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New Generation Varieties of Spring Oats Selected for Areas with the Climate as in Ural, Siberia and the Far East of Russia

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***Abstract*—New varieties of spring oats Otrada and Foma have been created in the Northern Trans-Ural Agricultural Research Institute. Midseason varieties are resistant to drowning and shedding, and mid resistant to spring-and-summer drought, have potential productivity of 7,0 - 8,0 t/ha. The top grain yield of the variety Otrada was received in 2013 on the Barachatsky state seed-trial ground of the Kemerovo region (7,63 t/ha). The top grain yield of the variety Foma was received in 2014 on the Nerchinsk state seed-trial ground (Trans-Baikal Territory) – 8,27 t/ha. Those varieties had rather high grain yield (Kz. = 37,4 – 38,7). They formed high quality grain (grain-unit up to 518,5 - 548,0 g/l, thousand-kernel weight is up to 37,4 - 42,1 g, grain hoodness is 23,6-24,7%). The varieties can be used as forage as well as food. The varieties are listed on the National registry of selection achievements. The variety Otrada has been included in the registry since 2013 and recommended for cultivating forage in 9 regions of Ural, 10 regions of Western Siberia and 12 regions of the Far East of Russia. The variety Foma has been included the registry since 2015 to cultivate for feed and food purposes in 10 regions of Western Siberia, 11 regions of Eastern Siberia and 12 regions of the Far East of Russia.**

Keywords— variety, spring oats, morphological features, feed and food purposes, yield, grain quality.

I. INTRODUCTION

Grain production was and remains a key problem in the development of agricultural industry. Unjustified decline in production of fodder grain, including oats, mainly due to the reduction of cultivated areas, have not reduced the interest in culture and need for its grain. Oat is one of the most widespread and important grain crops in the Russian Federation. It takes the 4th position in the world production of grain crops. Russia is included into the five leading grain producing countries and is the leader in producing fodder culture grain including oats [1, 2].

It should be recognized that the essential condition for increasing in oat seed yield and quality, along with the improvement of cultivation technology, is creating and applying new varieties combining high potential productivity with resistance to abiotic and biotic stresses in specific natural climatic conditions [3, 4, 5, 6, 7].

Taking into account natural climatic factors, requirements and demand of production, nowadays, the priority directions of selection research are: high productiveness at the optimum vegetation period, adaptability, resistance to actions of abiotic and biotic factors and product quality [8, 9, 10, 11, 12].

In recent years the National registry of selection achievements has included a significant amount of the new, high-yielding varieties of oats, including developed in the Northern Trans-Ural Agricultural Research Institute (NTU ARI), and recommended for cultivation in a number of regions of the Russian Federation (Ural, Siberian and Far-Eastern). In this regard much interest is aroused by new spring oats varieties Otrada and Foma.

The objective of research is to describe biological, agronomical, technological, biochemical indicators and morphological features of new spring oats varieties Otrada and Foma.

II. SUBJECTS AND METHODS

The experimental part of the study was carried out on the trial field of the NTU ARI, the branch of the Tyumen Scientific Center (Tyumen region, the northern forest-steppe).

The soil was gray forest, heavy clay-loamy. The predecessor was spring wheat [13, 14].

Weather conditions in the days of research were various on temperature range and rainfalls. The vegetation period in 2013 was rather warm and humid, there was a lack of moisture in the second fortnight of June and in the first decade of July. The hydrothermal index (HTI) within May - August had been 1,31. The vegetation period was cold and damp in 2014 with HTI equaled 1,32. The weather of the spring and summer period in 2015 was characterized by considerable rainfalls at high average daily temperatures in May-June and low temperature in July-August. The HTI was 1,46. The meteorological conditions of 2016 differed in instability of providing plants with warmth and moistness during the vegetative period. May was warm and dry, June was within the norm, there were periodic rainfalls in July. August was characterized by dry and hot weather. The HTI in May-August was 0,69. The weather conditions of the vegetative period in 2017 differed in overwetting and a lack of warm weather in June and July. A few rainfalls and high average daily temperatures in August provided timely crops maturing. HTI was 1,48.

