Article

Pacífico FL 15 and Golfo FL 16, multi-environmental varieties of rice with extra long grain for Mexico

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Abstract

During the 2012-2015 they were selected, biometrically evaluated, purified and morphologically characterized in plant and grain the rice lines FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-1P-3P-M-150pZa-250pZa-0Za. Due to its high and stable yield potential, both in the Pacific slope and the Gulf of Mexico, in 2016 it was proposed to be released and registered with the National Seed Inspection and Certification Service (SNICS) as new varieties Pacífico FL15 (registry ARZ-026-010716) and Golfo FL 16 (registry ARZ-025-010716), and in 2018 they were assigned the numbers 1871 and 1872 of breeder's title, respectively. Both varieties are resistant to the sogata-VHB complex (white leaf virus) and the endemic 'rice burning' disease (*Pyricularia oryzae*), and are moderately resistant to the new 'spotted grain' disease caused by *Helminthosporium oryzae* in association with others pathogens. The grain of both varieties is extra-long with excellent milling quality and good culinary quality. Basic seed was produced, and in October 2016 were delivered to the Mexican Rice Council, AC., 2.42 t of Pacífico FL 15 and 2.1 t of Golfo FL 16, and in the autumn-winter 2016-2017 began a program of production of registered and certified, seeds for planting in the rice areas of the Pacific Ocean slope and in the plains of the Gulf of Mexico. With these varieties, the rice growers will be able to contribute with 300 000 t of extra-long-grain rice demanded by the population.

Keywords: *Oryza sativa* L., FLAR, industrial quality, seed, yield stability.

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Introduction

Until the mid-eighties of the twentieth century, due to the production of rice (*Oriza sativa* L.) thin long grain 'Sinaloa type', in Mexico there was self-sufficiency in this cereal (Hernández, 2016). With the incorporation of the country to the General Agreement on Tariffs and Trade (GATT) in 1986, import permits for agricultural products were transformed into tariffs and in 1989, the guarantee price for basic grains, including rice, was eliminated. (Calva *et al*., 1998). In 1994, the North American Free Trade Agreement (NAFTA) entered into force and tariffs on rice imports were eliminated mainly from the United States (Bartra, 2005).

With the commercial opening in 2000, the 'Sinaloa type' rice lost competitiveness due to the massive importation of rice of the same type of grain, favored by the production and commercialization at low prices, generated by the high subsidies received by producers in the United States of America (Ireta *et al*., 2011). The consequences were reflected in a drastic reduction in the area planted and in the production volumes of thin long grain rice in the country (Chávez-Murillo *et al*., 2011).

Currently 75% of the rice consumed in Mexico is imported and with long thin grain, in 2015, 1 062 500 tons were imported at a cost of three hundred million dollars, equivalent to six billion pesos annually (Hernández, 2016). Only 25% of the consumption is supplied by the national production, of which the fourth part is 'Morelos rice' (long with 20% of 'white belly') and three quarters is Filipino Milagro rice (medium with 10% of 'white belly') (SIAP-SAGARPA, 2016).

To help solve this situation, INIFAP, with the financial support of the Sector Fund SAGARPA-CONACYT in synergy with the Latin American Rice Irrigation Fund (FLAR) of the International Center for Tropical Agriculture (CIAT) of Cali, Colombia, during the 2012-2015 period carried out selection activities (Álvarez *et al*., 2016; Barrios *et al*., 2016a) and biometric evaluation of thin long grain rice materials (Barrios *et al*., 2016b) under the environmental conditions of the tropics dry and wet of Mexico. In view of this situation, the proposed objectives were to generate new multi-environmental varieties of long-grain rice with a high and stable yield, resistant to diseases prevalent in Mexico, with good industrial grain quality, and competitive with imported rice; and produce and deliver high quality seed for the establishment of certified seed production programs, which contribute to the recovery of production levels of thin long grain rice in Mexico.

Materials and methods

During the year 2012, nurseries identified as VIOFLAR-2008, VIOFLAR-2009, VIOFLAR-2010 and VIOFLAR-2011 were introduced from FLAR, and integrated by 40, 35, 40 and 226 F_5 lines, respectively.

