https://doi.org/10.26898/0370-8799-2021-1-2
УДК: 632.93: 631.524.5:633.11
Тип статьи: оригинальная
Type of article: original

ВЛИЯНИЕ ПРЕДПОСЕВНОЙ ОБРАБОТКИ СЕМЯН ЯРОВОЙ ПШЕНИЦЫ НА ЛИНЕЙНЫЕ РАЗМЕРЫ И ГЕОМЕТРИЧЕСКИЕ ХАРАКТЕРИСТИКИ ЗЕРНА

Власенко Н.Г., Бурлакова С.В.
Сибирский федеральный научный центр агробиотехнологий Российской академии наук
Новосибирская область, р.п. Краснообск, Россия

Представлены результаты оценки воздействия биопрепаратов и протравителя семян на технологические качества зерна мягкой яровой пшеницы Новосибирская 31. Эффективность применения биологических средств защиты растений изучали в полевом эксперименте, заложенном в 2020 г. в условиях лесостепи Приобья. Предпосевная обработка семян включала следующие варианты: контроль (без обработки); Триходермин, П (*Trichoderma viride,* титр более 6 млрд спор/г), норма расхода – 15 кг/т семян; Споробактерин, СП (*Bacillus subtilis* + *Trichoderma viride*, штамм 4097), норма расхода – 0,5 кг/т семян; Скарлет, МЭ, химический эталон (имазалил (100 г/л) + тебуконазол (60 г/л), норма расхода – 0,3 л/т семян. Применение препаратов способствовало росту урожайности на 0,40 и 0,52 т/га при использовании Триходермина и Споробактерина соответственно и на 0,08 т/га при применении фунгицида Скарлет. При этом масса 1000 зерен увеличилась на 0,84; 0,80 и 0,96 г соответственно относительно контроля. Препараты Триходермин и Споробактерин оказывали достоверное влияние на рост зерновки в длину и ширину относительно контроля – на 5,4–6,9 и 9,6%, Скарлет – на 10,6 и 13,9% соответственно. Предпосевная обработка семян способствовала росту таких показателей зерновки, как объем (на 19,6–29,3%), площадь поверхности (на 12,1–19,2%), сферичность (на 6,3–7,8%). В большей степени они увеличивались при применении фунгицида Скарлет. Получение более крупного зерна привело к росту содержания эндосперма на 0,76–1,14%. Показана тесная коррелятивная связь между показателями массы 1000 зерен и линейными размерами зерна (r = 0,92–0,98), а также с объемом зерновки, сферичностью и содержанием эндосперма (r = 0,98–0,99). Предпосевная обработка семян яровой пшеницы обеспечивает получение зерна с улучшенными технологическими свойствами.

Ключевые слова: мягкая яровая пшеница, биопрепараты, протравитель зерна, фунгицид, линейные размеры зерна, геометрические характеристики зерна

EFFECT OF PRE-SOWING TREATMENT OF SPRING WHEAT SEEDS ON LINEAR SIZES AND GEOMETRIC GRAIN CHARACTERISTICS

Vlasenko N.G., Burlakova S.V.
Siberian Federal Scientific Centre of AgroBioTechnologies of the Russian Academy of Sciences
Krasnoobsk, Novosibirsk region, Russia

The results of assessing the effect of biological preparations and a seed disinfectant on the technological qualities of grain of soft spring wheat Novosibirskaya 31 are presented. The effectiveness of the use of biological plant protection products was studied in the field experiment, laid down in 2020 in the forest-steppe conditions of the Ob region. Pre-sowing seed treatment included the following options: control (without treatment); Trichodermin, P (Trichoderma viride, titer more than 6 billion spores/g), consumption rate – 15 kg/t seed; Sporobacterin, SP (Bacillus subtilis + Trichoderma viride, strain 4097), consumption rate – 0.5 kg/ton of seeds; Scarlet, ME, chemical standard (imazalil (100 g/l) + tebuconazole (60 g/l), consumption rate – 0.3 l/t of seeds. The use of the preparations contributed to an increase in yield by 0.40 and 0.52 t/ha when using Trichodermin and Sporobacterin, respectively, and by 0.08 t/ha when using fungicide Scarlet. In this case, the mass of 1000 grains increased by 0.84, 0.80 and 0.96 g, respectively, relative to the control. The preparations Trichodermin and Sporobacterin had a significant effect on the growth of grain in length and width relative to the control – by 5.4-6.9 and 9.6%, Scarlet – by 10.6 and 13.9%, respectively. Pre-sowing seed treatment contributed to the growth of such indicators of the caryopsis as volume (by 19.6–29.3%), surface area (by 12.1–19.2%), and sphericity (by 6.3–7.8%).

