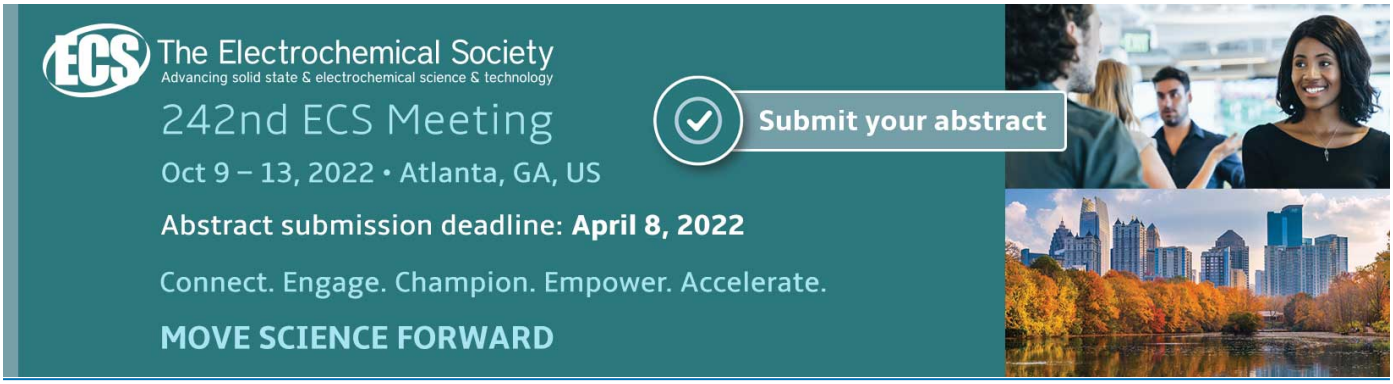
Influence of elements of cultivation technology on yield and grain quality of winter triticale in the conditions of the Urals



Influence of elements of cultivation technology on yield and grain quality of winter triticale in the conditions of the Urals

L Kh Sukhanberdina, D K Tulegenova, L T Kaliyeva, A Zh Turbayev and M K Mussina

Zhangir Khan West Kazakhstan Agrarian-Technical University, 51, Zhangir Khan Street, Uralsk, 090009, Republic of Kazakhstan

E-mail: a.zh.turbayev@mail.ru

Abstract. The article presents the results of experimental studies to identify the optimal sowing dates and seeding rates for seeds of winter triticale varieties. Grain yield indicators at different sowing dates and seeding rates for 2019-2020 indicate that 2020 was more favorable for the formation of high productivity of winter triticale. Analysis of two-year data on the productivity of winter triticale varieties showed that with a late sowing period (September 15), a decrease in productivity is observed. The use of an increased seeding rate leads to an increase in the density of the productive stalk, with a simultaneous decrease in the mass of grain in the ear and the grain content in the ear. Favorable conditions were created for plants of the first (August 25) and second (September 5) sowing dates, with a seeding rate of 3.0 million and 4.0 million germinating grains per hectare. It was revealed that, regardless of the seeding rate, an increase in the level of protein in the grain of triticale varieties occurs at a late sowing period (September 15). The maximum protein content was noted in the Kastus variety (15.1%) at the third sowing period, at a seeding rate of 3.0 million germinating grains per hectare. To obtain high and stable yields of winter triticale grain in local conditions, the optimal sowing period should be considered the period from august 25 to September 5, at a seeding rate of 3.0 and 4.0 million germinable grains per hectare. With a favorable regime of moisture supply, it is allowed to sow winter triticale until September 15. The use of an increased rate (5.0 million) is not a factor contributing to an increase in yields in winter triticale varieties under WKO conditions. The most productive varieties adapted to the conditions of the dry steppe zone are the varieties Kastus, Fidelio, Valentin 90, which can be recommended for introduction into production.

1. Introduction

Great prospects for increasing the fodder base of animal husbandry in Kazakhstan are opening up in connection with the creation and introduction of a new agricultural crop, triticale. Triticale has a stable and high yield, resistance to stress factors, increased content and biological value of proteins, which make this crop a good feed for farm animals.

The introduction of triticale culture into fodder production contributes to the intensification of this industry. The feed orientation of triticale is determined by the high yield potential of green mass and the increased biological value of proteins [1].

The widespread use of triticale as a fodder crop is indicated by a large number of researchers [2-10].

