mircești Street, MD-2049, Chisinau, Republic of Moldova

Corresponding author email: m.rurac@uas.md

Abstract

This article presents the 3-year yield data of two winter triticale varieties depending on the forerunner plants (grain pea and vetch + oats), planted in three different sowing periods (early, optimal, acceptable) and according to three sowing rates - 4.0, 5.0 and 6.0 million of viable seeds per 1 ha. In the multifactorial experiment, the greatest influence on the yield of the studied varieties of winter triticale was recorded by the sowing period (Factor B) – 54.06 – 61.53%, followed by the used forerunner plants (Factor A) – 10.48 – 28.15%, the sowing rate (Factor C) – 9.11 – 18.89%, and the last was the interaction of Factors AB – 6.16 – 8.00%. The highest quality of grain and crude protein content was recorded by Ingen 93 variety where grain pea was used as a forerunner plant. The sowing period of both winter wheat varieties contributed to the mass increase of 1,000 seeds by 0.3-0.7 g on average in 3 years for both forerunner plants. Over the years of research the size of seeds ranged from 37.2 g in 2011 up to 49.4 g in 2013.

Key words: density, forerunner plant, sowing period, triticale, yield.

INTRODUCTION

Triticale is a new cereal, characterized by a high yield of grain and green mass exceeding the indices of wheat and rye. The interest in triticale increases due to the unique combination of a number of economic characteristics: high yield of grain, significant amount of the accumulated protein with a high content of essential amino acids, and primarily lysine, as well as high degree of adaptive capacity. It is a valuable source of protein both for human consumption and animal feed (Zelenskaia and Proshina, 2002; Zelenskaia and Pigunova, 2004). This culture is of great practical interest for Moldova, where winter wheat yields are poorer than triticale yields.

MATERIALS AND METHODS

We studied the following aspects in the multifactorial experiments:

- two varieties of winter triticale: Ingen 35 and Ingen 93;
- two forerunner plants: grain pea (control group) and vetch + oats;
- three different sowing periods: early 12.X (control group), optimal 24.X and acceptable 01.XI;

- three sowing rates: 4.0, 5.0 (control group) and 6.0 million viable seeds per 1 ha.

The experiments were carried out at the Didactic Experimental Station “Chetrosu” in 2011-2013. The experiment was repeated 3 times and the area of the plot was 40 square meters. The winter triticale was sown in rows with row spacing of 12.5 cm and the sowing depth of 5-6 cm. It was used Gossortoseti methodology to experimentally conduct phenological observations of the winter triticale plants. There were defined the elements of plant productivity. The harvest was gathered plot by plot and it was counted for 100% of purity and 14% of humidity. The total nitrogen was determined by Kjeldahl method, the crude protein content was calculated with factor 5.73. Statistical processing of the yield data was performed by the analysis-of-variance method of the multifactorial experiment according to Dospekhov (1985).

RESULTS AND DISCUSSIONS

The winter triticale yield ranged from 1549 to 5108 kg/ha due to the various precipitation amounts during the three years of investigations. The average yield of Ingen 35 variety, with pea as forerunner plant, was of

2,717 kg/ha (Table 1), which is by 113 kg lower than with vetch + oats as forerunner plants, i.e. it was of 2,830 kg/ha. However, the resulting difference of grain yield was not significant, as it was within the LSD₀₅ (Least Significant Difference) -134 kg/ha. In terms of planting dates, we can notice higher productivity rate in the first sowing period

(12.X) which constituted 3191 kg/ha with peas as forerunner plant, yield that was significantly higher than in the second (24.X) (by 326 kg/ha) and in the third (01.XI) (by 1095 kg/ha) sowing periods. The resulting increase in the crop yield depending on the sowing period was trustworthy and significantly higher than the value of the LSD₀₅ - 164 kg/ha.

Table 1. Grain yield of the winter triticale variety Ingen 35, 2011-2013, kg/ha

Seeding rate, million/ha (Factor C)	Forerunner plant (Factor A)						The average for Factor C LSD ₀₅ C -164	± to the control group
	vetch + oats			grain pea (control group)				
	Sowing period (Factor B)							
	12. X (Control)	24. X	01. XI	12. X (Control)	24. X	01. XI		
4.0	3210	2820	2170	3206	2735	1958	2683	-62
5.0 (HTC)	3310	2929	2279	2981	2850	2122	2745	-
6.0	3395	3045	2311	3385	3010	2207	2292	147
The average for Factor A	2830			2717				
LSD ₀₅ A -134	113							
The average for Factor B	3305	2931	2253	3191	2865	2096		
LSD ₀₅ B -164	-	-374	-1052	-	-326	-1095		
LSD ₀₅ of the experiment	402							

