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RESPONSE OF WINTER TRITICALE CULTIVAR MODERATO TO SOWING TIME AND DENSITY IN NORTH-EAST POLAND

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Abstract. Studies were conducted in years 2005-2008 at the Production-Experimental Station in Bałcyny (53°35' N; 19°51' E). Research aimed at determining the effect of diversified sowing dates and densities on the yield and formation of yield components of winter triticale cultivar Moderato in the weather conditions of north-east Poland. In the described conditions, this cultivar has a very high yield potential. Average grain yield from three years was 8.91 Mg·ha^{-1}, and in a favourable year even 10.55 Mg·ha^{-1}. The highest grain yield was obtained when the sowing date was September 22nd. Delay in the date by 10 days significantly decreased mostly the number of spikes per area. Increasing the sowing number from 300 to 500 grains per 1 m^2 did not diversify grain yield or any of its elements. Relation between the sowing date and density on grain yield was found but not on the particular yield components.

Key words: grain yield, sowing date delay, yield components, winter cereals, winter triticale

INTRODUCTION

Winter triticale is a long-day plant. Its requirements in regard to the weather conditions during sowing and autumn development result from the genotype of the cultivars [Mazurek and Jaśkiewicz 1998, 2000]. Winter cereal sowing should take place in such a time that day length and thermal conditions after sowing guarantee good plant tillering before winter and generative diversification of shoot apex in the conditions of gradually shortening days in the autumn. During the tillering stage, basic element of grain yield structure develops, namely the number of spikes, and after vernalization completion, also the number of grains per spike. Winter cereals well-tillered in the autumn, after wintering form a dense lowland meadow in the spring and guarantee a good balance of spikes from the lateral shoots with the main shoot [Podolska and Mazurek 1999].

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Cereal sowing date correlates with sowing density [Grabiński *et al.* 2007]. Spike number before harvest, which is a basic yield component, may be regulated not only through the sowing date but also with proper sowing density. Transgression of the optimum plant number for a given area may lead to increased plant falling during growth. This is a result of meadow self-regulation due to plant competition caused by insufficient light intensity and photosynthesis limitation during spike morphogenesis and grain formation. Excessive plant density in the lowland meadow may consequently lead to the reduction in the number of grains formed per spike, decrease in spike grain mass, and in the mass of 1000 grains [Piech and Stankowski 1990, Dubis *et al.* 1992, Kozdój 1994, Jaśkiewicz 1994, 2000a, b].

Optimum sowing time of winter triticale from the point of view of thermal and light requirements is relatively short [Krężel and Sobkowicz 1994]. In north-east Poland, as a result of rapidly shortening days and clearly decreasing temperatures, delay in the sowing date of winter cereals does not allow good plant tillering before winter. Tillering process takes place only in the spring in the conditions of rapidly lengthening days, increasing temperatures, and decreasing soil humidity. This causes accelerated plant development in the spring and shortening of the phenophase straw shooting – earing and determines unfavourable changes in the formation of yield structure elements. This concerns in particular the decrease in the number of highly productive main shoots and the increase in the number of lateral shoots, which as the lower ones are not equal in regard to yield formation with the shoots that develop in the autumn. One of the results of the above may be the decrease in spike length and the number of spikelets in them, and as a result their lower productivity [Podolska 1999, Podolska and Mazurek 1999, Grabiński *et al.* 2007].

In recent years, great quantitative and qualitative progress has been observed in national winter triticale breeding and an increase in the number of cultivars in the Research Centre for Cultivar Testing register [Cyfert 2004]. It results from the hitherto existing experiments [Mazurek and Jaśkiewicz 1998, 2000] that the agricultural cultivars of winter triticale, as hybrids of wheat and rye, demonstrate a different response in the yield to the sowing date. Among them, there are both cultivars more and less tolerant to this agrotechnical factor. Transferring breeding progress to agricultural practice is only possible through the testing of new cultivars in strict research and determining their response to the most important agrotechnical factors [Rozbicki 1997, Mazurek and Jaśkiewicz 1998, 2000]. In the work hypothesis it was assumed that the requirements of new cultivars of winter triticale in regard to the sowing date depend first of all on the genotype formula of the crossed species. Their response to the sowing date and density in the more severe agroecological conditions of north-east Poland may be different than in other regions of the country.

