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CULTIVAR RELEASE

FAEM Carlasul: new white oat cultivar with high grain yield

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ABSTRACT - *The white oat cultivar FAEM Carlasul was developed at the Plant Genomics and Breeding Center, Faculty of Agronomy Eliseu Maciel, Federal University of Pelotas, as a result of the cross between UFRGS 10 and 90SAT-28 (Coronado2/Cortez3/Pendek/ME 1563). It is characterized by high yield and grain quality.*

Key words: Avena sativa *L., genetic improvement, yield, quality*.

INTRODUCTION

The primary focus of the Plant Genomics and Breeding Center, Faculty of Agronomy 'Eliseu Maciel', Federal University of Pelotas (CGF-FAEM/UFPel) is the technical and human education of undergraduate and graduate students. Throughout its history, numerous basic and applied studies on grasses, especially with species of the genus *Avena, Oryza* and *Triticum* have been developed, using classical breeding techniques, bioinformatics and biotechnology tools. At the same time, the center maintains the White Oat Breeding Program (*Avena sativa* L.) since nearly 15 years, which has so far made the following white oat cultivars available for production: Albasul, released in 2003, Barbarasul in 2008 and Brisasul in 2009 (Lorencetti et al. in 2004, Carvalho et al. in 2009, CBPA 2009).

Pedigree and selection method

The white oat cultivar FAEM Carlasul was obtained from the cross between the genotypes of white oat (*Avena sativa* L.) UFRGS 10 and 90SAT-28 (Coronado2/Cortez3/Pendek/ME 1563), in 2000. Artificial hybridizations were performed in a greenhouse, on the grounds of the plant Genomics and Breeding Center (CGF), Faculty of Agronomy 'Eliseu Maciel', Federal University of Pelotas, city of Capão do Leão-RS. The F_1 generation was grown in a greenhouse in the summer of 2001, obtaining the seeds of the F_2 generation. In the cold growing season of 2001, the F_2 generation was grown in an experimental field of the Agricultural Center of Palma, belonging to the Federal University of Pelotas, in Capão do Leão, Rio Grande do Sul. The F_2 generation was sown in spaced planting, with a distance of 0.30 m between plants and rows. The best F_2 plants were selected, considering the important agronomic performance characteristics based on the plant phenotype observed during cultivation, and of the panicles and grains under laboratory conditions. In the cold growing season of 2002, the plants of the F_3 generation were obtained by selection, planted in full rows, thinned to 66 plants per meter, and rows spaced 0.20 m apart. The artificial selection consisted of choosing the best individual plants in each row. In the cold growing season of 2003, the F_4 generation selected in the previous growing season was grown. The plants were sown in full row, and the best lines were selected again. Therefore,

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the selection method to develop cultivar FAEM Carlasul has the characteristics of the Genealogical Method, since two selection cycles of individual plants were carried out in an experimental field within the lines under evaluation, in F_2 and F_3, and the selected plants gave rise to new lines in subsequent generations, with selection of the best lines in F_4. In the summer of 2004, seeds from the selected F_4 lines, in the F_5 generation, were grown in a greenhouse, without artificial selection, but for seed multiplication, producing F_6 seeds.

In view of the high uniformity, a series of lines were planted in an experimental field in the cold growing season of 2004, in Internal Preliminary tests for grain yield, which included three white oat cultivars regarded as controls (standard genotypes recommended for this purpose by the Brazilian Oat Research Commission). In this test, the line was called CGF 03-005. In the cold growing season of 2005, CGF 03-005 was tested again in the Internal Preliminary tests for grain yield and for other desirable agronomic traits. The Internal Preliminary tests in 2004 and 2005 were evaluated in a randomized complete block design, with four replications, at a density of 300 viable plants per square meter. Each replication consisted of one plot with five 5- m rows spaced 0.20 m apart, and the yield was assessed from the production of the three central rows, i.e., of an evaluation area of 3.0 m^2. In the cold growing season of 2006, more seeds of line 03-005 CGF were produced in the experimental field.

Performance

In view of the performance observed in the Internal Preliminary Trials of 2004 and 2005, CGF 03-005 was included in Regional line tests, coordinated by the Brazilian Oat Research Commission (ERLA) in 2007. Based on the results obtained in the test network of CBPA, line CGF 03-005 was included in the Brazilian line tests (EBLA), where its performance was assessed in the growing seasons of 2008 and 2009.

Based on the general performance of line 03-005 CGF at different sites of cultivation, in the growing seasons of 2007, 2008 and 2009, the grain yield performance of this line was competitive, with a 5% higher average grain yield than of the best control cultivar (average of three years), and meeting the criteria established by CBPA (2006). Line CGF 03-005 was promoted to become the white oat cultivar 'FAEM Carlasul' in 2010 (CBPA 2010).

