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THE RESULTS OF RYE BREEDING IN THE CENTRAL–CHERNOSEM REGION OF RUSSIA

ABSTRACT:

Winter rye in the Central–Chernosem Region of Russia carries out the role of the ((insurance culture». To carry out this role, winter rye should have varieties with genetic protection against un–favorable conditions, which might threaten the potential productivity. For that new genetic sources were created. On the basis of the created breeding material new varieties with better (than earlier created) resistance to severe weather conditions, were developed

Key words. winter rye, breeding resistance to severe conditions new sources for breeding.

SHORT COMUNICATION

Winter rye in the Central–Chernosem Region of Russia was the basic food culture in the 1950s of the last century. Its sowing areas were ap–proximately equal to 2 mln ha. But the development of winter–hardy and productive varieties of winter wheat caused decrease of winter rye acreage in thisregion in the1960s, despite of significant growth of po–tential productivity of some new created cultivars (Fig. 1)

Nowadays the winter rye in the Central–Chernosem Region carries out a role of the "insurance culture" which can contribute to the har–vest in case of the severe weather conditions. Significant areas of the crop are used for green forage as well. Acreage fluctuates between 300000 and 500000 ha.

To carry out the role of the insurance culture, winter rye should have varieties with genetic protection against unfavorable conditions! fac–tors, which might threaten the potential productivity. Among such factors in our region there are lodging, different diseases and drought. The low resistance of cultivated rye varieties to lodging was the basic reason for reduction of rye acreage in the region. This drawback was eliminated only due to using a gene *Hi (Dw–1)*, discovered by the pro–

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fessor V. D. Kobylyansky. The gene, when used in the selection pro–cess, allowed creating varieties with short–stem. Due to this, many new rye varieties with lodging resistance and high real productivity were developed. Our institute was one of the first to carry out this pro–ject. We created new varieties with lodging resistance, such as Talovskaya 12, Talovskaya 15. Table 1 illustrates the effectiveness of these new short–stem varieties.

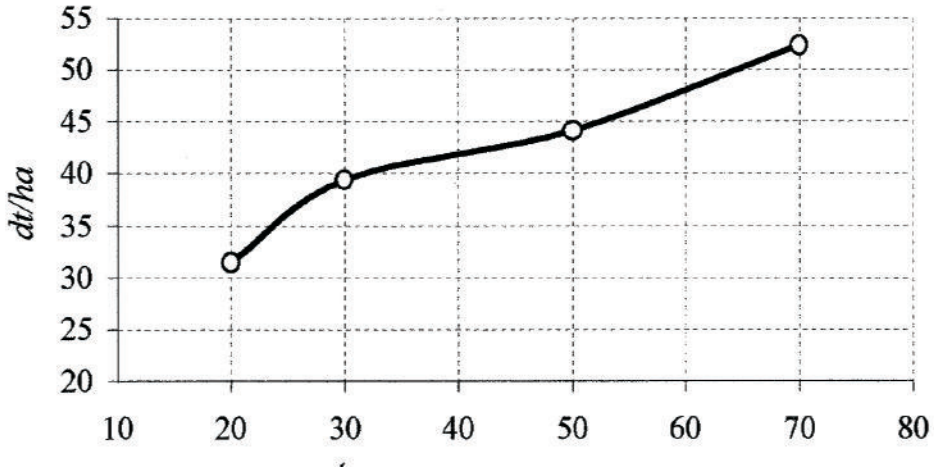

Fig. 1 The contribution of breeding into increase of efficiency potential of winter rye in the Central Chernosem Region of Russia

Table 1

The basic parameters of winter rye varieties in competitive test

Year	Yield [t × ha–1]			Score for the lodging resistanceevaluation according to the 5–point scale		
	Kharkovskaya 60	Talovskaya 12	Difference	Kharkovskaya 60	Talovskaya 12	Difference
1976	4.10	4.50	0.40	2.85	3.64	0.79
1977	3.73	4.22	0.49	3.35	4.39	1.04
1978	6.54	6.63	0.09	3.30	4.47	1.17
1979	7.42	7.53	0.11	3.57	4.62	1.05
1980	3.77	6.22	2.45	3.08	4.76	1.68
1981	5.50	6.14	0.64	3.92	4.54	0.62
1982	4.69	6.66	1.97	2.58	4.78	2.20
1983	5.69	6.69	1.00	3.54	4.63	1.09
Average	5.18	6.07	0.89	3.27	4.48	1.21
%	100	117.2	17.2	100	137.0	37.0

As a result, lodging resistance of the new variety increased up to 1.21 points (37%) and its productivity has increased with 17.2%. The essen–

tial increase of its productivity was in high humidity years (1980 and 1982), when the productivity amounted accordingly 65% and 42%.