Selection study of material was conducted according to the standard scheme. Assessment and selection sample with the aimed parameters at all stages of selection process was carried out by the method of N.I. Vavilov Research Institute of Plant Industry [15] and by the method of the State Committee for the Testing of New Varieties of Agricultural Plants. The chemical composition and technological qualities of grain were defined in the analytical laboratory of the NTU ARI. The protein concentration in grain was determined by the photocolorimetric method, the oil content was determined by Rushkovsky's extraction method on the oil extraction machine ЭЖ-101, the starch content was determined by a polarimetric method according to the state standard 10845-98 (ГОСТ).

Statistical data were processed by the held trial method using software applications package Microsoft Excel and "Snedekor".

As an initial material we used samples of oats from the collection of the N.I. Vavilov Research Institute of Plant Industry, the selection samples received from other research establishments of the Russian Federation (SibAgricultural Research Institute - SARI, Kemerovo State University, Narym department of SARI) and developed in NTU ARI.

III. Results

Spring oats varieties Otrada and Foma are created in The Northern Trans-Ural ARI by the method of step hybridizating varieties with various ecologic-geographical origin followed by the subsequent single plant selection. There were selected and assessed 121 samples from hybrid population (WW 170079 x Pc 39) x (Mutica 600 x Risto) in the fourth (F4) and in the fifth (F5) generations in selection nursery-gardens. Only three selection lines reached the competitive variety trial. According to the results of assessment in nursery-garden of the competitive variety trial two promising lines were consigned to the State Committee for testing new varieties of agricultural plants for estimating on a variety test plot of various regions of the Russian Federation (tab. 1).

TABLE I. Processing of initial material from a hybrid population [(WW 170079 x Pc 39) x (Mutica 600 x Risto)].

Generation	SN - 1*	SN – 2*	CN*	PVT *	CVT *	Consigned to the State variety trial	Included in the State Registry
F_4	91	32	8	4	2	1	1
F_5	30	12	4	4	1	1	1
Total	121	44	12	8	3	2	2

* SN - 1 – first-year selection nursery, SN – 2 – second-year selection nursery, CN – control nursery, PVT – preliminary variety trial, CVT– competitive variety trial

The TM 030-11 selection line had been assessed in the nursery of a competitive variety trial from 2007 to 2010, and it was consigned to the state variety trial in 2011 under the name of Otrada. The TM 02-27-4 selection line had been studied on a competitive variety trial from 2007 to 2012, and was consigned to the state variety trial under the name of Foma.

A. Spring Oats Otrada

Morphological description of the variety. Subvariety mutica. Semi-upright panicle. Downiness of the lower leaves axil is absent or very weak. Downiness of leaf edges beneath lower flag is absent or very weak. The stalk has strong downiness of the top articulation. The direction of head branches is half one-sided, their arrangement is semi-elevated. The glume is short. It has a waxiness from weak to average. Heads are nodding. Grain is average and extended. Thousand-kernels weight is 32.8-37.4 g. Caryopsis is densely closed in a white-colored shell. The waxiness on lemma of the first caryopsis is absent. The first caryopsis tends to an awnedness. Awned grains can make 7-10%. Awns are short, thin, light, with the dark basis. Downiness of a lemma back is absent. The basis of the first caryopsis is either without downiness or is very weak. The first caryopsis has a mid-length rachilla (fig. 1).

Fig.1 – Appearance of panicle and grains of oat variety Otrada (TM 030-11).

Biological and economic properties of the variety. The variety Otrada is mid-season, the average vegetation period for five years of studying in a competitive variety trial (2013-2017) had been 75 full days with fluctuations by years from 68 to 82 full days (tab. 2).

