Description of cultivar

Valles F2015: new wheat variety for rainfed crops in Mexico

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Abstract

Valles F2015 is a variety of bread wheat that was released by the Wheat Genetic Improvement Program of the INIFAP. The experimental line was obtained through the male sterility technique to facilitate the recurrent selection (EMFSR), which requires a source of male sterility, a recombinant population and the recurrent selection, in such a way that Valles F2015 is the first variety that generates in Mexico through EMFSR. It is a variety of spring habit, intermediate to late cycle, tall and tolerant to lodging. The genealogy of the variety is: PAMDOLY.PABG (Late.C4). Valles F2015 was evaluated from 2011 to 2015 in 79 different conditions under temporary, comparing with 11 control varieties, which exceeded in grain yield of 15% (Altiplano F2007) to 35% (Nana F2007), showing good behavior in any environment of temporary. Under the natural incidence of blight, leaf spots and yellow rust, Valles F2015 was more resistant than the control varieties and was the variety that showed the lowest loss in yield (9% and 10%, respectively) when evaluated with and without protection with fungicides. Valles F2015 is hard grain that produces a strong gluten mass, suitable for mechanized or artisan baking and to be used in mixtures to improve flours with little force or tenacious. This new variety is recommended in all areas producing rain wheat in early to intermediate sowings.

Keywords: disease resistance, male sterility, spring wheat, yield.

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The production of wheat in Mexico has not escaped the global trend of shortage of this grain, since it has reduced the planted area of almost 1 100 000 ha in 1985 to less than 700 000 ha in 2017. This fact supposes that there will be complications to meet the national demand for wheat (Fuentes, 2008, SIAP, 2018). In the country, the production of irrigated wheat in the autumn-winter (AW) cycle in the Northwest and The Bajío regions has greater importance in the national supply, where higher yields are achieved due to the availability of water for irrigation, in these at present, it is difficult to increase the area, so that the increase in production must be achieved by high yields and not by increases in the irrigated area.

Temporary production in the spring-summer cycle is complementary to the national supply; in these conditions the rains are increasingly erratic and approximately 80% of the producing regions present deficiencies of humidity during the crop cycle 60% of them the diseases affect the production in susceptible varieties. In Mexico, historically, wheat that is produced under rainfed conditions, unlike harvested under irrigation, is planted in small, isolated and contrasting areas in about 15 states, from the Mixteca Oaxaqueña to the North Central of the country, where environmental conditions they are very diverse (Villaseñor and Espitia, 2000).

Given this scenario, it is important to generate new varieties for rainfed conditions that help farmers minimize the negative effects of biotic and abiotic factors that occur in these areas, thus contributing to making their crop more profitable.

Valles F2015 was released by the National Institute of Forestry, Agriculture and Livestock Research (INIFAP, for its acronym in Spanish), which is suitable for seasonal sowing, since it shows good behavior in the different production conditions, surpassing the varieties that are currently sown; likewise, it has stood out for its resistance to rusts and tolerance to the complex of foliar diseases; another important aspect is its industrial quality, which is suitable for the production of box bread and for mixing as a flour enhancer of soft and tough gluten wheats.

The variety of bread wheat (*Triticum aestivum* L.) Valles F2015 is of spring habit and the experimental line was obtained in the Program of Genetic Improvement of Temporary Wheat of the INIFAP, later that line was evaluated in the Nurseries and National Trials. The line was obtained using the male sterility technique to facilitate recurrent selection (EMFSR), which requires a source of male sterility, a recombinant population and recurrent selection. The source of male sterility was due to a dominant androsterile mutant named ‘Oly’ (Villaseñor *et al*., 2014), the recombinant population was formed with 20 progenitors of the INIFAP temporal wheat program that made up the population with a broad genetic base (PABG), the line was generated from the recombination that took place in the fourth cycle of recurrent selection during the autumn-winter (AW) cycle of 2007-08 (4°CSR-O-I/07-08) in the PABG and in the group of late plants.

The genealogy of the variety is as follows: PAMDOLY.PABG (late C4). The seed of the recombinant androsterile population PAMDOLY.PABG, product of its third cycle of recurrent selection, was sown during the A-W cycle 2007-2008 in Roque, Guanajuato, under normal irrigation conditions, the population size was 10 000 plants, during flowering, 5% of the androsterile plants that were left to free mating were selected; these recombinant plants were harvested in masse to give the fourth cycle of recurrent selection (C4). The seed of this recombination cycle was planted during the S-S/2008 cycle in Chapingo, State of Mexico, under regular seasonal conditions and plant No. 182 (182C) was harvested individually. The seed of that plant, in its equivalence to a F_3 generation due to its level of homozygosis, was planted as a family in Roque, Guanajuato, in the A-W cycle 2008-2009 under limited irrigation conditions (a relief irrigation) and was harvested (0R).