The aim of the study was the determination of the effect of diversified sowing dates and densities on the yield and formation of grain yield elements of winter triticale cultivar Moderato in the weather conditions of the south-west part of Warmian-Masurian Voivodeship.

MATERIAL AND METHODS

Field experiment was carried out in years 2005-2008 on the experimental plot at the Production-Didactic station in Bałcyny near Ostróda (53°35' N; 19°51' E), which is part of the University of Warmia and Mazury in Olsztyn. The experiment was conducted as a split-plot design in four repetitions. Plot area for harvest was equal to 15 m^2. In the experiment, two factors were taken into account. The primary factor was the sowing date (September 12, September 22, and October 2), and the secondary factor was sowing density (300, 400, and 500 grains per 1 m^2). The cultivar of winter triticale chosen for the experiment was Moderato.

Experiment was localized on typical lessives formed from medium clay, class IIIa, good rye complex. Forecrop was winter rapeseed. Soil richness in assimilable phosphorus and potassium was high, and in magnesium medium, and its pH was nearly neutral. Phosphorus fertilisation at the dose of 30.5 kg $P \cdot ha^{-1}$ (triple superphosphate 46%) and potassium fertilization at the dose of 83.0 kg $K \cdot ha^{-1}$ (sylvinite 60%) were applied pre-sowing. Nitrogen fertilization at the dose of 90 kg $N \cdot ha^{-1}$ was applied top--dressing twice: 60 kg N (urea 46%) at the BBCH 29 stage (growth onset), and 30 kg N (ammonium nitrate 32%) at the BBCH 32 stage (3-node).

Infestation was controlled in the autumn with the use of after-sowing Treflan 480 EC (active substance – trifluralin) at the dose of 1.25 $dm^3 \cdot ha^{-1}$ and at the stage of BBCH 27 – Glean 75 DF (active substance – chlorosulphuron) at the dose of 5.0 $g \cdot ha^{-1}$. Occurrence of pathogens in the lowland meadow was controlled through the application at the BBCH 39 stage of fungicide Alert 375 SC (active substances – flusilazol + carbendazim) at the dose of 1.0 $dm^3 \cdot ha^{-1}$, and at the BBCH 65 stage – Amistar 250 SC (active substance – azoksystrobin) at the dose of 1.0 $dm^3 \cdot ha^{-1}$.

In the studies, morphometrical plant characteristics were determined (straw length and spike length), as well as grain yield and its components (spike number per 1 m^2, number of grains per spike, and mass of 1000 grains). The obtained results were statistically processed, and the analysis of variance for two-factor experiments was carried out using the STATISTICA 9.1® programme. Experimental error was estimated with the t-Duncan's test.

Cultivar Moderato was included in the national register in 2004 as a fodder cultivar. In the Research Centre for Cultivar Testing characteristics [Cyfert 2004], it is classified as a traditional type. It has a relatively high straw, of medium resistance to lodging. Plants are characterized by medium frost resistance. Resistance to leaf rust is very high, to leaf septoriosis high, to mildew, stem rust, chaff septoriosis, and rhynchosporiosis quite high, to snow mould and straw base diseases average, and to fusarium head blight rather low. It shows an average earing time, and a rather late time of ripening. It is characterized by a low mass of 1000 grains, average grain balance and density in loose form, rather low falling number and resistance to sprouting in spikes, and average protein content in the grain. Its fertility in the conditions of an average agrotechnical level is very good. In the conditions of a high agrotechnical level, it shows average yield growth. It has a rather high tolerance to soil acidification.