It is well known that rye belongs to farm crop with stem type of pho–tosynthesis. Shortening of the stem up to 30–3 *5%* caused a serious concern of disease protection of new varieties (Table 2). With regard to this at the second stage of our work the basic attention was given to creation of varieties resistant to leaf (in the first place) and stem dis–eases. For this the perennial rye variety Derzhavinskaya 29 was used with simple and effective infectious backgrounds and finally two new varieties (Talovskaya 29 and Talovskaya 33), resistant to lodging and diseases, were created. The new rye varieties have higher and more stable productivity during the periods of epiphitothy, when their pro–ductivity is about 40% or more (judging by the grain mass of one ear, the criteria which is influenced mostly in case of a disease – Table 2).

Table2

The comparative characters of winter rye varieties with various resistance to diseases

Variety	Natural background		Artificial infectious background					
	Yield [t × ha^{-1}]	**Lodging resistance	*Susceptibility on: Rust brown	Rust stem	Powdery mildew	Weight [g] Grains per ear	1000–grain weight	Grains per ear [%]
Talovskaya 15	4.78	4.52	3.04	2.84	1.64	1.08	24.8	67.0
Talovskaya 29	4.85	4.35	1.34	0.98	1.18	1.52	32.2	69.4
Difference	0.07	–0.17	–1.70	–1.86	–0.46	0.44	7.4	2.4
In %	1.5	–3.9	–55.9	–65.5	–28.0	40.7	29.8	3.6

Susceptibility on diseases: from 0.0 to 3.6 points
Resistance to lodging according to scale 1–5 points

In the Central Chernosem Region the significant decrease of winter rye productivity is mainly due to droughts. In regard to this at the 3rd stage of our work the attention was given to creating short–stem vari–eties resistant to diseases and droughts. So the hybridization involved the modern varieties, developed by the Saratov selection group, and our rye forms with vertical leaves. At the same time some other more valuable sources of lodging, disease and drought resistance, were cre–ated also from this material. Their characteristics are given in Table 3. With the use of these sources the new selection material was created. Its characteristics are given in Table 4.

The Table 4 illustrates that the new selection material has preserved the previous level of productivity potential and disease resistance, but obviously demonstrates the higher level of drought resistance. It can preserve the level of its productivity in severe weather conditions. However, the potential productivity itself has not increased.

To increase potential productivity we created the plant with changed architectonics: with short stalks, vertical big leaves, larger ear and

Table 3

Sources of winter rye selection improvement

Attributre	Talovskaya 15 (standard)	Population 52	Population 57	Population 32	Population 56	HK–1205	HK–1192 k/st	Selection from Talovskaya 29
Loging resistance	0.35	0.29	0.28	0.25				
coefficient Seko*	–	20.6	25.0	40.0				
Drought resistance [scale 1–5 points]	3.67				4.72	4.12	4.00	
Susceptibility to powdery mildew [%]	17.5							0.2
Susceptibility to brown rust [%]	85.8							4.2
Susceptibility to stem rust [%]	98.0							15.0

* – excess above the standard

Table 4

Characteristics of new breeding material within the years 1944 – 1996

Variety	A natural background		An artificial infectious background					
	Yield [t × ha–1	**Lodging resistance	*Susceptibility on			Weight [g]		Grains per ear [%]
			Rust		Powdery mildew	Grains per ear	1000–grain weight	
			brown	stem				
Talovskaya 15	5.0	4.96	3.15	3.11	0.60	1.09	26.0	65.2
Talovskaya 29	5.16	4.87	1.32	1.25	0.40	1.62	33.5	67.5
New material	5.08	5.0	1.65	1.52	0.50	1.60	33.7	68.5

Susceptibility on diseases: from 0.0 to 3.6 points
Resistance to lodging according to scale 1–5 points

grain and other. This will allow to create a new population of rye plants with optimal optical and biological organization of sowing.

The study of photosynthetic features of the most interesting rye forms has revealed some interesting characteristics (Table 5*)*. They (Population 56 with vertical leaves; Population 54 with large leaves; Population 57 with short stem) are found to have a photosynthetic sur–face of bigger size and often contain more chlorophyll, which proves their bigger potential of productivity.

