CULTIVAR RELEASE

FAEM Chiarasul: new white oat cultivar with high yield and grain-processing quality

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Abstract - *The white oat cultivar FAEM Chiarasul was developed from a cross between UFRGS 17 and UFGS 10/ Coronado2/Cortez3/ Pendek/ME 1563. It is characterized by reduced plant height, and high yield, grain quality and grain-processing quality.*

Key words: Avena sativa *L., plant improvement, grain-processing quality.*

INTRODUCTION

White oat grains are characterized by a composition of high contents of quality components, i.e., high contents of carbohydrates, proteins, essential lipids, and dietary fiber, as well as by an adequate physical structure for the food industry, indicating this cereal as a quality product for human consumption. White oat was the first to be classified as functional food, receiving this designation in June 29, 1995, by the Food and Drug Administration (FDA/USA), and was also recognized in Brazil, in 1999, by the National Sanitary Surveillance Agency, as an official acknowledgement of the relation between a regular consumption of the cereal with health benefits (AACC 1996, ANVISA 2011). Soon, the growing demand for white oat grain in the food industry challenged the Brazilian improvement programs of white oat grain to adopt new properties as selection target, especially traits that represent direct components of the grain-processing quality, e.g., the index of grains thicker than 2 mm and the dehulling index, as well as properties of the chemical composition of the caryopsis. Thus, the improvement process based on the selection of genotypes with superior agronomic, industrial and chemical traits will allow the development of elite white oat cultivars that meet the needs of different market niches in the country.

The Federal University of Pelotas (UFPel) has contributed to the genetic improvement of white oats through a range of publications and the release of white oat cultivars, e.g., Albasul (Lorencetti et al. 2004) Barbarasul (Carvalho et al. 2009), Brisasul (Oliveira et al. 2011), and FAEM Carlasul (CBPA 2010), grown in the South and Southeast of Brazil.

PEDIGREE AND BREEDING METHOD

The white oat cultivar FAEM Chiarasul was obtained from the cross between the genotypes of white oat (*Avena sativa* L.) UFRGS 17 and UFRGS 10/Coronado2/Cortez3/Pendek/ ME 1563 (F_1 generation), performed in 2001. Artificial hybridizations were performed in a greenhouse, on the grounds of the Plant Genomics and Breeding Center, Faculty of Agronomy 'Eliseu Maciel', Federal University of Pelotas, in Capão do Leão, Rio Grande de Sul. The F_1 generation was grown in a greenhouse in the summer of 2002, to obtain seeds of the F_2 generation. In the winter season of 2002, F_2 plants were grown on an experimental field of the UFPel, in Capão do Leão, RS. The F_2 generation was sown in a spacing of 0.30 m between plants and rows. The best F_2 plants were selected, considering their performances in the field and laboratory for agronomic and panicle traits, respectively. In the winter of 2003, seeds in the F_3 generation were sown in a density

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Table 1. Average performance of white oat FAEM Chiarasul and control cultivars in relation to agronomic traits of interest, when grown without fungicide application at different cultivation sites in Brazil, coordinated by the Comissão Brasileira de Pesquisa de Aveia, in the growing seasons of 2007, 2008, 2009, and 2010

