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ОРИГИНАЛЬНАЯ СТАТЬЯ

Т. Е. Кузнецова,
С. А. Левштанов,
Н. В. Серкин

Общество с ограниченной
ответственностью
«Агростандарт»
350000, г. Краснодар,
ул. Октябрьская, 135/81
e-mail: Agrostandart.dr@list.ru

СЕЛЕКЦИЯ ОВСА НА КУБАНИ

Актуальность. Овес (*Avena sativa* L.) – важнейшая фуражная и продовольственная культура, обладающая широкой экологической адаптивностью. Содержание в зерне белков, углеводов, жиров, витаминов, микроэлементов является оптимальным для нормальной жизнедеятельности человека и животных. В России в основном возделывается яровой овес, его площади сосредоточены в Сибирском, Приволжском и Центральном Федеральных округах. Доля Северо-Кавказского округа в производстве этой культуры составляет 1,5–3,2%. В последние годы возрос спрос сельхозтоваропроизводителей на овес. Районированные сорта крайне нестабильны по годам по урожайности. **Материал и методы.** 20 линий, отобранных из урожайных сортов овса были изучены В 2014 году ООО «Агростандарт» передал на Государственное испытание два сорта ярового овса: ‘Десант’ и ‘Ассоль’. **Результаты и заключение.** ‘Десант’ (*A. sativa* var. *diffuse aristata* Ks.) получен методом индивидуального отбора из шведского сорта ‘Magne’. Метелка прямостоячая, средней длины. Высота растения 60–95 см. Сорт высокоустойчив к полеганию, среднеспелый. Продуктивная кустистость 1,0–1,7 стеблей. Масса 1000 зерен 27,3–39,6 г. По натуре зерна превосходит ‘Валдин 765’ на 15 г. Обладает хорошей полевой устойчивостью к корончатой ржавчине и пыльной головне. Урожайность за 4 года составила 37,3 ц/га, что выше стандарта на 11%. Максимальная урожайность в КСИ составила 53,8 ц/га. Сорт ‘Ассоль’ (*A. sativa* var. *diffuse mutica* Al.) – результат индивидуального отбора из сорта ‘Краснодарский 73’. Среднеспелый. Высота растений 68–105 см, устойчив к полеганию. Метелка прямостоячая, пирамидальная, рыхлая, длина 20–25 см. Зерно харьковского типа, мелкое, масса 1000 зерен – 23,2–34,7 г. Длина метелки, число зерен в метелке, масса зерна с метелки и натура зерна свидетельствует о лучшей устойчивости сорта к абиотическим и биотическим стрессам. В среднем за 4 года (2012–2015 гг.) урожайность составила 36,6 ц/га, что выше ‘Валдина 765’ на 2,8 ц/га. Максимальная урожайность – 52,4 ц/га.

Ключевые слова:

овес, коллекция, сорт, линия, отбор, открытое цветение, перекрестное опыление, рекомбиногенез, мутация

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T. E. Kuznetsova,
S. A. Levshantov,
N. V. Serkin

AGROSTANDART Limited
Liability Company 135/81
Oktyabrskaya St.,
Krasnodar 350000
e-mail: Agrostandart.dr@list.ru

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OAT BREEDING IN THE KUBAN REGION

Background. Oat (*Avena sativa* L.) is an important forage and food crop. In Russia, mainly spring oat is cultivated, and its area is concentrated in the Siberian, Volga and Central Federal Districts. The share of the North Caucasus Federal District in the production of this crop is only 1.5 to 3.2%, and that of the Krasnodar Territory is even less. In recent years, the demand of agricultural producers for oat has significantly grown. Commercialized cultivars are extremely unstable year by year in their productivity. **Material and methods.** Twenty lines were allowed to participate in the competitive variety trials. According to the results of the three-year study, two cultivars – ‘Desant’ and ‘Assol’ – were submitted for the state trials. **Results and conclusions.** ‘Desant’ was obtained by individual selection from the Swedish cultivar ‘Magne’. It belongs to the *A. sativa* var. *diffuse aristata* Kc. The panicle is erect of average length. Plant height is 60–95 cm. The cultivar is highly resistant to lodging. Productive tillering capacity is 1.0–1.7 stems. It is ripening midseason, with the 1000 grain weight of 27.3–39.6 g. Its grain-unit exceeds ‘Valdin 765’ by 15 g. This cultivar has good field resistance to crown rust, and is resistant to semi-loose smut of oats. The average yield over 4 years was 3.73 t/ha, which is higher than the reference by 11%. The highest yield of 5.38 t/ha was obtained when preceded by white mustard. The cultivar ‘Assol’ was the result of individual selection from cv. ‘Krasnodarsky 73’. It belongs to the *A. sativa* var. *diffuse mutica* Al. Its growing season attributes it to midseason varieties. Plant height is 68–105 cm; the cultivar is resistant to lodging. Its panicle is erect, pyramidal, loose, with average length of 20–25 cm. The grain is Kharkiv-type, small; the weight of 100 grains is 23.2–34.7 g at the level of the reference. Its panicle length, number of grains per panicle, grain weight per panicle and grain-unit attest to the cultivar’s better resistance to abiotic and biotic stresses. On the average over 4 years (2012–2015), its yield was 3.66 t/ha, which is higher than ‘Valdin 765’ by 0.28 t/ha. The highest yield obtained was 5.24 t/ha.