The highest grain yield with vetch + oats as forerunner plants was also obtained in the first sowing period (12.X) – 3305 kg/ha. A later sowing, in the third decade of October (the second period) and early November (the third period) led to lower yields of winter triticale, by 374 and 1,052 kg/ha respectively. This decrease depending on the sowing period was reliable too, and exceeded the value of the LSD₀₅. The change of the seeding rate per 1 ha had also influenced the amount of the resulting

grain yield. On average, the lowest yield was obtained with the seeding rate of 4.0 million seeds/ha and it constituted 2,683 kg/ha, while the highest yield was received with the seeding rate of 6.0 million seeds/ha – 2,892 kg/ha. Yield differences depending on the experiment options were not significant ranging within the limits of LSD₀₅ -164 kg/ha. The studied forerunner plants used in the experiments had a significant impact on the grain yield of Ingen 93 variety (Table 2).

Table 2. Grain yield of the winter triticale variety Ingen 93, 2011-2013, kg/ha

Seeding rate, million/ha (Factor C)	Forerunner plant (Factor A)						The average for Factor C LSD ₀₅ C - 164	± to the control group
	grain pea (control group)			vetch + oats				
	Sowing period (Factor B)							
	12. X (Control)	24. X	01. XI	12. X (Control)	24. X	01. XI		
4.0	3281	2907	2,100	3250	3018	2136	2782	-58
5.0 (control group)	3347	2906	2244	3223	3039	2278	2840	-
6.0	3380	2952	2388	3401	3090	2351	2927	87
The average for Factor A	2834			2865				
LSD ₀₅ A -134	31							
The average for Factor B	3336	2922	2244	3291	3049	2255		
LSD ₀₅ B -164	-	-414	-1092	-	-242	-1036		
LSD ₀₅ of the experiment	139							

The yield of winter triticale with vetch + oats as forerunner plants was of 2,865 kg/ha which exceeds the control value by 31 kg – 2,834 kg/ha. The yield of the winter triticale variety with vetch + oats as forerunner plants ranged from 2255 to 3291 kg/ha depending on the sowing period, while the figure with grain pea

as forerunner plant ranged from 2224 to 3336 kg/ha. The highest yield was obtained with both forerunner plants in the first sowing period (12.X) due to greater tillering capacity of plants and spike size. Thus, during the first sowing period under conditions of insufficient moisture, namely the sowing period ensured a

more vigorous tillering capacity of plants and the formation of larger spikes. The study of the experiment factors influence on the grain yield of the two winter triticale varieties showed the following: the degree of the forerunner plant influence on Ingen 35 variety yield was of 10.85%, while on Ingen 93 variety yield - almost 3 times more - 28.15% (Table 3).

Table 3. The degree of factors influence on winter triticale grain yield, 2011-2013, %

Factors	Symbols	Ingen 35	Ingen 93
Forerunner plant	A	10.48	28.15
Sowing period	B	61.53	54.06
Seeding rate	C	18.89	9.11
Interaction: the forerunner plant + the sowing period	AB	6.16	8.00
Interaction: the forerunner plant + the seeding rate	AC	0	0
Interaction: the sowing period + the seeding rate	BC	1.97	0.66
Interaction: the forerunner plant + the sowing period + the seeding rate	ABC	1.00	0
Total		100	100

The sowing periods had almost the same effect on the productivity of the studied winter triticale varieties - 61.33% and 53.06% respectively. The effect of the seeding rate was twice as high for Ingen 35 variety (18.89%), while for Ingen 93 variety it constituted only 9.11%. The influence of the forerunner plant and the sowing period were noticed as a result of double interaction of factors, 6.16% and 8.00% respectively. The double and triple interaction of other factors was not significant. The study of the crude protein content in the winter triticale grain showed that for Ingen 35 variety it ranged from 10.59% in the third sowing period (1.XI) to 11.15% in the first sowing period (12.X) with grain pea as forerunner plant (Table 4). On average, it amounts to 10.79% depending on the sowing period. The protein content ranged from 10.29% to 11.37% when vetch + oats were used as forerunner plants and on average, it amounted to 10.68% depending on the forerunner plant. The yield of crude protein was of 223.4 kg/ha when grain pea used as forerunner plant, and 236.0 kg/ha – when vetch oats were used as forerunner plants.