Table 5

The area of photosynthetic surface and amount of chlorophyl plantsof various morphological types during the ripening period of grain (1998, 1999)

Variety/population	Ear		Leaves		Stem	Leaves vagina
	Area [cm^2]	Amount of chlorophyl [$mg \times g^{-1}$]	Area [cm^2]	Amount of chlorophyl [$mg \times g^{-1}$]	Amount of chlorophyl [$mg \times g^{-1}$]	Area [cm^2]
Talovskaya 15 [std]	53.3±1.45	0.30	17.6±1.26	0.87	0.46	135.1±5.17
Population 54	54.3±1.0	0.38	29.5±1.26***	1.10	0.58	153.0±3.71**
Population 56	57.3±1.09*	0.45	25.4±1.47***	1.19	0.40	161.7±4.68***
Population 57	60.9±1.12***	0.46	37.0±1.26***	1.24	0.50	175.3±4.48***
$LSD_{0.05}$		0.04		0.21	0.11	

*, **, *** – significant at α = 0.05, 0.01 and 0.001 respectively
std – standard

The creation of highly productive rye varieties is impossible without using short–stem forms. However, there is always a contradiction be–tween the height of a plant and its efficiency. Yet we managed to "break the tradition" and developed short–stem (80–105 cm in com–parison with usual 110–140 cm of Talovskaya 15 which is adjusted for the region) highly productive populations.

It has resulted into essential architectonics change of a plant. The assimilation surface of the sprout has decreased whereas the assimila–tion surface of the leaves and, the ear especially, has largely increased. Due to this, their role during ripening has considerably increased, which allows the short–stem plant to form a productive ear with help of multiflowered ear and larger grains.

Effective results are achieved through creation of short–stem rye forms with larger, vertical leaves. On the basis of the created breeding material new varieties with better, than earlier created, resistance to severe weather conditions (Table 6).

Variety Talovskaya 35, which is being tested, is characterized by vertical leaves and due to this drought resistance. It is resistance and to lodging. Another variety, Talovskaya 36, which is also being tested at present, is characterized by 3 most valuable features: resistance to lodging, drougt and the most harmful diseases.

Table 6

The characteristics of perespective winter rye bonitation (competetive test within the years 1997–1999)

Variety	Yield		Resistance to								Frost resis–tance [%]
			Lodging		Droughts		Brown rust		Stem rust		
	[t/ha]	Difference from standard [t/ha]	According to scale [points]	Difference from standard [t/ha]	According to scale [points]	Difference from standard [t/ha]	Suscepti–bility [%]]	Difference from standard [t/ha]	Suscepti–bility [%]]	Difference from standard [t/ha]	
Talovskaya 15*	5.37	–	4.08	–	3.60	–	70.7	–	68.3	–	60.1
Talowvskaya 33**	5.08	–	4.00	–	3.56	–	24.7	–	19.3	–	64.0
Talowvskaya 35	5.52	0.15	4.16	0.08	4.52	0.92	72	1.5	50.0	–18.3	52.9
Talovskaya 36	5.43	0.36	4.35	0.35	4.10	0.54	43.3	18.6	38.7	19.4	61.5

* standard for Talovskaya 35
** standard for Talovskaya 36

Table 7

Polyploid influence on productivity and green mass quality

Parameter	Diploid	Tetraploid	Percent from initial diploid
Yield of green mass [dt/ha]	476.0	542.0	113.9
Yield of hay [dt/ha]	79.0	88.8	112.4
The amount of fodder units per 1 kg	0.727	0.732	100.7
Amount of energy exchange [MJ]	9.15	9.19	100.4
The amount of fodder units collected from 1 ha	58.6	65.6	112.0
Amount of energy exchange per 1 ha [103 MJ]	73.7	82.4	111.8
Raw fiber [dt]	9.45	10.93	115.7

Table 8

Efficiency of genes used in winter rye breeding

Genes used in breeding	Result of breeding	Effect of genes used in the breeding
Dw 1 (Hl)	Talovskaya 12 Talovskaya 15	Incerease yield with 15–20% and increase of resistance to lodging with 35–40%
Dw 1 (Hl), Pm, Lr1–Lrn, Sr	Talovskaya 29 Talovskaya 33 Talovskaya 36	Good resistance to lodging and increase of productivity within epiphitoty with 45–50%
Dw 1 (Hl), Sl	Talovskaya 35	Good resistance to lodging and increase of resistance todrought with 25%
Dw 1 (Hl), al (el), mul	Strain 1193	Good resistance to lodging and increase of amount of energy exchange in hay with 5% and number of seeds with 35–40%

For creation of varieties for green mass production tetraploid forms were used. They are found to be better in comparison with diploid forms in relation to productivity and quality of green mass (Table 7). Using these forms a new variety, Savala Tetra, was created and rec–ommended to use.

Another perspective tendency in selection of varieties for green mass production is the combination in one variety of dominant short–stem feature (gene Hi), vertical arrangement of leaves (gene *a1* or *S1*) and gene of multiflowered ear (gene *mul*). It allows to create (see strain 1193 in Table 8) highly productive, lodging resistant varieties with high quality of green mass and good seed yield. They can also function as suitable components when mixed with winter vetch.

Table 8 illustrates the efficiency of different genes used in selection procedure with winter rye in our institute.