Introduction

Oat (*Avena sativa* L.) is one of the most important forage and food crop. It grows on all continents of the world. It is widespread due to its variety of forms, adapted to specific soil and climatic conditions. Compared to other crops, oats is less demanding as regards the soil; it can utilize hard soluble soil elements and late rainfall. One of the oat's advantages is its tolerance to soil acidity.

Oat entered the human diet significantly later than other grains. Until the 1930s it was used exclusively as livestock feed. The nutritional value of this crop's grain is taken as a unit.

Oat is the "treasury" of nutrients and biologically active substances, vitamins and microelements essential for normal life and good health of both humans and animals. The optimal combination of grain proteins, carbohydrates and fats, a relatively high content of selenium and silicon, the presence of β -glucan and avenantramides make oat a valuable immunomodulator (Loskutov, 2007). The most valuable characteristics is the high content of fiber from the water-soluble group called (1-3; 1-4) β -d-glucans in the endosperm cell walls.

It has been found that β -glucans have a marked cholesterol-lowering effect and are natural antioxidants. Taking into consideration the areas under oats, this crop is the fifth after wheat, rice, maize and barley in the world production of grain. The main oat cultivation areas are in the countries with temperate climate. The last fifteen years have seen an annual reduction in oat production. In 2012, due to the reduced areas and drought the shortage of oat grain was 9.0% as compared with 2011.

In Russia, the acreage under oats and oat grain production declined by more than 60%. In 1990, oats were planted over the area of 9,100 thousand hectares (t/ha), but in 2012 only 3,241 t/ha of arable land were planted, in 2013, 3.324 t/ha, and in 2014, 3.248.7 thou. ha. According to Russian statistics, during the past 10 years the area under oats has decreased by 8.6%. The reasons are the underestimation of the role of oats for human healthy nutrition, lack of understanding of the importance of this crop as a fodder, and, of course, an overall reduction of livestock. However, despite the significant reductions, Russia remains the world's leader in oat production. According to the statistics, the gross yield of oat grain is closely linked with the sowing area ($h = 0.30 \dots 0.94$), while the contribution to the yield defined by a

variety, quality of the seeds and breeding technology is significantly lower ($h = 0.18 \dots 0.19$) (Botalova, 2013). However, some positive trend in yields should be noted. In 2014, the yield of oats in Russia amounted to 1.71 t per hectare of harvested area, in 2013, 1.64 t/ha, while in the early 1990s it did not exceed 0.12 t/ha. Spring oat is cultivated mainly in Siberian, Volga and Central Federal Districts. The share of the North Caucasus region in the production of this crop is only 1.5–3.2%, and the share of Krasnodar region is even less.

Cultivated oat (*Avena sativa* L.) with the genomic composition AA SS DD in our region is represented by spring and winter forms. The first cultivars were obtained by individual selection from local varieties – populations. In the 1930s, the main areas under oats in Krasnodar region were occupied with one of these varieties – 'Kharkovsky 596'. In the 1950s, such cultivars as 'Lokhovskiy', 'Victory', 'Leytevitskiy' and 'Sovetskiy' obtained by inter-variety hybridization and subsequent individual selection from a hybrid population were planted. In 1968, the spring oat 'Krasnodarskiy 73' was commercialized. This cultivar was obtained in Krasnodar Agricultural Research Institute under the direction of V. N. Gromachevskiy by crossing the collection local sample 'Bendery' with cv. 'Sovetskiy'. 'Krasnodarskiy 73' ripened 2–6 days earlier than 'Lgovskiy 1026', and its yield exceeded the latter by 0.3–0.4 t/ha. Another achievement of the Krasnodar oat breeding was the spring oat cultivar 'Zeleniy'. With the help of chemical mutagenesis Academician V. M. Shevtsov was able to induce a large number of mutants valuable for breeding: dwarf and second growth forms with a strong stem, with altered growing period, coarse-grained mutants, forms with improved grain quality. One of the mutants, called var. 'Zeleniy', proved to be suitable for direct reproduction. After the successful state trials in 1976, it was included in the State Register and has been cultivated in 8 regions of the country. The cultivar was obtained as a result of treating seeds with a chemical mutagen – nitrosoethylurea (0.05% for 24 hours). Its late panicle emergence – 20–25 days later – made it an important link in the organic chain, especially when there is a shortage of rich fodder. Winter oat is a relatively young crop. In the absence of frost resistant forms its distribution is limited. Therefore, its main sowing areas are concentrated in the countries with a mild climate. Practical experience proved the possibility of effective cultivation of winter oats in