To a greater extent, they increased with the use of fungicide Scarlet. Getting larger grain led to an increase in the endosperm content by 0.76–1.14%. A close correlation has been shown between the indicators of the mass of 1000 grains and the linear grain sizes (r = 0.92–0.98), as well as with the grain volume, sphericity and endosperm content (r = 0.98–0.99). Pre-sowing treatment of spring wheat seeds provides grain with improved technological properties.

Keywords: soft spring wheat, biological preparations, grain disinfectant, fungicide, grain linear dimensions, grain geometrical characteristics

Для цитирования: *Власенко Н.Г., Буралакова С.В.* Влияние предпосевной обработки семян яровой пшеницы на линейные размеры и геометрические характеристики зерна // Сибирский вестник сельскохозяйственной науки. 2021. Т. 51. № 1. С. 18–24. https://doi.org/10.26898/0370-8799-2021-1-2

For citation: Vlasenko N.G., Burlakova S.V. Effect of pre-sowing treatment of spring wheat seeds on linear sizes and geometric grain characteristics. *Sibirskii vestnik sel'skokhozyaistvennoi nauki = Siberian Herald of Agricultural Science,* 2021, vol. 51, no. 1. pp 18–24.. https://doi.org/10.26898/0370-8799-2021-1-2

Конфликт интересов
Авторы заявляют об отсутствии конфликта интересов.
Conflict of interest
The authors declare no conflict of interest.

INTRODUCTION

The technological properties of grain are a set of signs and quality indicators that characterize its state in the technological processes of processing, affecting the yield and quality of flour [1, 2]. The technological properties of grain are derived from a group of primary properties that can be subdivided into physicochemical, biochemical, structural-mechanical, thermophysical, and also anatomical structure of grain. The linear dimensions and shape of the caryopsis affect the degree of injury to seeds and the quality of grain conditioning. For this reason, in breeding practice, they try to select leveled shortened grains of a round shape [3]. Grain volume and shape are related to the endosperm content, which provides the actual flour yield; the outer surface area determines the intensity of the interaction of the grain with the surrounding atmosphere; the ratio of the volume and the outer surface of the grain is the so-called determining size, the role of which is manifested in the processes of heat transfer during storage, drying and hydrothermal treatment of grain [4–6]. The shapes and sizes of seeds are variable and depend on both soil and weather conditions during the growing season. When studying the physic mechanical properties of seeds, not only average sizes are important, but also all indicators of variability of individual properties of seeds of grain crops [6, 7]. Much attention is paid to studies of the parameters of caryopses. Their linear dimensions, shape and anatomical structure are influenced not only by weather conditions, but also by the cultivation technology, as well as the characteristics of the genotypes of varieties [8].

The pre-sowing seed treatment with biological and chemical preparations leads to an increase in the yield of spring wheat and contributes to the production of grain with a higher weight [9, 10].

The purpose of the research is to study the effect of pre-sowing seed treatment on its linear and some geometric characteristics.

MATERIAL AND METHODS

The effectiveness of the use of biological plant protection products was studied in the field experiment, laid down in 2020 at the station of the Siberian Research Institute of Agriculture and Chemicalization of the Siberian Federal Scientific Center of AgroBioTechnologies of the Russian Academy of Sciences. The scientific experiment took place in the forest-steppe conditions of the Ob region on the crops of spring wheat Novosibirskaya 31 (medium-early variety, growing season 70–76 days), which was placed along the steam predecessor. Sowing was carried out on May 14 with a seeding rate of 6 million germinating grains / ha. Pre-sowing seed treatment included the following options:

– control (without treatment);

– Trichodermin, P (Trichoderma viride, titer more than 6 billion spores / g), consumption rate - 15 kg / t of seeds;

– Sporobacterin, SP (Bacillus subtilis + Trichoderma viride, strain 4097), consumption rate - 0.5 kg / t of seeds;

– Scarlet, ME, chemical standard (imazalil (100 g / l) + tebuconazole (60 g / l), consumption rate - 0.3 l / t of seeds.