The pre-selected materials were established and evaluated through preliminary yield tests (PPR), preliminary yield trials (EPR), compact yield trials (ECR) and technology validation in contrasting ecosystems and moisture regimes of different localities of the dry tropic of the Pacific slope and of

the Depression of the Balsas, as well as of the humid tropic of the Gulf of Mexico (Table 1) in turn, the evaluation of the industrial quality of the grain was made in the laboratory of the Experimental Field Zacatepec of the INIFAP, located in Zacatepec, Morelos.

Table 1. Locations and geographical coordinates of location, moisture regimes and ecosystems where FLAR rice materials were evaluated in the period 2012-2015.

Locations	North latitude	West length	Moisture regimes	Ecosystems
Ebano, SLP (Las Huastecas)	22° 10’20”	98° 27’58”	Conventional irrigation	Sub-humid tropics
Zacatepec, Morelos	18°39’17”	99º12’04”	Conventional irrigation	Dry tropics
Paracuaro, Michoacán	19°10’12”	102°01’55”	Conventional irrigation	Dry tropics
El Gargantillo, Tomatlan, Jalisco	19°59’58”	105°19’02”	Conventional irrigation	Dry tropics
Sauta, Santiago Ixcuintla, Nayarit	21º43’35”	105º09’38”	Conventional irrigation	Dry tropics
Buenavista, Colima	19º15’01”	103º37’38”	Temporary with irrigations precarious	Dry tropics
Loma del Chivo, Tres Valles, Cotaxtla, Veracruz	18º50’07”	96º23’41”	Temporary common	Humid tropics
Poblado C-21, Huimanguillo, Tabasco	18º26’08”	93º33’06”	Temporary common	Humid tropics

Preliminary performance test

With the initial 341 lines, in 2012 five PPR were performed without repetitions, in the localities: Tecoman, Colima; Zacatepec, Morelos; Ebano, San Luis Potosí, Cotaxtla, Veracruz, and Palizada, Campeche. The selection criteria in the first instance were based on levels of resistance/susceptibility to pests and diseases, phenotypic acceptability of plants and grain type (IRRI, 1996). Most of the materials were discarded because of their high susceptibility to the endemic diseases ‘rice burning’ (*Pyricularia oryzae* Cav.) and ‘spotted grain’ (*Helminthosporium oryzae* Breda de Haan), and only 26 lines were selected (INIFAP, 2013).

Preliminary performance test

With the 26 lines selected in 2013, EPR was established with four repetitions, in Tecoman, Colima (irrigation), Tomatlan, Jalisco (irrigation), Paracuaro, Michocán (irrigation), Zacatepec, Morelos (irrigation), Ebano, San Luis Potosí (irrigation); Cotaxtla, Veracruz (temporary), Huimanguillo, Tabasco (temporary) and Palizada, Campeche (irrigation). At each site, the 26 lines were compared with three local witnesses. The same selection criteria used for the PPR were considered and the yield potential and evaluation of the industrial quality of the grain was determined. From this trial, 13 materials were selected.

Compact performance test

In 2014 and 2015 through the ECR with three and four repetitions, respectively, biometric evaluation was performed by determining the interaction ‘genotype x environment’ and study of stability parameters. The 13 elite lines were compared with three witnesses, in eight locations: Santiago Ixcuintla, Nayarit; Tecoman, Colima; Tomatlan, Jalisco; Paracuaro Michoacán; Zacatepec, Morelos; Ebano, San Luis Potosí; Cotaxtla, Veracruz, and Huimanguillo, Tabasco. In both cycles, due to their levels of stability, yield potential, resistance to endemic diseases, and type and industrial quality of the grain, the lines FL07562-7P-3-3P-2P-M and FL08224-3P-2-1P-3P-M stood out. However, both lines showed a certain degree of segregation (INIFAP, 2015, INIFAP, 2016a). According to the FLAR, both lines derived from triple crosses FL001028-8P-3-2P-1P-M-2X-3P-1P/FL03146-3P-2-2P-3P-M//FL03188-7P-5-5P-1P-M; and FL05512-7P-6-1P/ FL03157-10P-6-2P-1P-M// FL04577-3P-11-4P-1P-M, respectively.

The data of the yields of each site were integrated and analyzed through a factorial design for the determination of the interaction ‘genotype x environment’ and study of stability parameters, with whose information a combined statistical analysis was performed, with SAS software (2009), to confirm the stability of genotypes (Eberhart and Russell, 1966).