Genotypes	2007 (%MT)	2008 (%MT)	2009 (%MT)	2010 (%MT)	Mean	Mean (%MT**)
			Plant height (cm)			
FAEM Chiarasul	90.7 (101.3)	114.5 (99.1)	111.4 (100.9)	100.0 (105.3)	104.2	101.1
UPFA 22 (C)	89.5 (100.0)	117.9 (102.1)	-	-	103.7	100.6
URS 21 (C)	95.6 (106.8)	119.0 (103.0)	123.3 (111.7)	103.0 (108.4)	110.2	106.9
URS Guapa (C)	91.6 (102.4)	115.5 (100.0)	110.4 (100.0)	95.0 (100.0)	103.1	100.0
Barbarasul (C)	-	-	112.9 (102.3)	99.0 (104.2)	106.0	102.8
Test locations	8	8	9	10	-	-
			Days from emergence to flowering (days)			
FAEM Chiarasul	84.5 (107.6)	78.2 (103.9)	84.5 (105.0)	74.0 (101.4)	80.3	104.4
UPFA 22 (C)	78.5 (100.0)	75.3 (100.0)	-	-	76.9	100.0
URS 21 (C)	82.8 (105.5)	80.3 (106.6)	82.5 (102.5)	76.0 (104.1)	80.4	104.6
URS Guapa (C)	79.8 (101.7)	77.2 (102.5)	80.5 (100.0)	73.0 (100.0)	77.6	100.9
Barbarasul (C)	-	-	84.8 (105.3)	74.0 (101.4)	79.4	103.3
Test locations	6	8	8	15	-	-
			Days from emergence to physiological maturity (days)			
FAEM Chiarasul	122.6 (106.3)	117.6 (102.8)	123.1 (103.0)	120.0 (100.8)	120.8	105.1
UPFA 22 (C)	115.3 (100.0)	114.4 (100.0)	-	-	114.9	100.0
URS 21 (C)	118.3 (102.6)	116.9 (102.2)	121.2 (101.5)	120.0 (100.8)	119.1	103.7
URS Guapa (C)	119.2 (103.4)	116.3 (101.7)	119.5 (100.0)	119.0 (100.0)	118.5	103.1
Barbarasul (C)	-	-	124.4 (104.2)	122.0 (102.5)	123.2	107.2
Test locations	6	6	7	12	-	-
			Hectoliter weight (kg hl^{-1})			
FAEM Chiarasul	47.8 (102.4)	44.9 (95.9)	43.4 (93.7)	49.5	46.4	100.0
UPFA 22 (C)	42.7 (91.4)	42.2 (90.2)	-	-	42.5	91.6
URS 21 (C)	46.7 (100.0)	46.8 (100.0)	46.3 (100.0)	45.8	46.4	100.0
URS Guapa (C)	43.8 (93.8)	42.7 (91.2)	40.3 (87.0)	41.1	42.0	90.5
Barbarasul	-	-	42.0 (90.7)	45.15	43.6	94.0
Test locations	8	8	9	11	-	-
			1000-grain weight (g)			
FAEM Chiarasul	30.2 (93.5)	32.0 (98.5)	31.8 (98.1)	32.0 (106.7)	31.5	99.1
UPFA 22 (C)	29.3 (90.7)	30.8 (94.8)	-	-	30.1	94.7
URS 21 (C)	27.7 (85.8)	28.6 (88.0)	29.6 (91.4)	28.0 (93.3)	28.5	89.6
URS Guapa (C)	32.3 (100.0)	32.5 (100.0)	32.4 (100.0)	30.0 (100.0)	31.8	100.0
Barbarasul (C)	-	-	27.4 (84.6)	28.0 (93.3)	27.7	87.1
Test locations	7	7	8	8	-	-
			Grain yield (kg ha^{-1})			
FAEM Chiarasul	2796 (97.8)	3587 (104.8)	2572 (98.1)	3320 (90.7)	3069	99.6
UPFA 22 (C)	1968 (68.8)	2477 (73.2)	-	-	2223	72.1
URS 21 (C)	2849 (99.5)	3385 (100.0)	2621 (100.0)	3473 (94.9)	3082	100.0
URS Guapa (C)	2862 (100.0)	3149 (93.00)	2373 (90.5)	2931 (80.10)	2829	91.8
Barbarasul (C)	-	-	2356 (89.9)	3659 (100.0)	3008	97.6
Test locations	8	8	10	16	-	-

MT: Best control of the year evaluated;
MT **: Best control for all years evaluated.

of 66 plants per meter, in rows spaced 0.20 m apart. On this occasion, another artificial selection cycle was carried out, by choosing the best plants per row. In the winter of 2004, the F_4 plants were grown. The plants were sown without spacing, and the best lines selected. Therefore, the Pedigree selection method was adopted for the development of cultivar FAEM Chiarasul. Two selection cycles of individual F_2 and F_3 plants were carried out in an experimental field in the rows under evaluation, which gave rise to new lines in the following generations, from which the best lines were selected in the F_4 generation. Seeds from the selected F_4 lines in F_5 were grown in a greenhouse in the summer of 2005,

without artificial selection, only for seed multiplication, and seeds obtained in F_6.