The consumption rate of the working fluid is 10 l / t of seeds. The area of the accounting plot is 14.7 m^2, the arrangement is sequential in one tier, the repetition is four times. Wheat yields were taken into account by direct combining, and were brought to 100% purity and 14% moisture. The weight of 1000 grains was determined in the resulting crop.

The following indicators of the grain were studied: length, width, thickness[1], and their volume, surface area, sphericity, and endosperm content[2] were also calculated. The sample volume was 100 grains. Grain products were assessed using an electronic micrometer in the Micro Capture Pro program. Statistical analysis of experimental data was carried out using the Snedecor[3] software package.

The meteorological data for the growing season of 2020 significantly differed from the long-run annual average in terms of the temperature regime and the amount of precipitation. The month of May of the current season especially stood out in terms of temperature and moisture regime. The air temperature this month exceeded the long-run annual average by 6.2 ºC, the amount of precipitation was 1.5 times higher than the norm. In June, the air temperature was at the level of the long-run annual average, the arrival of atmospheric moisture on average per month was 2.4 times lower than the norm. In July, the temperature regime exceeded the average annual indicators by 0.6 ºC, precipitation fell 1.2 times more than the norm. August was warm enough: the air temperature exceeded the long-run annual average by 2.8 ºC. The arrival of atmospheric moisture in the first ten-day period of the month was 1.7 times lower than the norm, in the second ten-day period precipitation was 2.2 times more than the long-run annual average.

RESULTS AND DISCUSSION

In the variants of the experiment with the treatment of seeds with biological preparations, a significant increase in the yield of wheat was obtained relative to the control: when the seeds were treated with Trichodermin - by 0.4 t / ha, Sporobacterin - by 0.52 t / ha (see Table 1).

The dressing of the seed with Scarlet under the conditions of the current year did not affect the grain yield. However, the weight of 1000 grains significantly increased compared with the control in all variants of the experiment by 0.80-0.96 g, in the variant with the use of Scarlet fungicide it was the greatest.

When using the preparations, the linear dimensions of the grain significantly changed: the length increased by 5.4 and 6.9% when the seeds were treated with biological preparations, by 10.6% when using a chemical preparation, the width - by 9.6 and 13.9%, respectively (see

Табл. 1. Влияние предпосевной обработки семян биопрепаратами и фунгицидом на урожайность и массу 1000 зерен яровой пшеницы Новосибирская 31

Table 1. Influence of pre-sowing seed treatment with biological products and fungicide on yield and weight of 1000 grains of spring wheat Novosibirskaya 31

Option	Yield, t/ha	The mass of 1000 grains, g
Control	1,81	30,83
Trichodermin	2,21	31,67
Sporobacterin	2,33	31,63
Scarlet	1,89	31,79
LSD_{05}	0,26	0,63

[1]Talanov I.P. Plant growing. Workshop: textbook. manual for academic undergraduate 2nd ed. Moscow: Yurayt Publishing House, 2018.288 p.

[2]Egorov G.A. Flour technology. Practical course. M.: DeLi print, 2007.143 p.

[3]Sorokin O.D. Applied statistics on the computer. 2nd ed. Novosibirsk, 2012. 282 p.

Table 2). Of the three dimensions (length, width and thickness), thickness is the most characteristic of the milling properties of the grain. A high correlation was found between the grain thickness of common wheat and the content of endosperm in it [11]. When growing wheat which was treated before sowing with preparations, the thickness of the grain increased by 3.2-3.5% compared with the control.

The linear dimensions of the grain determine its size, which is the most important indicator of the quality of the grain. Coarse grain has more endosperm and fewer shells, therefore, the higher the yield of finished products from grain [12]. In variants where Trichodermin and Sporobacterin were used for pre-sowing seed treatment, the volume of the grain increased by 19.6 and 21.3% compared with the control, but to a greater extent it increased when using the fungicide Scarlet - by 29.3% (see Table 3). The surface area of the grain also turned out to be 12.1–19.2% higher in the variants with the treatment of seeds with preparations; it was the largest when the fungicide Scarlet was applied. The sphericity of the grain also increased by 6.3-7.8% when sown with treated seeds.

