

The influence of frondiferous diseases on the main indicators of spring wheat quality

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ABSTRACT

Among frondiferous diseases of spring wheat in Northern Kazakhstan, Septoria blight and brown and stem rust are the most widely spread. Yield losses at moderate development of Septoria blight are 10-15 %, at epiphytoses - up to 30%, and at joint manifestation with brown rust - up to 40 %. The existing literature data about the effect of frondiferous diseases on wheat grain quality, and especially on its baking properties are scarce and often contradictory. The research was aimed at studying the effect of frondiferous diseases on the main indicators of wheat quality. The used methods were those generally adopted for phytopathological studies. The effect of Septoria blight on the main indicators of wheat quality has been studied. In 2018, no effect of Septoria blight was noted on such indicators as the natural weight of grain, its vitreousness, ultimate dough resilience, valorimetric assessment, dough dilution, and general baking assessment. The content of protein and gluten was higher in all studied wheat grades on the plots treated with fungicides. Gluten quality in Astana, Akmola 2, Tselinnaya Yubileinaya varieties on the test plots was higher, and related to the first group, compared to the plots treated with the chemical drug. In 2019, no effect of Septoria blight on the quality indicators, such as the natural weight of grain, gluten quality, valorimetric assessment, and general baking assessment, was detected. According to the readings of the farinograph, grain vitreousness, the content of protein and gluten, ultimate dough resilience and dough dilution were higher in all studied wheat grades on the plots treated with fungicides. On average over the two years of the study, such indicators as vitreousness, protein and gluten content, and ultimate dough resilience were higher in the variants with the use of fungicide, compared to the reference.

Key words: Spring soft wheat, Septoria blight, Brown rust, Harmfulness, Grain quality.

Introduction

Kazakhstan is one of the largest grain-producing countries in the world. The country produces about 13.5 – 20.1 million tons of grain, which allows just slight lagging behind Russia and Ukraine (Analysis of crop production, 2013). Among frondiferous diseases of spring wheat in Northern Kazakhstan, brown and stem rust and Septoria blight are the

most widely spread. In recent years, manifestation of Septoria blight on wheat crops has been noted annually, even in dry years: weak - in 2003 and 2010, moderate - in 2002, 2004, 2005, 2006, 2008, 2012, 2014, and 2015, and strong - in 2007, 2009, 2011, and 2013 (Babkenova, 2015). This is explained by the fact that spring wheat occupies about 70 % of the acreage in this region, and by the use of grain-fallow crop rotations, where infections are accumu-

lated. Manifestations of brown rust are observed annually, except for arid years. Epiphytotic of this disease were observed three times in the period between 2003 and 2015. Yield losses at moderate development of Septoria blight are 10 – 15 %, at epiphytotic - up to 30 %, and at joint manifestation with brown rust - up to 40 % (Koishybayev, 2018; Bhathal *et al.*, 2003). In the recent years, the phytosanitary situation in spring wheat crops in the North of Kazakhstan has deteriorated, the frequency and harmfulness of the mass development outbreaks of previously insignificant diseases have increased, for example, leaf and ears Septoria blight, which had been caused by the use of zero and minimum tillage for grain crops (Suleimenov *et al.*, 2014).

Grain quality is one of the main priorities in spring wheat breeding. In recent years, deterioration of the commercial quality of the wheat produced in the conditions of Northern Kazakhstan has been noted. There are several complex reasons for deterioration of grain quality: temperature changes, presence of pests and diseases during the vegetation season, abundant rainfall in the period of grain filling, and early autumn frosts (Babkenov, 2010; Bayahmetova, *et al.*, 2014). The existing literature data about the effect of frondiferous diseases on wheat grain quality, and especially on its baking properties are scarce and often contradictory (Sanin and Zhokhova, 2012; Ganiev and Khasanov, 1998).

The research was aimed at studying the effect of frondiferous diseases on the main indicators of wheat quality.

Materials and Methods

Spring wheat varieties were studied in 2018 – 2019 at the station of the Department of Spring Wheat Breeding. In 2018, the meteorological conditions of spring wheat vegetation period were characterized as arid (Hydrothermal Index (HTI) = 0.4), and in 2019 - as humid (HTI = 1.3). Three commercial varieties of spring wheat were studied: Astana variety - of the medium early type, Akmola 2 variety - of the mid-season type, and Tselinnaya Yubileynaya - of the middle-late ripening type. These varieties of spring wheat are susceptible to Septoria blight and rust diseases. The varieties were sown in two repetitions, following the methodology of agricultural plant grade testing. Indicators of the physical and physicochemical properties of grain have been determined: nature, the weight of 1,000 grains, the

content and quality of gluten using devices MOK – 1M, IDK, (GOST ISO 7971-2-2002, 2013; GOST 10842-89, 2009; ST RK 1054-2002, 2006), protein content following GOST 10846-91 Grain and products of its processing. Method for determination of protein (GOST 10846-91, 1993). The physical properties of dough were studied using the method of alveography following ICC-121-92 (1992) and farinography following ICC-115-92 (1992). The baking properties of spring wheat varieties were assessed following the methodology of state grade testing (Methods of agricultural crop state grade testing, 1988).