In the years 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, 12 m asl), using the cultivars Albasul, Brisasul, Barbarasul and UFP 18 for comparison.

The average performance in 2007, 2008, 2009 and 2010 of cultivar FAEM Carlasul and the standard white oat cultivars at different cultivation sites was compared (Table 1). The average plant height of FAEM Carlasul was 108.8 cm, i.e., 5.5% higher than of the best control cultivar, URS Guapa, with an average height of 103.1

Table 1. Average performance of the white oat cultivar FAEM Carlasul and control cultivars in relation to agronomic traits of interest, grown without fungicide application at different sites in Brazil, under the coordination of the Brazilian Committee for Oat Research in the growing seasons of 2007, 2008, 2009, and 2010.

Genotypes	**2007** (%BC)	**2008** (%BC)	**2009** (%BC)	**2010** (%BC)	**Mean**	**Mean%BC****
	Plant height (cm)					
FAEM Carlasul	92.4 (103.3)	120.2 (104.1)	119.4 (108.2)	103.0 (108.4)	108.8	105.5
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 Carlasul	87.2 (111.1)	82.0 (108.9)	88.7 (110.2)	78.0 (106.8)	84.0	109.2
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	-	-

to be continued...

			Days from emergence to physiological maturity (days)			
FAEM Carlasul	122.4 (106.2)	120.9 (105.7)	127.1 (103.1)	122 (102.5)	123.1	107.1
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 (100.8)	119.1	103.7
URS Guapa (C)	119.2 (103.4)	116.3 (101.7)	119.5 (100.0)	119 (100.0)	118.5	103.1
Barbarasul (C)	-	-	124.4 (104.2)	122 (102.5)	123.2	107.2
Test locations	6	6	7	12	-	-
			Test weight (kg hl^{-1})			
FAEM Carlasul	49.2 (105.4)	44.3 (94.7)	45.3 (97.8)	45.5	46.1	99.4
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 Carlasul	29.7 (92.0)	29.4 (90.5)	30.8 (95.1)	31.0 (103.3)	30.2	95.0
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 Carlasul	3029 (105.8)	3768 (111.3)	2685 (102.4)	3796 (103.7)	3320	107.7
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	-	-

BC: best control in the assessed year;
BC**: best control of all assessed years.

cm. The growth cycle lasted on average 123.1 days, from emergence to physiological maturity and the plant development was completed within 84.0 days. The average performance of test weight and 1000- grain weight of the cultivar were 46.1 kg hL^{-1} and 30.2 g, respectively, which were somewhat lower than of the best controls URS 21 (46.4 kg hL^{-1}kg) and URS Guapa (31.8 g).

Considering the grain yield performance of white oat cultivars, the mean grain yield of FAEM Carlasul of 3320 kg ha^{-1} is around 7.7% higher than of URS 21 (3082 kg ha^{-1}), the best control in all years tested. This high potential of FAEM Carlasul for the most important character caused the CGF to make this cultivar available for the production sector of white oat.

The performance of cultivar FAEM Carlasul and of four white oat control cultivars was assessed for traits related to industrial suitability and chemical grain quality, for the conditions in Capão do Leão-RS, in the 2009 growing season (Table 1). Considering the properties for the grain processing industry, the performance of FAEM Carlasul for the trait grains > 2 mm was inferior to the other cultivars (73.00%), of which URS Guapa performed best with 95.25%. For the dehulling index, the cultivars behaved very similar, and 71.73% of the grains of FAEM Carlasul consisted of seeds > 2 mm. Consequently, approximately 53% of the grain yield of cultivar FAEM Carlasul corresponded to the portion of grains suitable as raw material for the food industry.

In general, it appears that the performance of FAEM Carlasul was similar to that of the cultivars UPFA 22, URS 21, URS Guapa, and Barbarasul regarding the chemical grain properties. The contents of crude protein, β-glucan and total dietary fiber of cultivar FAEM Carlasul were slightly lower, but higher for the levels of crude fiber, acid-detergent fiber (ADF) and nitrogen-free extracts in the grains.