Weather conditions in the years of the experiment were rather diversified (Table 1). The most favourable in regard to weather conditions was the growth season of 2007/2008, in which the highest grain yield was obtained. The least favourable weather conditions were noted in the growth season of 2006/2007, in which the growth period of winter triticale was the shortest (depending on the sowing date from 290 to 310 days). It was characterized by a very long period of autumnal growth (111-131 days), and at the same time the highest precipitation sum (633-638 mm). In those conditions, winter triticale obtained the lowest grain yield. In spite of dissimilar weather conditions that occurred in the particular research years and periods of winter rest (Table 1), the plants managed wintering conditions well, and the degree of their over-wintering, regardless of the sowing date, was similar and amounted to 90-95%.

Table 1. Weather conditions during the growth season of winter triticale cultivar Moderato
Tabela 1. Warunki pogodowe w okresie wegetacji pszenżyta ozimego odmiany Moderato

Specification Wyszczególnienie	Sowing date Termin siewu	2005/2006			2006/2007			2007/2008		
		a*	b	c	a	b	c	a	b	c
Autumn growth Wegetacja jesienna	12.09	60	9.9	60.3	131	7.7	274.3	62	8.0	111.6
	22.09	50	8.9	43.3	121	7.0	271.6	52	7.4	101.9
	02.10	40	7.7	39.8	111	6.2	269.0	42	5.7	74.3
Winter rest Spoczynek zimowy	all dates wszystkie terminy	137	-3.6	136.0	44	1.7	70.3	135	1.2	152.2
Spring-summer growth Wegetacja wiosenno-letnia	all dates wszystkie terminy	135	14.5	268.4	135	14.8	293.6	133	17.9	196.5
Growth period Okres wegetacji	12.09	332	6.1	464.7	310	9.3	638.2	330	9.2	460.3
	22.09	322	5.9	447.7	300	9.1	635.5	320	9.2	450.6
	02.10	312	5.7	444.2	290	8.9	632.9	310	9.0	423.0

* a – number of growth days – liczba dni wegetacji
b – average daily temperature – średnia temperatura dobowa, °C
c – precipitation sum – suma opadów, mm

RESULTS

The studied agrotechnical factors affected significantly the formation of the morphological characteristics of winter triticale plants cultivar Moderato (Table 2). Straw length was significantly diversified by the sowing date. The longest straws were formed by the plants sown on September 22nd, and sowing delay by 10 days caused their significant shortening. Sowing density did not diversify significantly the straw lengths. Spike length was not significantly diversified by the sowing date, although on the last of the studied sowing dates spikes were from 2.9% to 3.5% shorter than those from the earlier dates. This characteristic was significantly diversified by sowing density. The longest spikes were formed by triticale sown at the smallest density, namely 300 grains per 1 m^2, and the increase in sowing density to 400 grains did not cause significant changes in the spike length. Only in the sowing conditions of 500 grains per 1 m^2, spikes of winter triticale underwent significant shortening.

Winter triticale grain yield was significantly diversified by the weather conditions, which was confirmed by a significant relation between year x yield (Fig. 1). The most favourable for yield was the growth season of 2007/08, in which winter triticale obtained grain yield equal to 10.55 Mg·ha^{-1}. In growth season 2005/06, its yield was lower by 18.6%, and in 2006/07 by 28.2%.

Table 2. Morphological characteristics of winter triticale cultivar Moderato
Tabela 2. Cechy morfologiczne pszenżyta ozimego odmiany Moderato