Results

There are several reasons for the formation of the main grain quality indicators: temperature changes, pests, and diseases. In the Northern regions of Kazakhstan, the development of Septoria blight and wheat rust diseases, which reduce the vegetation period of plants and affect the grain quality, was noted. During the vegetation season, they reduce the content and the quality of gluten in the grain and deteriorate the quality of protein substances.

In 2018, in the arid conditions of the summer (HTI = 0.4), strong development of the Septoria blight disease (50 %), and weak development of brown rust (10 %) on wheat crops were noted. In 2019, in the conditions of the humid summer (HTI = 1.3), strong development of Septoria blight and moderate development of brown rust were noted.

The natural weight (nature) is an important quality indicator that affects the milling qualities of the grain (Firsova and Popova, 1981). In Table 1, the natural grain weight of the studied lines ranged from 747.0 to 813.0 g/L. For the Astana variety, this indicator in the reference plot over the two years averaged to 780.0 g/L, which was lower by 5.0 g/L than in the plots treated with fungicides. For the Akmola 2 variety, no significant difference was found for this indicator. For the Tselinnaya Yubileynaya variety, the natural weight was higher by 13.5 g/L in the variant with the use of fungicide.

Vitreousness, being an outward attribute of grain quality, reflects the structure of the grain internal tissues. For the studied varieties, this indicator ranged from 41 to 63 %. For the Astana variety, this indicator was higher in the variant with the use of fungicides in 2018 – 2019, the average exceedance was 7.5 %. Vitreousness of the Akmola 2 variety

was higher in the plots with fungicide in 2018 and 2019 and amounted to 3.0 % and 10.0 %, respectively. For the Tselinnaya Yubileynaya variety, in 2018, no difference of this indicator was detected, and in 2019, vitreousness in the plot treated with fungicides was 50 %, while in the reference, it was 44 %. On average over the two years, the exceedance in the option with the use of fungicides was 2.5 %. Vitreousness of all tested wheat varieties in the variants with fungicides over the two years was higher on average by 2.5 – 7.5 % than in the reference plots.

Wheat protein is the main valuable element of this product, therefore, its content in the grain influences the final grade and the quality of the product (Bebyakin and Saifullin, 1997). Among the studied samples, this indicator ranged from 11.7 to 17.3 %. In 2018, the protein content of the studied varieties was higher than in 2019 due to the influence of the weather conditions in August (HTI in 2018 = 0.1,

HTI in 2019 = 1.8). For the Astana, Akmola 2, and Tselinnaya Yubileynaya varieties, the content of protein was higher in the variant with the use of fungicide in 2018 – 2019, and over the two years of the study on average amounted to 1.4 %, 1.5 % and 1.1 %, respectively.

The content and the quality of gluten determine the baking quality of wheat and depend on the ratio of complex protein substances -glutenins and gliadins. According to the classification standards, wheat varieties are classified as strong, valuable, filler, and weak wheat: strong wheat varieties are characterized by the gluten content over 28 %, and the quality of gluten should be grade 1 (40–75 FDM units), the gluten content in valuable varieties should be 23 - 28 %, and its quality should be grade 1 and 2. The weight percentage of gluten in the studied varieties varied from 19.0 to 39.4 %. In the variants with the use of fungicides in 2018 - 2019, in Astana, Akmola 2 and Tselinnaya Yubileynaya va-

Table 1. The main grain quality indicators for spring soft wheat varieties

Indicators	Years	Astana (reference)	Astana	Akmola 2 (reference)	Akmola 2	Tselinnaya Yubileynaya (reference)	Tselinnaya Yubileynaya
Natural weight, g/L	2018	747	763	773	775	752	778
	2019	813	807	812	812	810	811
	average	780.0	785.0	792.5	793.5	781.0	794.5
Vitreousness, %	2018	60	63	57	60	61	60
	2019	47	59	41	51	44	50
	average	53.5	61.0	49.0	55.5	52.5	55.0
Protein content, %	2018	15.4	17.3	13.8	16.2	14.3	16.0
	2019	12.8	13.8	11.7	12.3	11.8	12.3
	average	14.1	15.5	12.7	14.2	13.0	14.1
Gluten content, %	2018	34.7	39.4	30.2	35.6	31.4	35.2
	2019	23.6	27.2	20.5	23.7	19.0	21.6
	average	29.1	33.3	25.3	29.6	25.2	28.4
Gluten quality, FDM units	2018	70	93	71	80	60	78
	2019	56	66	49	44	50	52
	average	63.0	79.5	60.0	62.0	55.0	65.0
The ultimate dough resilience, units	2018	294	365	251	317	316	348
	2019	203	252	203	249	190	229
	average	248.5	308.5	227.0	283.0	253.0	288.5
Valorimetric assessment, units	2018	71	75	69	73	74	71
	2019	69	73	69	71	67	73
	average	70.0	74.0	69.0	72.0	70.5	72.0
Dough dilution, units	2018	150	110	140	115	120	135
	2019	150	145	180	135	165	135
	average	150.0	127.5	160.0	125.0	142.5	135.0
General baking assessment, score	2018	4.5	4.9	4.7	4.8	4.7	4.6
	2019	4.7	4.7	4.5	4.7	4.4	4.6
	average	4.6	4.8	4.6	4.8	4.6	4.6

rieties, higher gluten content was noted, compared to the reference. On average, the exceedance of this indicator was 4.2 %, 4.3 %, and 3.2 %, respectively. In all studied wheat varieties, this indicator in the reference was lower than in the variants treated with fungicides.