Genetic purification

Because the lines FL07562-7P-3-3P-2P-M and FL08224-3P-2-1P-3P-M segregated for plant and grain types in the different sites evaluated, in the spring-summer cycle (S-S) 2014 were established in the Experimental Field Zacatepec, lots of genetic purification of both lines by the genealogical filiation method that is applied in the technology for the production of high quality seed (Hernández and Tavitas, 2016). During the phase of maturation of the grain 150 panicles of each line were collected. In the autumn-winter (A-W) cycle 2014-2015 the seed of each panicle was planted in a single furrow, and when the plants reached maturity, the best panicles of the best plants of each furrow were harvested separately, leaving their genealogies as: FL07562-7P-3-3P-2P-M-150pZa and FL08224-3P-2-3P-M-150pZa.

In the following cycle (S-S 2015) the seeds of each panicle were seeded separately, and at the end of 2015, 250 panicles were selected, so their genealogies were extended to FL07562-7P-3-3P-2P-M-150pZa-250pZa and FL08224-3P-2-3P-M-150pZa-250pZa, respectively. In the 2015/2016 A-W cycle, each panicle was planted in a row, and the harvest of all the rows of each cultivar was carried out in a mass form, leaving the final genealogies as FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-3P-M-150pZa-250pZa-0Za. The product constituted the original purified seed of each genotype (López and Hernández, 2006).

Validation plots

In S-S 2015, the technological validation of both lines was carried out in Nayarit, Jalisco, Colima, Michoacán, Morelos, Tamaulipas, Veracruz and Tabasco (Huimanguillo and Emiliano Zapata) (INIFAP, 2016b).

Characterization

The characterization of a cultivar is of great importance for identification purposes through its morphological, agronomic and industrial characteristics, which can be used by plant breeders, agronomists and seed producers (Tavitas and Hernández, 2007). In the S-S 2015 cycle, in the Zacatepec Experimental Field, the morphological and agronomic characterization of the plants and the grain of the lines FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-3P-M-150pZa-250pZa-0Za was performed. This was done through the application of 42 descriptors recommended by the International Center for Genetic Resources (IRGC, 1980) of IRRI in the Philippines, and 65 descriptors required by the International Union for the Protection of New Plant Varieties (UPOV, 2004).

Millers and culinary quality

The grain milling quality of the lines FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-3P-M-150pZa-250pZa-0Za, was determined by analyzing samples from 200 g of grain, where the percentage of whole polished grains was obtained, the classification and appearance of the grain. In turn, for the culinary quality, the gelatinization temperature, the gel consistency, the amylose content and the cooking and tasting test were determined (Tavitas *et al*., 2009).

Results

In Table 2, the average grain yields of the ECR 2015 established in the rice localities of Mexico are presented. As can be seen, there is variation in the behavior of the materials between localities, some with higher yields such as Paracuaro, Michoacán and Santiago Ixcuintla Nayarit, followed by the other evaluated localities, with the exception of the locality Huimanguillo, Tabasco (temporary), which was the one that obtained the lower yields (Table 2).

Table 2. Average yields (t ha^{-1}) of 15 genotypes that integrated the 2015 ECR established in seven locations in the dry and humid tropics of Mexico in the S-S 2015 cycle.

Genealogies	Ebano, SLP	Zacatepec, Morelos	Paracuaro, Michoacán	Tomatlan, Jalisco	Santiago Ixcuintla, Nayarit	Buenavista, Colima	Huimanguillo, Tabasco
FL04867-2P-7-3P-3P-M	8.555	8.15	10.156	6.59	10.156	9.201	4.035
FL04952-1P-5-1P-1P-M	9.18	10.6	12.66	8.36	11.502	7.847	3.92
FL06747-4P-10-5P-3P-M	10.664	10.875	12.164	5.98	11.148	7.87	4.799
FL08224-3P-2-1P-3P-M	12.519	11.4	14.272	6.85	13.518	8.337	3.833
FL06689-3P-1-4P-M	9.746	12.1	12.24	7.19	10.014	4.455	4.402
FL06679-3P-5-3P-M	8.144	13.975	12.48	6.64	11.976	8.622	3.797
FL010164-7P-3-1P-1P-M	10.586	10.825	14.648	6.11	12.248	9.818	3.661
FL08378-3P-5-2P-2P-M	10.937	11.7	8.858	5.31	10.594	9.255	3.955
FL010129-12P-4-2P-3P-	13.125	13	12.072	7.37	11.152	9.178	4.015