Despite the valuable qualities in cultivation for grain and fodder purposes, winter triticale is not widely used in production. Improvement of the main elements of the technology of cultivation of winter triticale, adapted to the growing conditions, taking into account the varietal specifics, will make it possible to fully realize the high potential of the culture [2-3]. The correct choice of the optimal sowing time and seeding rate will allow, in local climatic conditions, to form highly productive crops with grain quality, suitable for both food purposes and the feed industry.

The purpose of the research is to reveal the influence of the sowing time and seeding rates on the yield and grain quality of winter triticale varieties.

2. Materials and methods

The object of research is varieties of winter triticale of various ecological and geographical origin. The research was carried out on the experimental field of the NJSC "West Kazakhstan Agrarian-Technical University named after Zhangir Khan". In 2018-2019 and 2019-2020 agricultural years. The soil of the experimental plot is dark chestnut. The predecessor is black steam. The content of humus in the arable layer is 3.1%, total nitrogen and phosphorus, respectively, 0.3 and 0.14%. Technological factors are represented by seeding rates 3.0; 4.0; 5.0 million germinating seeds per hectare and sowing dates are August 25, September 5 and September 15, with varieties of winter triticale Idea, Kastus, TI 17, Valentine 90, Fidelio, Krokha and line 15/4. Field experiments are based on 4 repetitions. The sowing of the experiment was carried out with a Wintersteiger disk seeder. Observations and assessments were carried out in accordance with the methodology for variety testing of agricultural plants [11]. The quality indicators of grain are determined in the Test Center of Oral Zher LLC.

3. Results

The climatic conditions during the years of research varied significantly. In the 2018-2019 agricultural year, during the sowing period of the studied triticale varieties, there was a deficit of atmospheric precipitation. The amount of precipitation in August was 11.2 mm, which is 44% of the average annual amount of precipitation; in mid-September, 12.3 mm of precipitation fell. The content of productive moisture during sowing was low (16 mm) to obtain friendly shoots. Precipitation in the amount of 20.6 mm in October contributed to the emergence of additional seedlings during the autumn growing season. During the spring-summer vegetation period, 71.8 mm of precipitation fell, which corresponded to the average long-term norm.

The growing season 2019-2020 agricultural year is marked by low moisture availability. The amount of precipitation during the autumn growing season was 49% of the average annual indicators. The autumn period was characterized by increased average daily temperatures in October by 5^0 C. The air temperature in the spring-summer period was at the level of average long-term data. Weather conditions in the spring-summer growing season for winter triticale were most favorable, precipitation in the spring-summer period in the amount of 90.4 mm, had a positive effect on grain productivity. The data on the yield of varieties at different sowing dates and seeding rates for 2019-2020, presented in table 1, which indicates that 2020 was more favorable for the formation of high productivity of winter triticale.

The studied varieties of winter triticale, on average, for 2 years of research, depending on the sowing period and the seeding rate, formed the grain yield at the level of 15.9-24.3 c / ha.

High productivity of varieties per unit area was obtained at all sowing periods, with a seeding rate of 4.0 million germinating grains per hectare. The average value of the yield for seven cultivars, at a rate of 4.0 million germinating grains per hectare, was 22.5 centners per hectare at the dates: 25 August; September 5 - 24.3 c / g; September 15 -17.4 c / ha.

Table 1. Grain yield of winter triticale varieties at different sowing dates and seeding rates for 2019-2020.