Sowing density plants·m^2 Gęstość siewu szt.·m^2	Sowing date – Termin siewu			Mean – Średnia
	September 12 12 września	September 22 22 września	October 2 2 października	
Straw length – Długość źdźbła, cm				
300	99.2	102.0	97.9	99.7
400	101.4	101.6	97.4	100.1
500	99.7	103.2	100.6	101.2
Mean – Średnia	100.1	102.3	98.6	–
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:				
sowing date – terminu siewu	2.2			
sowing density – gęstości siewu	ns – ni			
interaction – interakcja	ns – ni			
Spike length – Długość kłosa, mm				
300	87.5	89.9	89.4	88.9
400	89.3	87.5	85.6	87.5
500	84.1	84.5	79.5	82.7
Mean – Średnia	87.0	87.3	84.8	–
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:				
sowing date – terminu siewu	ns – ni			
sowing density – gęstości siewu	3.7			
interaction – interakcja	ns – ni			

* ns – ni – non-significant differences – różnice nieistotne

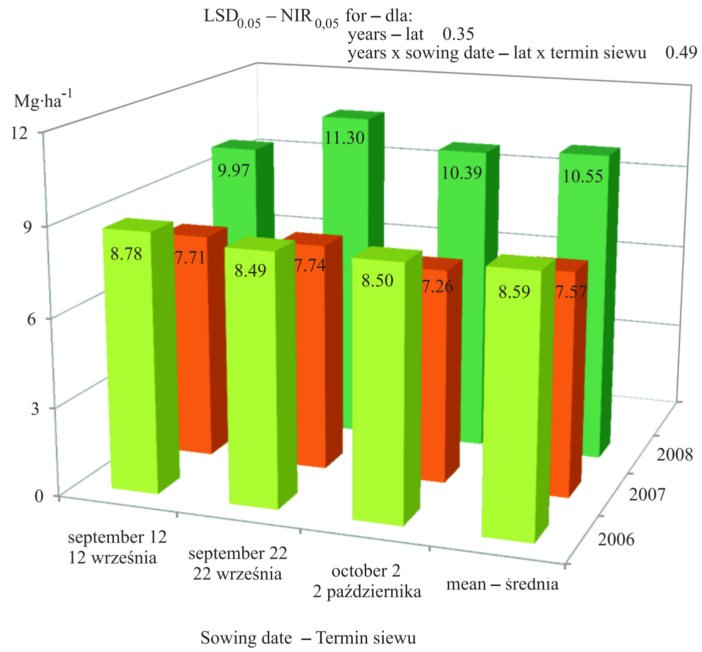

Fig.1. Grain yield of winter triticale cultivar Moderato in the research years
Rys. 1. Plon ziarna pszenżyta ozimego odmiany Moderato w latach badań

Average grain yield of winter triticale cultivar Moderato significantly depended on the sowing date (Table 3). In the agroecological conditions of Warmia and Masuria, its highest yield was granted by sowing on September 22nd (II date). Grain yields obtained from the plants sown the earliest (September 12) and the latest (October 2) were lower by 4-5% (significant differences) in comparison with the most favourable date. In the years of the experiment, significant relation was found in grain yield between the sowing date and the weather conditions. In the growth season of 2005/2006, in which the autumn was very dry and the whole growth period was the coolest (Table 1), winter triticale on all the sowing dates gave similar yields. In the growth season of 2006/2007, in which precipitation was very high, higher grain yield was given by September sowing dates. Delaying the sowing until October 2nd caused a decrease in grain yield by 5.8-6.2% (significant difference). In growth season 2007/08, with average humidity conditions in the spring, the highest grain productivity per area was given by sowing on September 22nd. Grain yield from that sowing date was higher from 8.8% to 13.3% (significant differences) than the ones from the earliest and the latest sowing dates (Table 4).