TABLE II. MAIN INDICATORS OF SPRING OATS VARIETY OTRADA, TYUMEN, 2013-2017

Показатеl ndicators	Varieties			
	Talisman (St)		Otrada	
	Average	Range of variability	Average	Range of variability
Vegetation period, days	75	68-81	75	68-82
Grain yield, t/ha	4.75	4.08-5.52	5.12	4.49-5.97
Fresh yield, t/ha	31.3	27.0-44.1	27.4	22.9-38.6
Dry basis gather, t/ha	9.83	7.83-12.76	9.33	7.17-10.62
Leaf coverage, %	43.6	36.4-53.6	44.7	37.07-54.4
Plant height, sm	92.6	79.5-118.0	92.9	72.5-113.0
Lodging resistance, score	4.5	4.0-5.0	4.7	4.0-5.0
Thousand-kernel weight, g	33.4	30.2-36.2	34.7	32.8-37.4
Grain-unit, g/l	461.1	405.5-495.7	495.7	438.3-548.0
Hoodness, %	26.5	24.9-29.0	24.7	22.9-27.0
Protein content, %	10.53	9.62-12.13	10.96	9.50-12.71
Oil content, %	3.94	3.37-4.44	5.23	4.40-5.64
Starch content, %	48.68	46.97-50.34	47.07	46.02-49.94
Grain coefficient, К з	34.6	20.9-44.6	38.7	24.5-45.0

During the test period in the state varietal network (2011-2013) depending on the cultivation regions the duration of the vegetative period of the variety Otrada had been changed from 63 (Udmurtia) to 95 full days (the Republic of Altai).

The variety formed a medium-height plant (72,5-113,0 cm) with a strong, resistant to drowning culm, not conceding the standard variety Talisman on these indicators (tab. 2).

The variety Otrada formed a heavy yield in the conditions of Ural, Western Siberia and the Far East. The potential productivity was more than 7,0 t/ha . The grain yield of more than 7.0 t/ha has been received in 2011 on the Ishim state variety test plot of the Tyumen region (7.03 t/ha), and in 2013 on the Barachatsky state variety test plot of the Kemerovo region (7.63 t/ha). Averagely, in the conditions of the northern forest-steppe of the Tyumen region the grain yield was 5.12 t/ha in a competitive variety trial for years of studying (2013-2017) when the standard yield of the variety Talisman is 4.75 t/ha (+0.37 t/ha)

The average yield in the state variety trial was 2.81 t/ha for years of studying, it varied according to the growing area within 1.47 t/ha (Orenburg region) – 4.55 t/ha (Kemerovo region). The results of assessment have shown the advantages of the given variety in a number of regions of Ural, Siberia and the Far East. The essential yield excess to the average standard had been noted in Perm Krai (+ 0.30 t/ha), Sverdlovsk region (+0.26 t/ha), Chelyabinsk region (+0.27 t/ha), Tyumen region (+0.44 t/ha), the Republic of Khakassia (+0.37 t/ha) and Primorski Krai (+0.,29 t/ha).

The variety had a rather high grain yield, the grain coefficient (Кз) was average 38.7 and variable by years from 24.5 to 45.0.

The technological assessment and the biochemical analysis of oats grain samples from a competitive variety trial prove that according to the majority of quality indicators this variety as good as the standard one, but to some indicators, such as grain-unit, thousand-kernel weight, protein and oil content, it excels. The variety formed grains with low hoodness. It means that, taking into account high productiveness, the new variety allows to receive the maximum yield of nutrients from the unit area.

Since 2013 this variety has been listed on the State registry of selection achievements, and has been recommended for grain cultivation in 9 Ural regions, 10 West Siberian regions and in 12 Far East regions.

B. *Spring Oats Foma*

Morphological description of the variety. Subvariety mutica. Upright panicle. The downiness of the lower leaves axil is absent or very weak. The downiness of leaf edges beneath lower flag is absent or is very weak. The downiness of the top articulation is absent. The direction of head branches is half one-sided, their arrangement is semi-elevated. Spikelets in a panicle is nodding. The glume is short. It has an average waxiness. The first caryopsis has an average waxiness on lemma. The head is long. The first caryopsis has no awns, sometimes it has, but very seldom. The lemma is short. Caryopsis is densely closed in a white-colored shell. The basis of the first caryopsis has no downiness or it is very weak. The first caryopsis has a mid-length rachilla. The grain is averagely big and extended (fig. 2). The thousand-kernel weight is 31.4 – 42.1g..