Variety sample	Sowing dates 2019			Sowing dates 2020		
	25.08	05.09	15.09	25.08	05.09	15.09
Seeding rate 3 million germinating grains per hectare						
Idea	9.4	12.5	10.9	40.6	34.7	24.1
15/4	9.6	9.7	9.9	28.1	33.2	24.4
Casting	9.5	9.5	9.4	37.7	39.1	18.5
TI-17 (standard)	10.5	9.0	9.2	38.4	45.0	23.1
Valentine 90	10.9	13.9	10.2	40.5	34.3	30.0
Fidelio	11.6	9.1	9.1	36.8	48.2	27.9
Crumb	9.3	9.7	9.5	21.8	31.8	28.0
HCP_{05} for factor A (year) = 0.38; HCP_{05} for factor B (terms) = 1.45; HCP_{05} for the interaction factor AB (year * terms) = 2.05; HCP_{05} for factor C (variety sample) = 1.36; HCP_{05} for the interaction factor AC (year * genotype) = 1.93; HCP_{05} for the BC interaction factor (terms * variety sample) = 2.36; HCP_{05} for the ABC interaction factor (year * terms * variety sample) = 3.34;						
Seeding rate 4 million germinating grains per hectare						
Idea	13.3	12.5	11.7	25.6	27.4	16.8
15/4	11.5	9.7	10.9	33.5	37.0	31.8
Casting	9.6	9.5	10.8	25.8	35.4	28.8
TI-17 (standard)	10.7	9.0	11.1	26.0	28.8	22.3
Valentine 90	14.2	13.9	11.0	40.8	26.3	24.8
Fidelio	14.4	9.1	9.4	33.4	39.1	22.4
Crumb	9.6	9.7	10.1	30.8	32.4	24.5
HCP_{05} for factor A (year) = 2.60; HCP_{05} for factor B (terms) = 1.09; HCP_{05} for the interaction factor AB (year * terms) = 1.54; HCP_{05} for factor C (variety sample) = 1.15; HCP_{05} for the interaction factor AC (year * genotype) = 1.62; HCP_{05} for the BC interaction factor (terms * variety sample) = 1.99; HCP_{05} for the ABC interaction factor (year * terms * variety sample) = 2.81;						
Seeding rate 5 million germinating grains per hectare						
Idea	11.1	15.7	11.9	21.4	33.1	18.2
15/4	11.6	12	13	36.7	17.0	15.5
Casting	11.2	14.3	11.5	32.1	27.3	30.1
TI-17 (standard)	10.3	13.4	11.2	27.4	37.2	15.3
Valentine 90	10.5	13.3	13.1	26.3	34.1	17.2
Fidelio	10.2	14.6	13.7	32.4	40.0	22.0
Crumb	11.1	12.7	11.6	26.1	27.4	18.3
HCP_{05} for factor A (year) = 4.85; HCP_{05} for the interaction factor AD (year * replication) = 1.16; HCP_{05} for factor B (terms) = 1.01; HCP_{05} for the interaction factor AB (year * terms) = 1.42; HCP_{05} for factor C (variety sample) = 1.38; HCP_{05} for the interaction factor AC (year * genotype) = 1.95; HCP_{05} for the BC interaction factor (terms * variety sample) = 2.39; HCP_{05} for the ABC interaction factor (year * terms * variety sample) = 3.38.						

Analysis of two-year data on the productivity of winter triticale varieties showed that with a late sowing period (September 15), a decrease in productivity is observed. The use of an increased seeding rate leads to an increase in the density of the productive stalk, with a simultaneous decrease in the mass of grain in the ear and the grain content in the ear.

In general, in 2019-2020, favorable conditions were created for plants of the first (august 25) and second (September 5) sowing dates, with a seeding rate of 3.0 million and 4.0 million germinating grains per hectare.

When cultivating varieties of triticale, not only the yield is important, but also the quality indicators of grain.

Biochemical analysis of winter triticale varieties presented in Table 2 indicates that the average value of the protein content in the grain of triticale varieties varied from 13.5% to 14.3%.

It was revealed that, regardless of the seeding rate, an increase in the level of protein in the grain of triticale varieties occurs at a late sowing period (September 15). The maximum protein content was observed in the Kastus variety (15.1%) at the third sowing period, at a seeding rate of 3.0 million germinating grains per hectare. Starch is one of the most important storage polysaccharides in grain, along with this, according to Pan L et al. Researchers [11], high concentrations of starch and other soluble carbohydrates can cause acidosis. Winter triticale under local conditions accumulates starch from 58.5 to 60%. The starch content in the grain of the studied varieties is influenced by the sowing time. The maximum amount of starch was found in the grain of the varieties at all sowing rates, when sowing on August 25 (average value of the indicator is 59.70%.) At late sowing dates (September 15), there is a decrease in starch in the grain to 58.5%. Fiber is important in animal nutrition, not only as a nutrient, but also as a ballast substance. The fiber content in grain varieties was 2.60% - 2.72%. Spare fat is used as a source of energy when animals are inadequately nourished. The accumulation of fat occurs with unequal intensity, which is associated with the genetic characteristics of the varieties.

Table 2. Biochemical composition of grain of winter triticale varieties at different sowing dates and seeding rates.