The geometric characteristics of the grain made it possible to calculate the endosperm content in it. This indicator, when growing wheat from seeds treated with biological products, increased by 0.76-0.83%, with a chemical fungicide - by 1.14%.

The smallest variation in the grain length was observed in the control and when using the Scarlet fungicide (V = 7.44 and 7.54%). Variation in the grain width indicator was at the level of 10.16–11.37%. The variation in the thickness of the grain decreased from 9.01% in the control to 7.12– 7.28% in the experiment. A correlation was revealed between the mass indices of 1000 grains and the linear grain sizes: length, width and thickness (r = 0.92; 0.98 and

Табл. 2. Влияние предпосевной обработки семян биопрепаратами и фунгицидом на линейные размеры зерна яровой пшеницы Новосибирская 31

Table 2. Influence of pre-sowing seed treatment with biological products and fungicide on the linear grain size of spring wheat Novosibirskaya 31

Option	Indicator				
	Size, mm	Mean square deviation, *S*, %	Variation coefficient, *V*, %	Sample relative error, S_x, %	Test, t_{f095} и t_{theor}
Grain length (n = 100)					
Control	6,33 ± 0,37	0,47	7,44	1,04	–
Trichodermin	6,67 ± 0,57	0,67	10,11	1,42	8,22 ≥ 1,98
Sporobacterin	6,77 ± 0,60	0,76	11,15	1,57	12,20 ≥ 1,98
Scarlet	7,00 ± 0,41	0,53	7,54	1,07	44,08 ≥ 1,98
Grain width (n = 100)					
Control	2,73 ± 0,22	0,28	10,16	1,45	–
Trichodermin	2,99 ± 0,26	0,32	10,75	1,51	19,00 ≥ 1,98
Sporobacterin	2,99 ± 0,27	0,34	11,37	1,61	17,15 ≥ 1,98
Scarlet	3,11 ± 0,25	0,32	10,26	1,46	40,46 ≥ 1,98
Grain thickness (n = 100)					
Control	2,82 ± 0,21	0,25	9,01	1,25	–
Trichodermin	2,91 ± 0,16	0,21	7,12	1,02	4,35 ≥ 1,98
Sporobacterin	2,92 ± 0,17	0,21	7,23	1,02	4,82 ≥ 1,98
Scarlet	2,91 ± 0,17	0,21	7,28	1,02	3,91 ≥ 1,98

Табл. 3. Влияние предпосевной обработки семян биопрепаратами и фунгицидом на геометрические показатели зерна яровой пшеницы Новосибирская 31

Table 3. Influence of pre-sowing seed treatment with biological products and fungicide on the geometric parameters of spring wheat grain Novosibirskaya 31

Option	Grain volume, mm^3	Grain surface area, mm^2	Grain sphericity	Endosperm content, %
Control	25,47 ± 3,99	63,95 ± 6,81	0,64 ± 0,04	82,48 ± 0,61
Trichodermin	30,46 ± 5,39	71,67 ± 9,00	0,68 ± 0,04	83,24 ± 0,83
Sporobacterin	30,90 ± 5,10	73,13 ± 9,00	0,68 ± 0,04	83,31 ± 0,78
Scarlet	32,93 ± 4,26	76,21 ± 7,66	0,69 ± 0,04	83,62 ± 0,65

0.97), as well as with the grain volume, sphericity and endosperm content (r = 0.98 –0.99). The length-to-width ratio for wheat grains decreased from 2.32: 1 in the control to 2.23: 1, 2.26: 1 and 2.25: 1 in variants with the use of Trichodermin, Sporobacterin and Scarlet. The ratio of width to thickness, on the contrary, increased slightly - from 0.97: 1 in the control to 1.03: 1; 1.02: 1 and 1.07: 1 in experimental versions. Nevertheless, the obtained grain was characterized by a rather favorable ratio of linear dimensions for the conditions of its processing.