Genealogies	Ebano, SLP	Zacatepec, Morelos	Paracuaro, Michoacán	Tomatlan, Jalisco	Santiago Ixcuintla, Nayarit	Buenavista, Colima	Huimangui-llo, Tabasco
M							
FL07562-7P-3-3P-2P-M	9.707	9.825	12.74	9.35	11.688	9.835	4.07
FL07162-7P-3-3P-3P-M	9.863	12.825	11.2	8.74	10.628	9.295	3.515
INIFLAR R	9.219	11.4	9.32	6.29	10.308	9.192	4.409
INIFLAR RT	10	6.85	13.908	6.46	12.892	7.378	4.491
El Silverio	8.086	5.35	10.996	7.04	10.214	7.028	3.62
Aztecas	7.109	13.6	12.572	8.3	12.15	8.455	4.242

As can be seen in Table 3, the environments in which the 15 genotypes reported yields of more than 10 t ha^{-1} were: Paracuaro, Michoacán, Sauta, Nayarit and Zacatepec, Morelos; the three sites are located in the dry tropics and the cultivation takes place under irrigation conditions; in Ebano, San Luis Potosí, located in the sub-humid tropics, also with conventional irrigation was slightly below 10 t ha^{-1}. In Buenavista, Colima, where the crop grows in rainy conditions with precarious irrigations, the yield was lower than reported, just like El Gargantillo, Jalisco located in the dry tropics, with irrigation regime and thin lateritic soils. On the other hand, for the Town C-21 of Huimanguillo, Tabasco, located in the humid tropics and common temporary moisture regime, the yield was the lowest of all (Table 3).

Table 3. Response of 15 long-grain rice genotypes in the seven locations where the 2015 ECR was established.

Locations	Average yield (t ha^{-1})
Ebano, San Luis Potosí	9.829 bc
Zacatepec, Morelos	10.8 ab
Paracuaro, Michoacán	12.02 a
El Gargantillo, Jalisco	7.105 d
Sauta, Nayarit	11.35 a
Buenavista, Colima	8.651 c
Town C-21 of Huimanguillo, Tabasco	4.051 e

Means followed by the same letter within columns do not differ statistically (Tukey p= 0.05).

In the Table 4 shows the results of the average yields of the 15 genotypes through the 'genotype x environment' interaction. As can be observed, the yields close to 10 t ha^{-1} corresponded to the lines FL010129-12P-4-2P-3P-M, FL010164-7P-3-1P-1P-M, FL08224-3P-2-1P-3P-M and FL07562-7P-3-3P-2P-M, these last two of extra-long grain. Although the INIFLAR and INIFLAR RT varieties of medium grains (released by INIFAP in 2015), were located at the same level of significance, but their yields were slightly lower, while the yield of the Aztecas variety was the lowest expressed of all the genotypes evaluated (Table 4).

Table 4. Average yields of the 15 genotypes in the seven sites in which the ECR 2015 was established to determine the 'genotype x environment' interaction.

Genealogies	Yield (t ha^{-1})
FL04867-2P-7-3P-3P-M	8.121 ab

Genealogies	Yield (t ha^{-1})
FL04952-1P-5-1P-1P-M	9.153 ab
FL06747-4P-10-5P-3P-M	9.071 ab
FL08224-3P-2-1P-3P-M	10.1 a
FL06689-3P-1-4P-M	9.164 ab
FL06679-3P-5-3P-M	9.376 ab
FL010164-7P-3-1P-1P-M	9.835 ab
FL08378-3P-5-2P-2P-M	8.658 ab
FL010129-12P-4-2P-3P-M	9.987 ab
FL07562-7P-3-3P-2P-M	9.825 ab
FL07162-7P-3-3P-3P-M	9.438 ab
INIFLAR R	8.592 ab
INIFLAR RT	8.854 ab
El Silverio	7.476 b
Aztecas	9.49 ab

Means followed by the same letter within columns do not differ statistically (Tukey *p*= 0.05).

On the other hand, the stability levels of the 15 genotypes evaluated in the seven sites are presented in Table 5. It is noteworthy that the lines FL08224-3P-2-1P-3P-M and FL07562-7P-3-3P-2P-M presented a capacity to adapt in all the evaluated environments, since they were reported with acceptable stability levels with average yields of 10.1 and 9.530 t ha^{-1}, respectively. Some other lines, although with good yields, were also stable but not in all environments. INIFLAR R, INIFLAR RT and Silverio, are also stable in all environments, although with lower performance. The Aztecas variety and the line FL06747-4P-10-5P-3P-M have yields higher than 9 t ha^{-1}, but they are only stable in favorable environments (Table 5).