Table 3. Grain yield of winter triticale cultivar Moderato, $Mg \cdot ha^{-1}$
Tabela 3. Plon ziarna pszenżyta ozimego odmiany Moderato, $Mg \cdot ha^{-1}$

Sowing density, plants·m^2 Gęstość siewu, szt.·m^2	Sowing date – Termin siewu			Mean Średnia
	September 12 12 września	September 22 22 września	October 2 2 października	
300	9.11	9.14	8.67	8.97
400	8.76	9.31	8.70	8.92
500	8.59	9.08	8.77	8.81
Mean – Średnia	8.82	9.18	8.72	–
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:				
sowing date – terminu siewu	0.29			
sowing density – gęstości siewu	ns – ni			
interaction – interakcji	0.27			

* ns – ni – non-significant differences – różnice nieistotne

Diversification of the grain yield of winter triticale depending on the sowing density was small and did not exceed statistical error. Only a tendency for more favourable yield in the conditions of looser sowings (300 or 400 grains per 1 m^2) was observed. It results from the interaction between the sowing date and density that in the conditions of September sowings (September 12 or 22), the highest grain yield was obtained in looser sowing, that is 300 grains per 1 m^2. On the other hand, more dense sowings of winter triticale (400 or 500 grains per 1 m^2) gave higher grain yield in the conditions of its sowing on the optimum date, September 22nd (Table 3).

The greatest number of triticale spikes per area was granted by sowing on September 22nd, and delaying the sowing by 10 days caused a significant decrease in their number by 5% (Table 4). The greatest number of winter triticale spikes was found in the conditions of the most dense sowing (500 grains per 1 m^2). In looser sowings (300 and 400 grains per 1 m^2), their number per area was lower by 8% in comparison with the sowing of 500 grains. However, the above differences were not confirmed statistically. No interaction was found in the formation of the number of spikes before harvest per area between the sowing date x sowing density, which indicates that the studied agrotechnical factors affected this particular yield structure element independently (Table 4).

Table 4. Grain yield components of winter triticale cultivar Moderato (mean from 3 years)
Tabela 4. Komponenty plonu ziarna pszenżyta ozimego odmiany Moderato (średnia z 3 lat)

Sowing density plants·m^2 Gęstość siewu szt.·m^2	Sowing date – Termin siewu			Mean – Średnia
	September 12 12 września	September 22 22 września	October 2 2 października	
Spike number per m^2 – Liczba kłosów na m^2				
300	403	415	375	398
400	391	410	392	398
500	428	434	434	432
Mean – Średnia	407	420	400	–
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:				
sowing date – terminu siewu	20			
sowing density – gęstości siewu	ns – ni			
interaction – interakcja	ns – ni			
Grain number per spike – Liczba ziaren w kłosie				
300	43.5	44.6	45.8	44.6
400	45.8	42.1	44.0	44.0
500	41.1	42.8	45.5	43.1
Mean – Średnia	43.5	43.2	45.1	–
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:				
sowing date – terminu siewu	ns – ni			
sowing density – gęstości siewu	ns – ni			
interaction – interakcja	ns – ni			
Mass of 1000 grains – Masa 1000 ziaren, g				
300	51.3	51.6	50.7	51.2
400	49.2	50.8	51.6	50.5
500	48.8	50.5	49.4	49.6
Mean – Średnia	49.8	51.0	50.6	–
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:				
sowing date – terminu siewu	ns – ni			
sowing density – gęstości siewu	ns – ni			
interaction – interakcja	ns – ni			

* ns – ni – non-significant differences – różnice nieistotne

Diversification in grain number per spike and mass of 1000 grains of winter triticale under the effect of the studied agrotechnical factors ought to be assessed as relatively low (Table 4). Somewhat more grains per grain were found in the conditions of the latest sowing date (October 2nd) and on the plots on which 300 grains per 1 m^2 were sown. Although the increase in sowing density decreased the number of grains per spike and delaying the sowing date increased this element of yield structure, the above differences were not statistically confirmed.

Sowing date did not diversify the mass of 1000 grains of winter triticale. This means that delaying the sowing date from September 12th to October 20th, that is by 20 days, did not cause significant changes in the mass of 1000 grains. Also increasing sowing density from 300 to 500 grains per 1 m^2 did not cause significant changes in the values of this grain yield structure characteristic (Table 4).