CONCLUSION

Seed treatment with biological products Trichodermin, Sporobacterin and Scarlet fungicide influenced not only grain yield and 1000 grain weight, but also linear dimensions and geometric characteristics of grain. The length of the grain increased by 5.4–10.6%, the width by 9.6–13.9, and the thickness by 3.2–3.5%. These indicators increased to the greatest extent with the use of a chemical fungicide. This led to an improvement in the geometrical characteristics of the grain: the volume of the grain increased by 19.6–29.3%, the surface area by 12.1–19.2, and its sphericity by 6.3–7.8%. The endosperm content in grain also increased by 0.76–1.14%. In addition, the ratio of the grain length to its width was reduced from 2.32: 1 in the control to 2.23: 1; 2.25: 1 and 2.26: 1 when using preparations. Thus, the preparations Trichodermin, Sporobacterin and Scarlet, which were used for pre-sowing seed treatment, had a positive effect on the technological properties of the grain of the new harvest.

СПИСОК ЛИТЕРАТУРЫ

1. *Осокина Н.М., Костецкая Е.В.* Сравнительная оценка зерна яровых пшеницы и тритикале как сырья для изготовления хлеба // Сельское, лесное и водное хозяйство. 2014. № 2.
2. *Nuttalla J.G., O'Learya G.J., Panozzoa J.F., Walkera C.K., Barlowb K.M., Fitzgerald G.J.* Models of grain quality in wheat – A review // Field Crops Research. 2017. Vol. 202. P. 136–145. DOI: 10.1016/j.fcr.2015.12.011.
3. *Фомина М.Н., Аверьясова Ю.С.* Геометрическая характеристика зерна голозерных сортов овса в зоне северной лесостепи Тюменской области // Аграрная наука Евро-Северо-Востока. 2016. № 3 (52). С. 4–9.
4. *El Fawal Y.A., Tawfik M.A., El Shal A.M.* Study on physical and engineering properties for grains of some field crops // Misr Journal of Agricultural Engineering. 2009. Vol. 26 (4). P. 1933–1951.
5. *Kheiralipour K., Karimi M., Tabatabaeefar A., Naderi M., Khoubakht G., Heidarbeigi K.* Moisture-Depend Physical Properties of Wheat (*Triticum aestivum* L.) // Journal of Agricultural Technology. 2008. Vol. 53. P. 53–64.
6. *Sýkorová A., Šárka E., Bubník Z., Schejbal M., Dostálek P.* Size distribution of barley kernels // *Czech Journal of Agricultural Technology*, 2009. Vol. 27. N 4. P. 249–258. DOI: 10.17221/26/2009–CJFS.
7. *Евченко А.В.* Анализ физико-механических свойств семян зерновых культур // Вестник Красноярского ГАУ. 2016. № 8. С. 144–149.

8. *Тоболова Г.В.* Геометрическая характеристика зерна тетраплоидного вида *Triticum carthlicum* Nevski. в условиях Северной лесостепи Тюменской области // Достижения науки и техники АПК. 2013. № 9. С. 40–43.
9. *Слободчиков А.А*. Влияние средств защиты растений на продуктивность сортов яровой пшеницы // Достижения науки и техники АПК. 2020. Т. 34. № 2. С. 10–14. DOI: 10.24411/0235–2451–2020–10202.
10. *Перцева Е.В., Васин В.Г., Бурлака Г.А*. Влияние предпосевной обработки семян на продуктивность яровой пшеницы // Вестник Ульяновской государственной сельскохозяйственной академии. 2019. № 3 (47). С. 78–85. DOI: 10.18286/1816–4501–2019–3–78–86.
11. *Рындин А.Ю.* Физические методы определения качества зерна: анализ источников // Вестник НГИЭИ. 2013. № 12 (31). С. 72–82.
12. *Кравченко Н.С., Ионова Е.В., Вожжова Н.Н., Олдырева И.М.* Качественные показатели зерна и муки сортов и линий озимой мягкой пшеницы // Зерновое хозяйство России. 2018. № 5 (59). С. 6–10. DOI: 10.31367/2079–8725–2018–59–5–6–10.