In view of the high uniformity, this line was included in the Internal Preliminary Test for grain yield, conducted in an experimental field in the cool growing season of 2005, together with other lines from UFPel and different breeding programs and three white oat control cultivars (standard genotypes indicated for this purpose by the Comissão Brasileira de Pesquisa de Aveia - CBPA). In this test, the line was named CGF 05-023. In the cool growing season of 2006, this line was retested in the Internal Preliminary Test for yield and other desirable agronomic characters. In 2005 and 2006, these tests were conducted in a randomized complete block design, with four replications, sown at a density of 300 seeds per square meter. Each replication consisted of plots with five 5-m long rows spaced 0.20 m apart, assessing the product harvested from the three central rows, from an area of 3.0 m².

PERFORMANCE

Based on the performance in the Internal Preliminary tests of 2005 and 2006, line CGF 05-023 was included in the Regional Line Tests (ERLA) coordinated by the Comissão Brasileira de Pesquisa de Aveia, in 2007. Based on the results obtained by the CBPA test network, the CGF 05-023 was included in the Brazilian Line Tests (EBLA), and its performance evaluated during the growing seasons of 2008 and 2009.

The criteria for the release of white oat cultivars by the CBPA (CBPA 2006) are based on the comparative performance of lines of the best control cultivar grown at several cultivation sites, in at least three consecutive years (one year as part of ERLA, and two years in EBLA). If a line has a three-year average grain yield ≥5% of the average grain yield of the best control cultivar, it may be released on the market. Other lines are released which have a grain yield of 100 - 105% of the average of the best control, together with a special trait of the line, or a line can be released for a specific region or location where its grain yield is 10% above that of the best control. Thus, based on the combined performance of line CGF 05-023 at several locations of cultivation, in the growing seasons of 2007, 2008 and 2009, and respecting the criteria established by CBPA, the line was considered a white oat cultivar in 2010, named 'FAEM Chiarasul'.

In 2008 and 2009 DUS (Distinctness, Uniformity and Stability) tests were carried out in Capão do Leão, RS (lat 31º 46' S, long 52º 20' W, alt 12 m asl), and the cultivars Albasul, Brisasul and Barbarasul were used for comparison.

The average performance of cultivar FAEM Chiarasul was compared to that of the standard white oat cultivars in the years 2007, 2008, 2009, and 2010, at different cultivation sites. The mean plant height of FAEM Chiarasul is reduced (104.2 cm), slightly higher (1.1%) than of the best control cultivar, URS Guapa (average height of 103.1 cm). The period from emergence to physiological maturity lasted 120.8 days, of which 80.3 days were attributed to its vegetative growth.

The 1000 grain weight and test weight represent essential traits, intensely modeled and targeted by selection in white oat breeding programs in the search for genotypes with high grain quality. In this sense, FAEM Chiarasul was noteworthy, with an average test weight of 46.4 kg hl⁻¹, equivalent to the performance of the best control URS 21, and a 1000-grain weight of 31.5 g, which is very close to that of the standard cultivar URS Guapa (31.8 g).

Comparing the grain yield of white oat cultivars, FAEM Chiarasul had an average yield of 3,069 kg ha⁻¹, higher than that of the control cultivars UPFA 22 (2,223 kg ha⁻¹), URS Guapa (2,829 kg ha⁻¹), and Barbarasul (3,008 kg ha⁻¹). At the same time, FAEM Chiarasul had roughly the same performance, with no statistical differences, evidenced by the URS 21 (3,082 kg ha⁻¹), which was the best control for the set of locations and years tested.

Table 2 shows the performance of FAEM Chiarasul and four white oat control cultivars for traits related to industrial suitability and chemical grain quality, in Capão do Leão -RS, in the growing season of 2009. The grain-processing quality of white oats is defined by the percentage of grains thicker than 2 mm in the total harvested grain mass. For this trait grains > 2 mm, the performance of cultivar FAEM Chiarasul was slightly inferior to the others (86.55%), of which URS Guapa performed best (95.25%). For the dehulling index, the cultivars performed very similar, and 69.20% of the grains of FAEM Chiarasul were thicker than 2 mm, in other words, approximately 60.00% of the total harvested grain of FAEM Chiarasul can potentially be used in the food industry. Thus, the release of cultivar FAEM Chiarasul was based on the fact that this genotype has important traits of interest for producers, which are industrial suitability, defined by high test weight and 1000-grain weight, high grain-processing yield, reduced average plant height, associated with a grain yield statistically equal to the best control cultivar.