DISCUSSION

Plant height of winter triticale is a cultivar characteristic. Tested in the present research cultivar Moderato, in regard to plant height, is classified as a traditional form [Cyfert 2004]. In the present research, plant height (straw + spike) reached on average 109 cm and, in comparison with the studies by the Research Centre for Cultivar Testing, was lower by 6 cm (7%). Delaying the sowing date significantly shortened the straw, like in the studies by Jaśkiewicz and Mazurka [1997], but did not diversify the spike length. On the other hand, increasing sowing density, like in the studies by Koziara *et al.* [1994], significantly shortened the spike but did not diversify straw length.

Average grain yield of winter triticale cultivar Moderato from the three years amounted to 8.91 $Mg \cdot ha^{-1}$. This confirms the opinion known from literature on a high production potential and yield level of winter triticale [Kuś and Siuta 1995, Rozbicki 1997, Wróbel and Szempliński 2006]. Yield level was, however, significantly determined by the weather conditions in the years of the experiment. The highest grain yield, namely 10.55 $Mg \cdot ha^{-1}$, was obtained in the growth year of 2007/2008, which was the most favourable one in regard to the weather conditions. In the remaining two research years, grain yields were lower by 18.6% to 28.2%. The relation between winter triticale yield and weather conditions in the research years was also pointed out by Piech and Stankowski [1990], Dubis *et al.* [1992], Romek and Dzienia [1997], and Wróbel and Szempliński [2006].

It is underscored in literature that one of the conditions for obtaining high grain yield is optimum sowing date [Jaśkiewicz and Mazurek 1997]. In the present study, the highest grain yield was obtained with the sowing date of September 22nd. This date ought to be considered as optimum for north-east Poland, where the research was carried out. Grain yield obtained in the conditions of sowing 10 days earlier (September 12) and 10 days later (October 2) were significantly lower (on average by 4-5%). In the studies by Krężel and Sobkowicz [1994], conducted in the weather conditions of Lower Silesia with first Polish cultivar Lasko, optimum for yield was sowing on October 5th, and earlier and later sowings caused a proven decrease in grain yield. In the studies by Piech and Stankowski [1990], conducted in Western Pomerania with cultivars Grado, Dagro, and Lasko, and by Jaśkiewicz and Mazurek [1997] in Puławy where the tested cultivars were Dagro, Largo, and Malno, grain yield of winter triticale underwent a gradual decrease with sowing delay in relation to the optimum date. Also in the studies by Rozbicki [1997] carried out in Mazovia, winter triticale cultivar Presto sown on September 20th gave significantly higher grain yield in relation to sowing delayed by 20 days. The results indicate that the sowing date of winter triticale depends on the cultivar and the climatic region of the country.

In the present research, sowing density (300, 400, and 500 grains per 1 m^2) did not diversify significantly grain yields of winter triticale cultivar Moderato, although a tendency was observed for its decrease as the sowing grain number increased. Similar relations of winter triticale yield under the effect of increasing sowing density were shown also by Koziara *et al.* [1994], who carried out research with long-straw cultivars Bolero, Malno, and Ugo, and by Jaśkiewicz [2000a] with cultivar Tornado. In a different research by Jaśkiewicz [2008b, 2009] with semi-dwarf forms, for obtaining the highest grain yield of cultivar Woltario, sowing of 200 proved to be sufficient, and for Fidelio circa 250 seeds per 1 m^2. This may suggest that in order to assure high yield of winter triticale, high sowing density is not required, which is also pointed out by Jaśkiewicz [2008b].

Present research shows that delaying the sowing date significantly decreased the basic element that determines grain yield, that is the number of spikes per area, while it did not diversify its remaining components. The most favourable number of spikes per 1 m^2 was found in the sowing from September 22nd, and delaying the sowing by 10 days caused a significant decrease in their number by 5%. In the studies by Piech and Stankowski [1990] and Rozbicki [1997], lower winter triticale yield at late sowing was caused mostly by the decreasing number of spikes per area and the number of grains per spike.