REFERENCES

1. Osokina N.M., Kostetskaya E.V. Comparative evaluation of spring wheat and triticale as feedstock for the bread production. *Sel'skoe, lesnoe i vodnoe khozyaistvo = Agriculture, Forestry and Water Management*, 2014, no. 2. (In Russian).
2. Nuttalla J.G., O'Learya G.J., Panozzoa J.F., Walkera C.K., Barlowb K.M., Fitzgerald G.J. Models of grain quality in wheat – A review. *Field Crops Research*, 2017, vol. 202, pp. 136–145. DOI: 10.1016/j.fcr.2015.12.011.
3. Fomina M.N., Aver'yasova Yu.S. Geometric characteristics of grain of naked oats varieties in the northern forest-steppe zone of the Tyumen region. *Agrarnaya nauka Evro-Severo-Vostoka = Agricultural Science Euro-North-East*, 2016, no. 3 (52), pp. 4–9. (In Russian).
4. El Fawal Y.A., Tawfik M.A., El Shal A.M. Study on physical and engineering properties for grains of some field crops. *Misr Journal of Agricultural Engineering*, 2009, vol. 26 (4), pp. 1933–1951.
5. Kheiralipour K., Karimi M., Tabatabaeefar A., Naderi M., Khoubakht G., Heidarbeigi K. Moisture-Depend Physical Properties of Wheat (Triticum aestivum L.). *Journal of Agricultural Technology*, 2008, vol. 53, pp. 53–64.
6. Sýkorová A., Šárka E., Bubník Z., Schejbal M., Dostálek P. Size distribution of barley kernels. *Czech Journal of Food Sciences,* 2009, vol. 27, no. 4, pp. 249–258. DOI: 10.17221/26/2009–CJFS.
7. Evchenko A.V. Analysis of physical and mechanical properties of grain crops seeds. *Vestnik KrasGAU = The Bulletin of KrasGAU*, 2016, no. 8, pp. 144–149. (In Russian).
8. Tobolova G.V. Geometric characteristics of grain tetraploid species Triticum carthlicum Nevski. in the forest-steppe of the Tyumen region. *Dostizheniya nauki i tekhniki APK = Achievements of Science and Technology of AIC*, 2013, no. 9, pp. 40–43. (In Russian).
9. Slobodchikov A.A. The influence of plant protection products on the yield of spring wheat varieties. *Dostizheniya nauki i tekhniki APK = Achievements of Science and Technology of AIC*, 2020, vol. 34, no. 2, pp. 10–14. (In Russian). DOI: 10.24411/0235–2451–2020–10202.
10. Pertseva E.V., Vasin V.G., Burlaka G.A. Influence of pre-sowing seed treatment on productivity of spring wheat. *Vestnik Ul'yanovskoi gosudarstvennoi sel'skokhozyaistvennoi akademii = Vestnik of Ulyanovsk State Agricultural Academy*, 2019, no. 3 (47), pp. 78–85. (In Russian). DOI: 10.18286/1816–4501–2019–3–78–86.
11. Ryndin A.Yu. Physical methods of defining grain quality: analysis of sources. *Vestnik NGIEI = Bulletin NGIEI*, 2013, no. 12 (31), pp. 72–82. (In Russian).
12. Kravchenko N.S., Ionova E.V., Vozhzhova N.N., Oldyreva I.M. Qualitative traits of grain and flour of the winter soft wheat lines. *Zernovoe khozyaistvo Rossii = Grain Economy of Russia*, 2018, no. 5 (59), pp. 6–10. (In Russian). DOI: 10.31367/2079–8725–2018–59–5–6–10.

Информация об авторах

(✉) **Власенко Н.Г.,** доктор биологических наук, главный научный сотрудник, заведующая лабораторией; **адрес для переписки**: Россия, 630501, Новосибирская область, р.п. Краснообск, а/я 463; e-mail: vlas_nata@ngs.ru

Бурлакова С.В., кандидат сельскохозяйственных наук, старший научный сотрудник

Author information

(✉) **Natalia G. Vlasenko,** Doctor of Science in Biology, Head Researcher, Head of Laboratory; **address:** PO Box 463, SFSCA RAS, Krasnoobsk, Novosibirsk Region, 630501, Russia; e-mail: vlas_nata@ngs.ru

Svetlana V. Burlakova, Candidate of Science in Agriculture, Senior Researcher

Дата поступления статьи 10.10.2020
Received by the editors 10.10.2020