The gluten quality varied from 44 to 93 FDM units. In 2018, this indicator for the studied varieties in the reference belonged to the first group, and on the plots treated with fungicides - to the second group. By the quality of gluten, all studied variants for Astana, Akmola 2 and Tselinnaya Yubileynaya varieties in 2019 belonged to the first group, i.e., no significant difference was found.

The results of the alveographic assessment in 2018 showed that the level of ultimate dough resilience (W) of the studied varieties was in line with the requirements to the improver varieties, i.e., more than 280 units, except for the Akmola 2 variety in the reference. This indicator in the varieties ranged from 251 units to 365 units. The difference between the reference variants and the variants treated with fungicides for various wheat varieties was the following: for the Astana variety - 71 units, for the Akmola 2 variety -66 units, for the Tselinnaya Yubileynaya variety - 32 units, i.e., it was higher on the plots treated with fungicides. In 2019, the level of ultimate dough resilience (W) for the studied varieties did not meet the requirements to improver grades and ranged from 190 units to 252 units. The difference for this indicator in the reference variants and the variants treated with fungicides for the Astana variety was 49 units, for the Akmola 2 variety - 46 units, and for the Tselinnaya Yubileynaya variety -39 units, and was higher in the variants with the use of fungicides. On average over the two years of the study, the exceedance of this indicator for Astana, Akmola 2, and Tselinnaya Yubileynaya varieties on the plots treated with fungicides was 60.0 units, 56.0 units, and 35.5 units, respectively. The analysis of the results of valorimetric assessment did not reveal any significant difference between the reference variants and the variants with the use of fungicides for the studied wheat varieties.

By the value of dough dilution determined with a farinograph, it has been found that in 2018, in the reference variants, this indicator was higher than in the variants with fungicides for Astana and Akmola 2 varieties, and belonged to satisfactory fillers, while for the Tselinnaya Yubileynaya, this indicator was higher in the variant with the fungicide, and be-

longed to good fillers following the baker's classification. In 2019, the dough dilution indicator, according to the readings of a farinograph varied from 135 units to 180 units. It has been found that for all studied varieties, this indicator in the reference groups was higher, and belonged to weak wheat, and in the variants treated with fungicides - to satisfactory fillers. On average over the two years, dough dilution according to the readings of a farinograph for Astana, Akmola 2, and Tselinnaya Yubileynaya varieties in the variants treated with fungicides belonged to satisfactory fillers. In the reference, this indicator for Astana and Akmola 2 varieties belonged to weak wheat, and for the Tselinnaya Yubileynaya variety -to satisfactory fillers. The general baking assessment of the varieties changed from 4.4 to 4.9 points. In 2018, by this indicator, in varieties Astana and Akmola 2, difference between the reference variants and the variants with the use of fungicide was observed, and for the Astana variety it amounted to 0.4 points, for the Akmola variety - to 2 - 0.1 points, and was higher in the variants treated with fungicides, while for the Tselinnaya Yubileynaya variety, on the contrary, this index was higher in the reference variant. In 2019, for the Akmola 2 and Tselinnaya Yubileynaya varieties, the exceedance of this indicator by 0.2 points over the reference was noted in the variants with the use of fungicides, and for the Astana variety, no difference was noted. On average over the two years, general baking assessment of the Astana and Akmola 2 varieties was higher in the variants with the use of fungicides, and no difference was found for the Tselinnaya Yubileynaya variety.

Conclusion

The effect of Septoria blight on the main indicators of wheat quality has been studied. In 2018, no effect of Septoria blight was noted on such indicators as the natural weight of grain, its vitreousness, ultimate dough resilience, valorimetric assessment, dough dilution, general baking assessment. The content of protein and gluten was higher in all studied wheat grades on the plots treated with fungicides. Gluten quality in Astana, Akmola 2, Tselinnaya Yubileynaya varieties on the reference plots was higher, and related to the first group, compared to the plots treated with the chemical drug. In 2019 no effect of Septoria blight on quality indicators, such as the natural weight of grain, gluten quality,

valorimetric assessment, and general baking assessment, was detected. According to the readings of farinograph, grain vitreousness, the content of protein and gluten, ultimate dough resilience, and dough dilution were higher in all studied wheat grades on the plots treated with fungicides. On average over the two years of the study, such indicators as vitreousness, protein and gluten content, and ultimate dough resilience were higher in the variants with the use of fungicide, compared to the reference.

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