Term	25.08				05.09				15.09			
Seeding rate	Protein	Fat,%	Cellulose, %	Starch, %	Protein	Fat,%	Cellulose, %	Starch, %	Protein	Fat,%	Cellulose, %	Starch, %
3.0	13.8	1.33	2.58	59.5	13.5	1.32	2.54	59.55	14.3	1.22	2.72	58.6
4.0	13.5	1.20	2.62	59.7	13.5	1.16	2.63	58.9	14.1	1.24	2.75	58.5
5.0	13.5	1.39	2.60	60.0	13.5	1.26	2.69	59.3	14.1	1.15	2.69	58.8
The average	13.8	1.30	2.60	59.7	13.5	1.24	2.62	59.2	14.3	1.20	2.72	58.6

The average value of fat indicators of triticale varieties is within 1.15-1.24%. There was a tendency to decrease the content of fat and starch in grain at late sowing dates.

4. Discussion

In connection with the growing interest in the triticale culture and the expansion of the cultivated areas, technology elements have been improved and developed, taking into account the varietal characteristics, which make it possible to obtain a stable yield of winter triticale with high grain quality. The varieties of winter triticale that are most adapted to local soil and climatic conditions have been revealed. These varieties are capable of forming a grain yield with good technological indicators. The optimal sowing time and seeding rate for winter triticale seeds in the dry steppe of the Urals were established. They differed from the conditions of the Middle Urals, where the highest grain yield was formed during sowing on August 15-25 seeding rates of 6, 7 and 8 million germinating grains per hectare [12].

5. Conclusion

As a result of the studies carried out, it was found that the sowing time has a significant effect on the yield of winter triticale. To obtain high and stable yields of winter triticale grain in the dry steppe of the Urals, the optimal sowing period should be considered the period from August 25 to September 5, at a seeding rate of 3.0 and 4.0 million germinable grains per hectare. With a favorable moisture supply regime, sowing of winter triticale is possible until September 15. The use of an increased rate (5.0 million) is not a factor contributing to an increase in yields in winter triticale varieties under ZCO conditions. The most productive varieties adapted to the conditions of the dry steppe zone are Kastus, Fidelio, Valentin 90.

References

[1] Kovtunenko V Y, Bespalova L A, Panchenko V V, Kalmysh A P and Goldvarg B A 2019 The role of triticale in increasing the productivity of forage production. *Feed production* **9** 14-17
[2] Goryanina T A 2017 Features of selection and improvement of the technology of cultivation of winter triticale in the Middle Trans-Volga region. *Bulletin of the Samara Scientific Center of the Russian Academy of Sciences vol.* **2(4)** 605-11
[3] Vyurkov V V 2017 Winter crops in the dry steppe of the Urals. *Uralsk: Western Kazakhst. agr.-tech. University named after Zhangir khan* 120
[4] Ponomarev S N, Ponomareva M L and Fomin S I 2018 Feed value of winter triticale varieties in the Middle Volga region. *Achievements of science and technology of the agro-industrial complex vol.* **32(7)** 47-56
[5] Krokhmal A V and Grabovets A I 2020 Breeding of triticale in the forage direction for productivity and adaptability. *Achievements of science and technology of the agro-industrial complex vol.* **34(6)** 54-8
[6] Sukhanberdina L K, Fillipova F V and Denizbaev S E 2019 Feed value of breeding samples of winter triticale. *Bulletin of the Orenburg State Agrarian University* **4(78)** 68-71
[7] Mushroom S I and Bushtevich V N 2016 Results and priorities of triticale breeding in Belarus. *Materials of the international scientific-practical conference "The role of triticale in stabilizing the production of grain, feed and technology for their use"* 67-76
[8] Tsvik G S, Sabirova T P and Kostenko S I 2020 Influence of elements of the technology of cultivation of winter triticale variety Nemchinovsky 56 on productivity and quality of grain in the non-black earth zone of the Russian Federation. *Feed production* **9** 24-8
[9] Bacchi M, Monti M, Calvi A, Lo Presti E, Pellicano A and Preiti G 2021 Forage Potential of Cereal. Legume Intercrops: Agronomic Performances, Yield, Quality Forage and LER in Two Harvesting Times in a Mediterranean Environment. *Agronomy* **11(1)** 121
[10] Fedin M A 1985 *Methodology of state variety testing of agricultural crops* (Moscow: Agropromizdat) 263
[11] Pan L, Huang K H, Middlebrook T, Zhang D, Bryden W L and Li X 2021 Rumen Degradability of Barley Oats, Sorghum, Triticale, and Wheat In Situ and the Effect of Pelleting. *Agriculture* **11(7)** 647
[12] Zholobova M S and Potapova G N 2012 Influence of elements of cultivation technology on winter hardiness and yield of winter triticale in the conditions of the Middle Urals. *Materials of the international scientific-practical conference "Triticale and its role in the conditions of increasing climate aridity"* 167-71