Table 5. Stability parameters of 15 rice genotypes thin long grain integrated Third ECR 2015, cycle S-S 2015.

Genealogies	Yield (t ha^{-1})	Standard deviation	Stability levels
FL04867-2P-7-3P-3P-M	8.12	-5.31	Stable
FL04952-1P-5-1P-1P-M	9.15	-5.64	Stable
FL06747-4P-10-5P-3P-M	9.07	-5.62	Stable in favorable environments
FL08224-3P-2-1P-3P-M	10.1	-5.29	Stable in all environments
FL06689-3P-1-4P-M	8.59	-2.7	Stable
FL06679-3P-5-3P-M	9.38	-3.88	Stable
FL010164-7P-3-1P-1P-M	9.7	-5.19	Stable
FL08378-3P-5-2P-2P-M	8.66	-3.23	Stable
FL010129-12P-4-2P-3P-M	9.99	-4.17	Stable
FL07562-7P-3-3P-2P-M	9.53	-4.6	Stable in all environments
FL07162-7P-3-3P-3P-M	9.44	-4.56	Stable
INIFLAR R	8.59	-4.87	Stable in all environments
INIFLAR RT	8.85	-1.63	Stable in all environments

El Silverio	7.48	-3.08	Stable in all environments
Aztecas	9.49	-2.93	Stable in favorable environments

Main morphological and agronomic characteristics of the lines FL07562-7P-3-3P-2P-M and FL08224-3P-2-1P-3P-M.

The identification of morphological, agronomic and industrial characteristics is of great importance for the purpose of being used in the decision-making related to this activity (Bajracharya *et al*., 2006; Tavitas and Hernández, 2007), this was done through the application of the descriptors recommended by the International Center for Genetic Resources (IRGC, 1980) of the IRRI in the Philippines, and the International Union for the Protection of New Plant Varieties (UPOV, 2004). Therefore, in Table 6, lines FL07562-7P-3-3P-2P-M and FL08224-3P-2-1P-3P-M present their main characteristics.

Table 6. Main morphological and agronomic characteristics of the lines FL07562-7P-3-3P-2P-M and FL08224-3P-2-1P-3P-M.

Characteristic	FL07562-7P-3-3P-2P-M	FL08224-3P-2-1P-3P-M
Leaves	Greens with intermediate pubescence	Greens, very pubescent
Stem angle and vigor	Intermediate (stems not thick, but with elasticity)	Strong (semi-erect)
Leaf banner (leaf angle banner)	Erect	Erect
Carriage of stem	Intermediate (intermediate height)	Intermediate
Knot color and internode	Light green	Light green
Panicle extraction	Fair (found between flag leaf and the stem)	Fair
Grain	No edge	No edge
Caryopsis	Extra-long fusiform shape, white color without aroma	Extra-long fusiform shape, white, without aroma
Days to flowering	113	113
Days to physiological grain maturity	135	135
Phenotypic acceptability	Semi-compact plant	Semi-compact plant
Degree of tillering	Medium	Medium
Response to lodging	Resistant	Resistant
Height of the plant	99 cm	101 cm
Response to the new disease ‘Stain of the grain’	Moderately resistant	Moderately resistant
Response to the disease ‘Burning of rice’ (*Pyricularia oryzae*)	Resistant	Resistant
Response to the sogata-VHB complex (white leaf virus)	Resistant	Resistant
Type of grain	Extra long thin	Extra long thin

Stability in dry tropics and humid tropics	Stable in all environments	Stable in all environments

Industrial grain quality of the lines FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-1P-3P-M-150pZa-250pZa

Mill quality

In line FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za the weight of 1000 polished grains was 22.4 g on average, with the recovery of whole polished grains of 60.5%. According to the length (7.6 to 7.9 mm), width (1.9 to 2 mm) and length/width ratio (3.7 to 4 mm), the grain was classified as extra-long thin with a crystalline appearance, which is why it is considered good milling quality and the type of grain that is required. In contrast, in line FL08224-3P-2-1P-3P-M-150pZa-250pZa, the weight of 1000 polished grains was 21.1 g on average, with the recovery of whole polished grains of 62%, its grain was classified as extra-long slim with 100% crystalline appearance.