It was found that the performance of FAEM Chiarasul in relation to the chemical grain properties was similar to that of the cultivars UPFA 22, URS 21, URS Guapa, and Barbarasul (Table 2). It is noteworthy that the β-glucan

Table 2. Analysis of traits related to industrial suitability and chemical quality of the cultivar FAEM Chiarasul and four white oat control cultivars grown in Capão do Leão-RS, in the growing season of 2009

Trait	Unit	Cultivar				
		FAEM Chiarasul	UPFA 22 (T)	URS 21 (T)	URS Guapa (T)	Barbarasul (T)
Percentage of grains > 2 mm	%	86.55±3.20	92.38±1.31	91.00±4.14	95.25±0.96	90.88±2.50
Percentage of hulled grains	%	69.20±2.31	72.11±3.31	72.80±2.34	72.39±5.23	70.46±2.75
Grain-processing quality	%	59.94±3.99	66.59±2.77	66.23±3.29	68.93±4.65	64.01±2.44
Crude protein *	g.100g^{-1}	17.46±0.91	18.53±0.79	17.91±0.22	16.89±0.92	16.57±1.07
Lipids *	g.100g^{-1}	7.46±054	8.10±0.25	8.14±0.54	7.15±0.40	7.43±0.44
Total Dietary Fiber *	g.100g^{-1}	8.62±0.27	9.34±0.23	9.05±0.09	8.87±0.55	8.70±0.43
Insoluble dietary fiber *	g.100g^{-1}	5.13±0.24	5.62±0.18	5.42±0.15	5.53±0.40	5.33±0.47
Soluble dietary fiber *	g.100g^{-1}	3.50±0.13	3.72±0.08	3.63±0.18	3.34±0.23	3.37±0.27
* β-glucan	g.100g^{-1}	3.71±0.95	5.68±0.66	5.57±0.30	5.64±0.51	5.82±0.68
Crude fiber *	g.100g^{-1}	2.08±0.27	1.81±0.27	1.50±0.21	2.04±0.36	2.04±0.34
NDF *	g.100g^{-1}	10.31±0.23	10.52±0.24	10.23±0.05	10.43±0.29	10.25±0.19
ADF *	g.100g^{-1}	3.17±0.45	2.64±0.29	2.52±0.16	2.99±0.40	2.55±0.68
Ash content *	g.100g^{-1}	2.26±0.06	2.29±0.03	2.28±0.02	2.22±0.06	2.22±0.09
Nitrogen-free extract *	g.100g^{-1}	70.05±0.83	67.84±1.61	69.42±0.69	71.11±2.34	70.28±0.72

T: White oat control cultivars;

* Chemical grain properties determined by near-infrared spectroscopy (NIR), in a laboratory of the Centro de Pesquisa em Alimentação **(Cepa),** of the Universidade de Passo Fundo (UPF), Passo Fundo-RS. NDF- neutral detergent fiber, ADF - acid detergent fiber.

content of the oat grains of FAEM Chiarasul was relatively inferior to that of the controls, of which the average content of β-glucan per 100 g grains was 3.71 g, and 5.82 g 100g^{-1} of the best cultivar, Barbarasul.

In terms of diseases of the aerial part, under experimental conditions FAEM Chiarasul was moderately resistant to leaf rust (*Puccinia coronata* Cda. F. Sp. Avenae), stem rust (*Puccinia graminis* Pers. F. Sp. Avenae) and to leaf spots (*Pyrenophora avenae* and *Cochliobolus sativus*), the most common shoot diseases of white oats in southern Brazil (CBPA 2010). In regions where conditions are favorable for the occurrence of leaf rust, great attention should be paid to monitoring the occurrence of this disease, since specific fungicides may have to be applied to avoid losses in grain quality and yield.

SEED MAINTENANCE AND DISTRIBUTION

Cultivar FAEM Chiarasul is registered by the Brazilian Ministry of Agriculture and Supply, under the number 28081 (MAPA 2011). The Federal University of Pelotas is responsible for the maintenance of genetic and basic seed of FAEM Chiarasul, while the Fundação Pró-Sementes de Apoio à Pesquisa is in charge of marketing the cultivar.

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