southern and suburban areas of the North Caucasus (Gudkova, 2011). If compared with spring oats, it forms 1.5–2.0 times higher grain yield and green mass (Schepetkov, Boytsova, 1974). Breeding of winter oats is carried out in Western Europe, North America, Australia and Russia. The Adygea Agricultural Research Institute has developed 10 varieties, 5 of which are approved for cultivation.

A breeder has got a nice choice of methods and new breeding approaches whose efficiency has been tested on a number of crops, including oats. The largest number of oat cultivars have been produced by Russian breeders. Currently, in the Russian State Register of breeding achievements there are 108 spring oat varieties and 5 winter ones.

Recently, farmers of Krasnodar region have taken interest in this crop. Perhaps, it has been induced by the increase in the acreage of areas under acidic soils due to systematic application of physiologically acidic fertilizers. There are 271.7 thou. ha of acidic soils in the region, 13.1 thou. ha of which are highly acidic (Romanenko *et al.*, 2015). According to the data available in the specialized literature, the loss of bases (Ca and Mg) due to leaching of carbonate chernozem is much higher than that of acid, and the loss rate increases with the application rates of physiologically acidic fertilizers. When the fertilizer application norms are increased twice, the loss of bases is 20–28% (Kozlovskiy *et al.*, 1980).

Currently, two cultivars of spring oats – ‘Valdin 765’ and ‘Skakun’ – are cultivated in the region. Due to the lack of drought resistance they are extremely unstable in yields from year to year, and in a droughty year the yield is twice or even more times less.

The grain market statistics shows the need to develop more adaptable cultivars with high productivity potential, which would be more drought-resistant, resistant to lodging and diseases in the region with its highly variable soil and climate environments and dramatically changing weather conditions over the years.

Successful breeding depends much on the diversity of the genetic source material. That is why the worldwide collection of VIR comprising 13,000 oat accession of various geographic origin is very important for oat breeding.

The initial stage of the breeding work is a comprehensive study of the collection accessions, released cultivars and promising material obtained in other institutions, and selection

of parental pairs for crossing. The breeders of LLC “Agrostandart” studied 29 collection accessions kindly granted by VIR, and they revealed heterogeneity of genotypes in the length of growing season, plant height, panicle shape, grain color, and grain weight per panicle. It is known that the majority of self-pollinating crops, including oats, are to a greater or lesser prone to open flowering and cross-pollination. Weather conditions greatly influence the process of flowering. In hot and dry weather, the number of openly blooming flowers increases, and, therefore, the possibility of cross-pollination increases as well. The number of open flowers on hullless oats reaches 10%. In view of this, it is necessary to emphasize the relative permanence of pure lines and varieties. Genotypes with new features and properties appear due to the influence of natural recombination and mutations in a variety. According to our data, this is the real cause of higher variability in the above-listed characteristics of the studied varieties. For example, the winter barley cultivars ‘Zimur’, ‘Kondrat’ and ‘Pharaon’ differ in frost resistance, length of growing season, resistance to lodging and diseases, though they have the same ancestor variety ‘Dobrynya 3’ (Kuznetsova, Serkin, 2006; Kuznetsova *et al.*, 2013).

Material and methods

About 350–420 panicles were collected from each of seven varieties: ‘Krasnodarsky 73’, ‘Kubansky’, ‘Zelenyi’, ‘Skakun’, ‘Valdin 765’, ‘Magne’, and ‘S. Romao’. After thorough screening in a breeding nursery, 312 families were selected for further study. Only 20 lines were allowed to participate in the competitive variety trials. According to the results of the three-year study, two cultivars – ‘Desant’ and ‘Assol’ – were submitted for the state trials.