Culinary quality

The gelatinization temperature of the polished grains of line FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za was low, while the amylose content was 30%, which is considered high. In the tasting test of cooked grains, they had a weak aroma and flavor, a tender and shiny appearance, they were well separated, and they were chewable with good appearance, so their culinary quality was rated as good (INIFAP, 2016a). According to the physico-chemical characteristics of the polished grain, the culinary quality of the line FL08224-3P-2-1P-3P-M-150pZa-250pZa is considered good, since it presents a low gelatinization temperature, the amylose content it is high (30%), the flavor and aroma of the cooked grains is weak; in addition, the grains remain partially separated and elongated, tender, moderately bright, moist, chewy with good appearance (INIFAP, 2016a).

Proposal for the release and registration of the lines FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-1P-3P-M-150pZa-250pZa

After carrying out the morphological, agronomic and industrial quality characterization of the lines FL07562-7P-3-3P-2P-M-150pZa-250pZa-0Za and FL08224-3P-2-1P-3P-M-150pZa-250pZa, in 2016, both genotypes were proposed to the National Seed Inspection and Certification Service (SNICS) for release and registration as new varieties. The first with the name of Pacífico FL15 (key ARZ-026-010716), and the second, as Golfo FL16 (key ARZ-025-010716) (SNICS, 2015). Simultaneously, in the Experimental Field Zacatepec two lots were established for the production of basic seed of both varieties, in which 2 420 kg of Pacífico FL15 and 2 100 kg of Golfo FL16 seeds were obtained, which in October 2016 were delivered to the Mexican Rice Council, AC, for the start of two registered seed production programs.

Discussion

The productivity of the Pacífico FL15 and Golfo FL16 varieties was 65.7 and 67.8 kg of grain per day (INIFAP, 2016b). With the variety Pacífico FL15, an average yield of 9.2 t ha^{-1} is obtained, which represents increases of 2.6 and 3.7 t ha^{-1} of paddy rice with respect to the Aztecas commercial varieties (6.6 t ha^{-1}) and Filipino Miracle (5.5 t ha^{-1}) of the ECR. On the other hand, with the Golfo FL16 variety, an average yield of 9.5 t ha^{-1} is obtained which represents increments of 2.9 and 4 t ha^{-1} of paddy rice with respect to the commercial Aztecas and Filipino Miracle varieties of the ECR. In addition, with the varieties Pacífico FL 15 and Golfo FL 16, the recovery of whole polished grains increases between 9 and 33% in relation to commercial varieties (García *et al*., 2011).

Another advantage of these varieties is that they have a high spectrum of resistance to the sogata-VHB complex (white leaf virus) and the endemic ‘rice burning’ disease (*Pyricularia oryzae*), as well as moderate resistance to the new disease ‘spotted grain’, caused by *Helminthosporium oryzae* in association with other pathogens, and stem borers (*Chilo loftini*, *Rupela albinella* and *Diatraea saccharialis*) (Hernández *et al*., 2013; Tapia *et al*., 2013). In addition, both varieties are distinguished by their extra-long grain with excellent milling quality and good culinary quality, so they can compete with the types of grain that are being imported from Thailand and Vietnam (Tolentino, 2014).

The multi-environmental varieties are of high potential yield, stable in the ecosystems of both coasts, resistant to lodging, shelling and diseases that attack this crop nationwide, with long thin grain of good industrial quality, are competitive with rice of import of this same type of grain. In addition, they will contribute to the expansion of the area and increase the production of rice with this type of grain, being a reference to counteract the import volumes of thin long grain rice, restoring the sources of work in the field and in the industry rice.

Conclusions

They were selected, purified, biometrically evaluated and released Pacífico FL 15 and Golfo FL 16, two varieties of thin long grain rice with high and stable yield potential, resistant to ‘rice burning’ and the sogata-(VHB) complex, with moderate resistance to the new disease ‘spotted grain’, to borers of the stems, and with good industrial grain quality. The multi-environmental variety Pacífico FL 15 is stable in all environments of the humid tropics of the Gulf of Mexico and the dry tropics of the Pacific Ocean. It can be grown under irrigation in both slopes, but it has greater potential in the Pacific slope. The Golfo FL 16 variety is also multi-environmental and stable in all environments of the humid tropics of the Gulf of Mexico and the dry tropics of the Pacific slope. It can be cultivated in both slopes, but it has greater potential in the plains of the Gulf of Mexico.

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