The family in its F_4 generation was planted in Yanhuitlan, Oaxaca, in the spring-summer cycle (SS) 2009 under regular seasonal conditions and was harvested massively (0OAX). In its F_5 generation, the seed was planted in Roque, Guanajuato, under normal irrigation conditions (three aid irrigation) and the family was massively harvested. In generation F_6, their seed was planted in Chapingo, State of Mexico, during the SS-2010 cycle under conditions of favorable weather, where Plant No. 2 (2C) was selected and harvested individually, which was planted in its F_7 generation in Roque, Guanajuato, in the A-W cycle 2010-2011 under normal irrigation conditions, and where the experimental line that was recognized with the following pedigree was massively harvested (0R): SRGD (4ºCSR OI 2007-2008)-182C-0R-0OAX-0R-2C-0R.

The indicated experimental line was evaluated during the SS-2011 cycle in the preliminary yield test (PPR) in four localities of the states of Tlaxcala and Mexico, later during the SS-2012 cycle it was evaluated in the national nursery of wheat selection of temporary (VSTHT) in 20 locations located from Oaxaca to Chihuahua. In the summers of 2013 to 2015 it was tested in the national trials of wheat yield of rainfed (ERTHT), in about 60 different trials, where stood out with respect to the control varieties for their higher yield of grain under different production conditions of temporary and its greater resistance to diseases. The genotechnic method of obtaining used was of recurrent selection by means of the use of the androsterility and method of selection of massive families to derive the uniform line.

In the Table 1 shows the reaction to rusts and foliar diseases of Valles F2015 and control varieties, where it is observed that they exceeded in resistance to yellow yellow rust (*Puccinia striiformis* f. sp. *Tritici*) and leaf rust (*Puccinia Triticina*), and highlighted, together with Rebeca F2000, as the most resistant variety to blight and leaf spots.

Table 1. Days to maturity and phytopathological characteristics of Valles F2015 and of control varieties in rainfed crops.

Variety	DM	Leaf rust	Yellow	Foliar
Valles F2015	114	0 a 20MR	0 a 15MR	6/30 (MR)
Altiplano F2007	115	0 a 20MR	10MR a 30MS	6/30 (T)
Nana F2007	107	15MR a 50MS	30MS a 90S	7/30 (T)
Triunfo F2004	112	15MR a 30MR	10MR a 70S	7/30 (T)
Nahuatl F2000	109	0 a 40MR	15MR a 60MS	7/80 (MS)
Tlaxcala F2000	110	10MR a 40MR	10MR a 40MS	7/40 (MS)
Juchi F2000	111	10MR a 30MR	20MS a 80S	7/40 (T)
Rebeca F2000	117	20MR a 50MS	10MR a 50MS	6/30 (MR)

Variety	DM	Leaf rust	Yellow	Foliar
Batan F96	111	40MS a 80S	20MR a 60MS	7/40 (T)
Romoga F96	111	10MR a 40MR	10MR a 30MR	7/60 (MS)

DM= days to maturity; R= resistant; S= susceptible; MR= moderately resistant; MS= moderately susceptible; T= tolerant; reaction to leaf rust and yellow rust is the minimum and maximum reading observed for five years. Reaction to foliar is the maximum reading observed in rainy environments where the complex of diseases caused by *Septoria tritici*, *S. nodorum*, *Phyrenophora tritici-repentis* and *Cochliobolus sativu*s.

In the Table 2 shows the yield losses caused by the foliar diseases and yellow rust complex in Valles F2015 and in three control varieties, where it was observed that in the case of foliar diseases, they caused losses in Valles F2015 of 9%, while in the control varieties were 20% (Altiplano F2007) to 36% (Nana F2007), with respect to yellow rust, the losses in Valles F2015 was 10% and in the witnesses of 20% (Altiplano F2007) to 54% (Nana F2007), which shows that Valles F2015 is more resistant than the control varieties.

Table 2. Losses of grain yield caused by the foliar diseases and yellow rust complex in Valles F2015 and control varieties evaluated in localities of the State of Mexico and Tlaxcala during the SS-2016 and SS-2017 cycles.

Variety	Foliar diseases§			Yellow rust§§		
	CF	SF	Losses (%)	CF	SF	Losses (%)
Tlaxcala F2000	6472	4938	-24	4761	3627	-24
Nana F2007	6771	4313	-36	4874	2320	-54
Altiplano F2007	6965	5597	-20	4798	3846	-20
Valles F2015	7257	6604	-9	5217	4711	-10

CF= with fungicide; SF= without fungicide; §= evaluated in Nanacamilpa, Tlaxcala in 2016-2017 and in Juchitepec, State of Mexico in 2017. §§= evaluated in Terrenate, Tlaxcala, 2016-2017 and Ixtafiayuca, Tlaxcala, and Santa Lucía, State of Mexico in 2017.