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

Traits	Measure	Cultivar				
		FAEM Carlasul	**UPFA 22** (T)	**URS 21** (T)	**URS Guapa** (T)	**Barbarasul** (T)
Grains> 2 mm	%	73.00±5.91	92.38±1.31	91.00±4.14	95.25±0.96	90.88±2.50
Dehulling index	%	71.73±0.96	72.11±3.31	72.80±2.34	72.39±5.23	70.46±2.75
Processing yield	%	52.78±3.41	66.59±2.77	66.23±3.29	68.93±4.65	64.01±2.44
Crude protein*	g $100g^{-1}$	15.84±0.27	18.53±0.79	17.91±0.22	16.89±0.92	16.57±1.07
Lipids*	g $100g^{-1}$	7.87±0.67	8.10±0.25	8.14±0.54	7.15±0.40	7.43±0.44
Total food fiber*	g $100g^{-1}$	8.57±0.04	9.34±0.23	9.05±0.09	8.87±0.55	8.70±0.43
Insoluble food fiber *	g $100g^{-1}$	5.17±0.14	5.62±0.18	5.42±0.15	5.53±0.40	5.33±0.47
Soluble food fiber *	g $100g^{-1}$	3.40±0.18	3.72±0.08	3.63±0.18	3.34±0.23	3.37±0.27
β-glucans*	g $100g^{-1}$	4.28±0.50	5.68±0.66	5.57±0.30	5.64±0.51	5.82±0.68
Crude fiber*	g $100g^{-1}$	2.80±0.40	1.81±0.27	1.50±0.21	2.04±0.36	2.04±0.34
NDF*	g $100g^{-1}$	9.97±0.13	10.52±0.24	10.23±0.05	10.43±0.29	10.25±0.19
ADF*	g $100g^{-1}$	3.08±0.15	2.64±0.29	2.52±0.16	2.99±0.40	2.55±0.68
Ash content*	g $100g^{-1}$	2.22±0.04	2.29±0.03	2.28±0.02	2.22±0.06	2.22±0.09
Nitrogen-free extracts *	g $100g^{-1}$	71.06±0.69	67.84±1.61	69.42±0.69	71.11±2.34	70.28±0.72

T: White oat control cultivars;
*Properties of the chemical grain composition determined by near-infrared spectroscopy (NIR) analyses, at the Laboratório de Cereais do Centro de Pesquisa em Alimentação **(Cepa),** of the Universidade de Passo Fundo (UPF), Passo Fundo-RS.

In terms of response to shoot diseases under the experimental conditions, FAEM Carlasul was moderately resistant to leaf rust (*Pucciniacoronata* C da. F. Sp. Avenae), stem rust (*Pucciniagraminis* Pers. F. Sp. Avenae) and to leaf spots (*Cochliobolussativus* and *Pyrenophoraavenae*), the most common shoot diseases in oats in southern Brazil (CBPA 2010). In regions where conditions are favorable for the occurrence of leaf rust, particular attention should be paid to monitoring this disease, and even specific fungicides may be required to avoid quality and grain yield losses.

Seed maintenance and distribution

Cultivar FAEM Carlasul is registered by the Ministry of Agriculture, Animal Husbandry and Supply, number 28084 (MAPA 2011). The Federal University of Pelotas is responsible for maintaining the genetic and basic seed of cultivar FAEM Carlasul, while the Fundação Pró-Sementes is in charge of marketing the seeds.

REFERENCES

Carvalho FIF, Oliveira AC, Valério IP, Benin G, Schmidt DAM, Ribeiro G and Silveira G (2009) Barbarasul: a high-yielding and lodging-resistant white oat cultivar. **Crop Breeding and Applied Biotechnology 9**: 181-186.

CBPA – Comissão Brasileira de Pesquisa de Aveia (2009) **Resultados experimentais da XXIX Reunião da Comissão Brasileira de Pesquisa de Aveia**. Universidade Federal do Rio Grande do Sul, Porto Alegre, 484p.

CBPA – Comissão Brasileira de Pesquisa de Aveia (2006) **Indicações técnicas para cultura da aveia**. Fundação Agrária de Pesquisa Agropecuária, Guarapuava, 82p.

CBPA – Comissão Brasileira de Pesquisa de Aveia (2010) **Resultados experimentais da XXX Reunião da Comissão Brasileira de Pesquisa de Aveia**. Embrapa Pecuária Sudeste, São Carlos, 404p.

Lorencetti C, Carvalho FIF, Oliveira AC, Marchioro VS, Benin G, Hartwig I, Schmidt D and Valério I (2004) Albasul – White oat. **Crop Breeding and Applied Biotechnology 4**: 123-124.

MAPA – Ministério da Agricultura, Pecuária e Abastecimento. **Registro Nacional de Cultivares – Aveia-amarela/Aveia-branca *(Avena sativa L. incluindo Avena byzantina K.* Koch).** Available at <http://extranet.agricultura.gov.br/php/proton/cultivarweb/cultivares_registradas.php> Assessed on June 01, 2011.