Table 4. Content and yield of crude protein in the grain harvest of winter triticale, 2011-2012

Varieties	Ingen 93				Ingen 35			
	grain pea (control group)		Vetch + oats		grain pea (control group)		Vetch + oats	
Sowing period	Protein content and yield				Protein content and yield			
	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha
12.X	11.50	240.5	10.90	241.9	11.15	236.8	11.37	273.9
24.X (control group)	12.27	278.1	11.27	255.5	10.64	233.3	10.29	229.5
01.XI	11.81	266.9	11.02	232.7	10.59	200.2	10.39	204.5
The average	11.86	261.8	11.06	243.3	10.79	223.4	10.68	236.0
± to pea as forerunner plant	-	-	-0.80	-27.5	-	-	-0.11	12.4

Table 5. The weight of 1000 seeds of winter triticale variety Ingen 93, 2011-2013, g

Sowing period (Factor B)	Seeding rate, million seeds/ha (Factor C)	Grain pea (control group) Factor A			Vetch + oats, Factor A		
		g	± to the control group C		g	± to the control group C	
			g	%		g	%
The first period	4.0	41.5	0.6	101.5	41.2	1.0	102.5
	5.0 (control group)	40.9	-	100.0	40.2	-	100.0
	6.0	40.3	-0.6	98.5	39.6	-0.6	98.5
	The average	40.9			40.3		
The second period	4.0	43.0	3.1	107.8	40.7	0.5	101.2
	5.0 (control group)	39.9	-	100.0	40.2	-	100.0
	6.0	42.0	2.1	105.3	40.3	0.1	100.3
	The average	41.6			40.4		
The third period	4.0	39.2	-1.7	95.8	40.8	0	100.0
	5.0 (control group)	40.9	-	100.0	40.8	-	100.0
	6.0	40.1	-0.8	98.0	40.2	-0.6	98.5
	The average	40.1			40.6		
The average for the forerunner plant		40.9			40.4		
± to the control group A					-0.5		

Ingen 93 variety accumulated more crude protein amounting to 11.86% when grain pea was used as forerunner plant and 11.06% when vetch + oats were used as forerunner plants.

The amount of crude protein with grain yield was of 261.8 kg/ha in case of grain pea as forerunner plant and 243.3 kg/ha - for vetch + oats as forerunner plants. Studies showed that there was a slight influence of the studied factors on the seed size of winter triticale variety Ingen 93 (Table 5). Under the influence of the sowing period (Factor B) there was observed a slight increase of 0.7 g in the mass of 1000 seeds when pea was used as forerunner

plants and of 0.3 g with vetch + oats as forerunner plants. The average weight of 1000 seeds amounted to 40.9 g and 40.4 g for pea and vetch + oats used as forerunner plants respectively. The research data on this index ranged from 37.2 g in 2011 to 49.4 g in 2013. The average weight of 1000 seeds of Ingen 35 variety was 41.8 g for pea and 41.3 g for vetch + oats used as forerunner plants (Table 6). Later sowing periods provided larger grains that were heavier by 0.5 - 0.7 g. Also, larger grains were formed by the plants where grain pea was used as forerunner plant.

Table 6. The weight of 1000 seeds of winter triticale variety Ingen 35, 2011-2013, g

Sowing period (Factor B)	Seeding rate, million seeds/ha (Factor C)	Grain pea (control group) Factor A			Vetch + oats, Factor A		
		g	± to the control group C		g	± to the control group C	
			g	%		g	%
The first period	4.0	42.6	2.3	105.7	41.3	0.1	100.2
	5.0 (control group)	40.3	-	100	41.2	-	100
	6.0	41.3	1.0	102.5	41.8	+0.6	101.5
	The average	41.4			41.4		
The second period	4.0	41.4	-1.0	97.6	41.1	0.5	101.2
	5.0 (control group)	42.4	-	100	40.6	-	1
	6.0	42.1	-0.3	99.3	39.2	-1.4	96.6
	The average	42.0			40.3		
The third period	4.0	42.9	-0.1	100.2	42.1	0.6	101.5
	5.0 (Control group)	42.8	-	100	41.5	-	100
	6.0	39.9	-2.9	93.2	42.8	+1.3	103.1
	The average	41.9			42.1		
The average for the forerunner plant		41.8			41.3		
± to the control group A					-0.5		

CONCLUSIONS

As we found out in the multifactorial experiments, grain yield of the studied winter triticale varieties is mostly influenced by the sowing period (Factor B) -54.06-61.53%, followed by the forerunner plants (Factor A) - 10.48-28.15%, the seeding rate (Factor C) – 9.11-18.89% and the interaction of AB factors - 6.16 - 8.00%. Ingen 93 variety, with grain pea used as forerunner plant, demonstrated the highest grain quality and crude protein yield. Seed size of winter triticale varieties in later sowing periods increased by 0.3-0.7 g for both forerunner plants.

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