Result and conclusion

Cv. ‘Desant’ was obtained by individual selection from the Swedish variety ‘Magne’. It belongs to the *A. sativa* var. *diffuse aristata* Kc. Its panicle is erect, flattened, its length is average. Plant height is 60–95 cm. The cultivar is highly resistant to lodging. Productive tillering is 1.0–1.7 stems. As far as the length of the growing season is concerned, it is considered a mid-season variety (table 1).

Таблица 1. Основные показатели ярового овса сорта 'Десант'
Table 1. Main characteristics of the spring oat cultivar 'Desant'

Characteristics	Desant	Reference var. Valdin 765	Parent Magne	Tolerance	
				Reference	Parent form
Growing season duration, days	105	108	103	-3.0	+2.0
Productivity, t/ha	3.73	3.37	3.41	+3.6	+3.2
Plant height, cm	80	85	80	-5.0	0
1000 grain weight, g	32.0	28.0	31.1	+4.0	+0.9
Productive tillering, stems	1.3	1.1	1.3	+0.2	0
Panicle length, cm	26	22	22	+4.0	+4.0
Grain number in the main panicle, pieces	102	86	92	+16.0	+6.0
Grain weight of the main panicle, g	3.2	2.4	2.8	+0.8	+0.4
Grain-unit, g	471	456	467	+15.0	+4.0
Content of raw protein, %	11.9	11.4	11.8	+0.5	+0.1

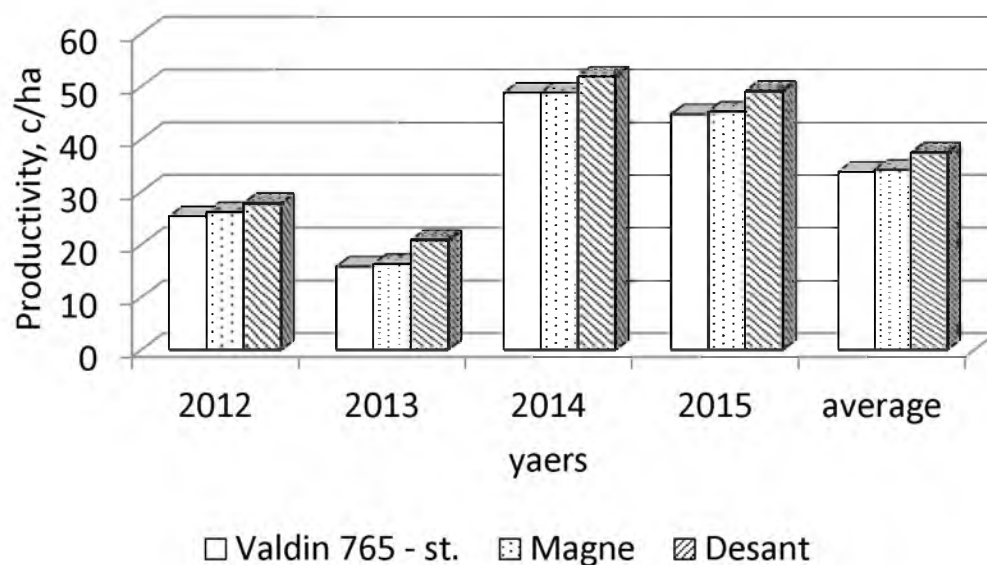


Рис. 1 Урожайность сорта ярового овса Десант в сравнении со стандартом 'Валдин 765' и родительским сортом 'Мagne'
Fig. 1 Productivity of the spring oat cultivar 'Desant' as compared with the reference 'Valdin 765' and the parent cv. 'Magne'

Mathematical processing (LSD_{05}) has shown that in the competitive trial nursery the yield increase was 0.24 t/ha.

The cultivar matures 2–3 days earlier than 'Valdin 765' and 2 days later than 'Magne'. Grain size is medium, grain base is bare, and grain shape is semilong (Moscow type). Depending on the prevailing weather conditions,

the mass of 1000 grains ranged from 27.3 g (2012) to 39.6 g (2014) which is higher than the reference 'Valdin 765' by 21.8–15.4%.

The cultivar is more resistant to abiotic stress than the commercialized varieties. It demonstrates good field resistance to *Puccinia coronifera* Kleb., and is almost resistant to *Ustilago avenae* (Pers.) Rost. The above-

mentioned characteristics enable 'Desant' to yield good harvest. The average yield for 4 years has been 3.73 t/ha, which is higher than that of 'Valdin 765' by 11% (fig. 1). Maximum productivity in the competitive variety trials obtained with white mustard as a preceding crop was 5.38 t/ha.

The cultivar 'Assol' was the result of individual selection from cv. 'Krasnodarskiy 73'.