Biological and economic properties of the variety. The variety is mid-season; the average vegetation period for years of studying in a competitive variety trial was 75 days varying by years from 69 to 81 full days (tab. 3).

According to the cultivation area of the state variety test plot of the Russian Federation, the vegetative period of the

variety Foma had been changed from 68 full days (e.g. in the Republic of Tyva) up to 96 full days (in Primorsky Krai) within 2013-2014.

Fig.2 – Appearance of panicle and grains of oat variety Foma.

The variety Foma formed a medium-height plant (78.4-111.6 cm), with a strong, resistant to drowning culm, the yield is more than 7.0 t/ha. The potential productivity is more than 8.0 t/ha. The grain yield of more than 7.0 t/ha was received in 2014 on the Ishim (7.77 t/ha) and Nizhniaya Tavda (7.15 t/ha) variety test plots of the Tyumen region. The maximum yield was received in 2014 on the Nerchinsk state variety test plot in Zabaykalsky Krai – 8.27 t/ha. For the last 5 years of studying (2013-2017) the average grain yield at the final stage of selection process (a competitive variety trial) was 5.13 t/ha in comparison with the standard yield of Talisman – 4.75 t/ha, that is 0.38 t/ha more, in the conditions of the northern forest-steppe of the Tyumen region

The variety had rather high grain yield, the average indicator for years of studying in CVT (within 2013-2017) was Kz. = 37.4. The amplitude of variability was from 24.9 to 46.6.

Technological assessment and the biochemical analysis of the promising oats grain samples from a competitive variety trial have proved that according to the majority of quality indicators the variety Foma is as good as the standard variety Talisman, but it excels it in grain-unit, thousand-kernel weight and starch content (tab. 3).

IV. Conclusion

The selectors of the Northern Trans-Ural State agricultural Research institute have created new varieties of spring oats Otrada and Foma. Midseason varieties are resistant to drowning and shedding, and mid resistant to spring-and-summer drought with potential productivity 7.0 -8.0 t/ha. They form high quality grain and can be used as feeding and food.

TABLE III. Main indicators of spring oats variety Foma, Tyumen, 2013-2017

Indicators	Varieties			
	Talisman (St)		Foma	
	Average	Range of variability	Average	Range of variability
Vegetation period, full days	75	68-81	75	69-81
Grain yield, t/ha	4.75	4.08-5.52	5.13	4.64-5.97
Fresh yield, t/ha	31.3	27.0-44.1	26.7	23.1-34.8
Dry basis gather, t/ha	9.83	7.83-12.76	8.07	7.00-9.50
Leaf coverage, %	43.6	36.4-53.6	45.2	37.0-53.5
Plant height, sm	92.6	79.5-118.0	90.1	78.4-111.6
Lodging resistance, score	4.5	4.0-5.0	4.8	4.4-5.0
Thousand-kernel weight, g	33.4	30.2-36.2	36.5	31.4-42.1
Grain-unit, g/l	461.1	405.5-495.7	486.9	461.0-518.5
Hoodness, %	26.5	24.9-29.0	23.6	23.0-24.0
Protein content, %	10.53	9.62-12.13	10.03	8.63-11.08
Oil content, %	3.94	3.37-4.44	3.78	3.52-3.92
Starch content, %	48.68	46.97-50.34	49.54	46.82-53.49
Grain coefficient, К з	34.6	20.9-44.6	37.4	24.9-46.6

The varieties have been listed on the National registry of selective breeding results. The variety Otrada has been listed on the registry since 2013 and is recommended for cultivating as feeding variety in 9 regions of Ural, in 10 regions of Western Siberia and in 12 regions of the Far East of the Russian federation. The variety Foma has been listed on the registry since 2015 in 10 regions of Western Siberia, 11 regions of Eastern Siberia and 12 regions of the Far East of the Russian federation for cultivating both as food and feeding variety.

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