Valles F2015 is moderately resistant to yellow rust, because it has specific race genes that manifest in seedling status, in particular to the CMEX14.25 race. The low degrees of severity registered in Valles F2015, in the field in the flag leaf stage (from 0 to 20), when artificial inoculations were made with the isolates CMEX14.25, MEX14.141 and MEX14.146 identified during 2014, which expired the resistance of Luminaria F2012 and of Nana F2007 (Solis *et al*., 2016) and that combine virulence for the genes Yr2, Yr3, Yr6, Yr7, Yr8, Yr9, Yr17, Yr27 and Yr31 among others, indicate that their resistance is based on at least three slow-growing genes in the adult plant, with the genes Yr18, Yr29 and Yr30 being important. These genes confer effective resistance against all races that exist in Mexico and other wheat regions in the world.

The moderate rust resistance of Valles F2015 leaf is due to the fact that it has the specific race resistance genes Lr10, Lr17, Lr23 and the complementary genes Lr27+Lr31. The presence of Lr10 in Valles F2015 confers resistance to the TCB/TD race, one of the most common until 1994 (Huerta and Singh, 1996; Huerta *et al*., 2002), the Lr17 gene confers resistance to the races

MFB/SP and TCB/TD and the Lr23 gene confers resistance to the MCJ/QM race and has been one of the most common resistance genes in the varieties planted in temperate in Mexico (Huerta and Singh, 2000). The complementary genes Lr27+31 present in Valles F2015, have no effect when separated against the races MBJ/SP and MCJ/SP, as well as the BBG/BP race of crystalline wheats (Huerta-Espino *et al*., 2009). In adult plant, the resistance of Valles F2015, is based on the action of three genes that confer slow rolling resistance and that are generally more effective in flag leaf, one of those genes is Lr34, associated with the burn of the tip of the leaf and that is common in the varieties Juchi F2000 and Tlaxcala F2000 (Huerta *et al*., 2002) and Triunfo F2004 (Villaseñor *et al*., 2007).

In the Table 3 shows the comparison of grain yield of Valles F2015 and the control varieties, which shows that in general and by type of environment, this new variety was more productive than the control varieties. On average, it exceeded 15% (Altiplano F2007) up to 35% (Nana F2007), in favorable environments of 7% (Altiplano F2007) up to 31% (Batan F96); in intermediate environments of 22% (Altiplano F2007) up to 44% (Nana F2007) and in critical environments 18% (Altiplano F2007) up to 32% (Nahuatl F2000).

Table 3. Grain yield of Valles F2015 and control varieties in different rainfed environments from 2012 to 2015.

Variety	General (79 Loc)		AF (24 Loc)		AI 25 (Loc)		AC (30 Loc)	
	(kg ha^{-1})	% Dif	(kg ha^{-1})	% Dif	(kg ha^{-1})	% Dif	(kg ha^{-1})	% Dif
Valles F2015	3149	…	4120	…	3591	…	2061	…
Altiplano F2007	2687	-15	3848	-7	2802	-22	1682	-18
Rebeca F2000	2365	-25	3519	-15	2410	-33	1482	-28
Temporalera M87	2343	-26	3220	-22	2423	-33	1608	-22
Romoga F96	2325	-26	3159	-23	2487	-31	1527	-26
Tlaxcala F2000	2248	-29	3184	-23	2296	-36	1463	-29
Triunfo F2004	2215	-30	2963	-28	2299	-36	1538	-25
Nahuatl F2000	2184	-31	3169	-23	2196	-39	1401	-32
Batan F96	2150	-32	2887	-31	2280	-37	1462	-29
Galvez M87	2139	-32	3032	-26	2165	-40	1431	-31
Juchi F2000	2117	-33	2870	-30	2217	-38	1440	-30
Nana F2007	2062	-35	2936	-29	2024	-44	1447	-30

AF= favorable environments; AI= intermediate environments; AC= critical environments; (%) dif= difference with respect to Valles F2015.

Valles F2015 has hard grain, which is desirable for rainy season conditions, because it reduces germination in the spike when there is rain at maturity. This new variety was characterized by having strong gluten masses (W on average 322 10^{-4}J) and extendable (PL value "tenacity/extensibility ratio" on average 0.7), which allowed it to reach on average a bread volume of 822 mL, matching the best control varieties. Due to its quality, Valles F2015 is a variety suitable for mechanized or artisan baking and for use in mixtures to improve flours with little force or tenacity.

Conclusions

Valles F2015, is a variety that adapts to all regions of wheat production in Mexico, since it is widely adapted, it can be planted in favorable or rainy environments (more than 600 mm), intermediate or rainy (between 300 to 600 mm) and critical or erratic (less than 300 mm) in the states of Oaxaca, Puebla, Tlaxcala, Hidalgo, Guanajuato, Jalisco, Aguascalientes, Zacatecas, Durango, Chihuahua and the State of Mexico.

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