It belongs to the *A. sativa* var. *diffuse mutica* Al. Its growing season attributes it to mid-season varieties: it forms a panicle and matures similarly to 'Valdin 765' and one day ahead of the parent cultivar. Plant height is 68–105 cm. The cultivar is resistant to lodging. The panicle is erect, pyramidal, semicompressed, loose, with average length of 20–25 cm.

Таблица 2. Основные показатели ярового овса сорта 'Ассоль'
Table 2. Main characteristics of the spring oat cultivar 'Assol'

Characteristics	Assol	Referencevar. Valdin 765	Parent Krasnodarskiy 73	Tolerance	
				Reference	Parent form
Growing season duration, days	108	108	109	0	-1.0
Productivity, t/ha	3.65	3.37	3.24	+2.8	+3.6
Plant height, cm	90	85	90	+5.0	0
1000 grain weight, g	27.8	28.0	27.1	-0.2	+0.7
Productive tillering, stems	1.3	1.1	1.0	+0.2	+0.3
Panicle length, cm	24	22	22	+2.0	+2.0
Grain number in the main panicle, pieces	96	86	82	+10.0	+14.0
Grain weight of the main panicle, g	2.7	2.4	2.2	+0.3	+0.5
Grain-unit, g	461	456	456	+5.0	+5.0
Content of raw protein, %	11.9	11.4	11.9	+0.5	0

Mathematical processing (LSD₀₅) has shown that in the competitive trial nursery the yield increase was 0.24 t/ha.

Conclusion

The grain is Kharkiv-type, small; the weight of 100 grains is 23.2–34.7 g at the reference's level. Its panicle length, number of grains per panicle, grain weight per panicle and grain-unit testify to the cultivar's better resistance to abiotic and biotic stresses. Resistance of cv. 'Assol' to *Puccinia coronifera* is higher than the average degree, and it is almost fully resistant to *Ustilago avenae*.

Ultimately, such combination of good characteristics has led to a yield increase. The average yield for 4 years (2012–2015) was 3.65 t/ha, which is higher than 'Valdin 765' by 0.28 t/ha, and higher than 'Krasnodarskiy 73' by 0.36 t/ha (fig. 2). The highest yield obtained during the competitive variety trials was 5.24 t/ha with white mustard as a preceding crop.

The results of one-year state trials show high prospects of the new cultivars. Productivity of cv. 'Desant' on the variety testing plots in the Republic of Crimea and Stavropol region was higher than the reference by 0.20–0.39 t/ha, and that of cv. 'Assol' on the variety testing plots in Krasnodar and Stavropol regions exceeded the reference by 0.22–0.38 t/ha. It should be mentioned that on the variety testing plots of Rostov region new cultivars showed equal productivity with 'Valdin 765', and they produced high-quality grain. Their 1000 grain weights were higher than reference's by 5.7–6.0 g.

We hope that the cultivars 'Desant' and 'Assol' will successfully pass the state variety trials and play an important role in grain production

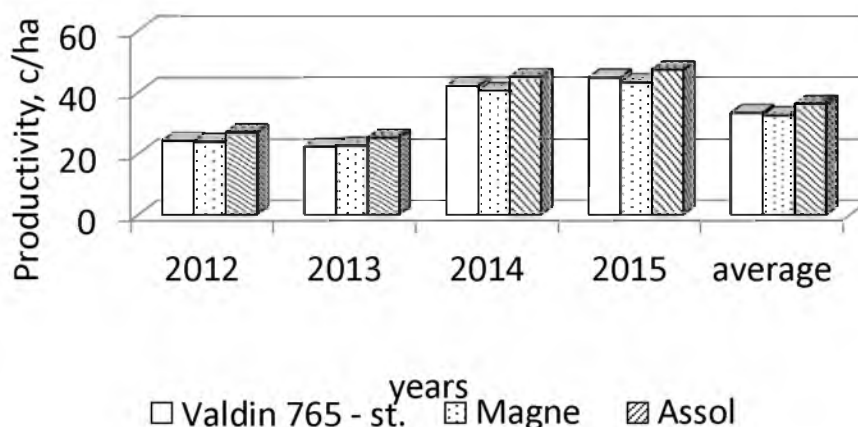


Рис. 2 Урожайность сорта ярового овса 'Ассоль' в сравнении с 'Валдин 765' и родительским сортом 'Краснодарский 73'

Fig. 2 Productivity of the spring oat cultivar 'Assol' as compared with the reference 'Valdin 765' and the parent cv. 'Krasnodarsky 73'

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