Among the tested sowing densities in the present research, the highest number of spikes before harvest was assured by dense sowing (500 grains per 1 m^2). In more loose sowings, their number was lower by 8%, although the difference was statistically insignificant. Similar relations are confirmed also by the studies by Piech and Stankowski [1990], Koziara *et al.* [1994], and Jaśkiewicz [2000a, 2008a, b, 2009]. It is underscored in literature that although increasing the sowing amount is related to the increase in the number of spikes per 1 m^2, it also causes their lower productivity [Dubis *et al.* 1992, Jaśkiewicz and Mazurek 1997, Jaśkiewicz 2008a, b, 2009] and reduction of the mass of 1000 grains [Jaśkiewicz 2000a, 2008a, b].

In the present research, the number of grains per spike and mass of 1000 grains were not significantly diversified by the sowing date and density. Only a tendency for lowering the values of those characteristics was found under the effect of the studied agrotechnical factors. Moreover, in forming the values of yield structure elements, no interaction between the sowing date x sowing density was found, which proves that in the conditions of the experiment, agrotechnical factors affected those characteristics independently. In the studies by Piech [1985] and Jaśkiewicz and Mazurek [1997], delaying the sowing date affected negatively the number of grains per spike in winter triticale. In the studies by Koziara *et al.* [1994] and Jaśkiewicz [2000a], under the effect of increasing plant density of winter triticale per area, no significant differences in the mass of 1000 grains were found, whereas in the studies by Dubis *et al.* [1992], Koziara *et al.* [1994] and Jaśkiewicz [2008, 2009], a decrease in the value of this characteristic was found.

CONCLUSIONS

1. Cultivar Moderato of winter triticale in the conditions of north-east Poland shows a very high yield potential. Average from three years grain yield amounted to 8.91 $Mg \cdot ha^{-1}$, and in a favourable year even to 10.55 $Mg \cdot ha^{-1}$.
2. The highest grain yield of cultivar Moderato was obtained with sowing on September 22nd. Delaying the time by 10 days significantly decreased mainly the number of spikes per area.
3. Increasing the number of sowings from 300 to 500 grains per 1 m^2 did not diversify grain yield or any of its components.
4. In the yield of cultivar Moderato, interaction was shown between sowing time and density. No interaction of the studied factors in yield component formation proves that their effects were independent from one another.

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REAKCJA PSZENŻYTA OZIMEGO ODMIANY MODERATO NA TERMIN I GĘSTOŚĆ SIEWU W PÓŁNOCNO-WSCHODNIEJ POLSCE

Streszczenie. W pracy przedstawiono wyniki badań przeprowadzonych w latach 2005--2008 w Zakładzie Produkcyjno-Doświadczalnym w Bałcynach (53°35’ N; 19°51’ E). Badania miały na celu określenie wpływu zróżnicowanego terminu i gęstości siewu na plonowanie i kształtowanie się elementów składowych plonu pszenżyta ozimego odmiany Moderato w warunkach klimatycznych północno-wschodniej Polski. Wykazano, że odmiana Moderato w opisywanych warunkach ma bardzo wysoki potencjał plonowania. Średni z 3 lat plon ziarna wynosił 8,91 $Mg \cdot ha^{-1}$, a w roku korzystnym nawet 10,55 $Mg \cdot ha^{-1}$. Najwyższy plon ziarna uzyskano, gdy siew wykonano 22 września. Opóźnianie tego terminu o 10 dni istotnie zmniejszało głównie liczbę kłosów na jednostce powierzchni. Zwiększanie ilości wysiewu z 300 do 500 kiełkujących ziaren na 1 m^2 nie różnicowało plonu ziarna ani żadnego z jego elementów składowych. Wykazano współdziałanie terminu siewu z gęstością siewu na plon ziarna, ale nie na poszczególne komponenty plonu.

Słowa kluczowe: komponenty plonu, opóźnienie terminu siewu, plon ziarna, pszenżyto ozime, zboża ozime

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