Cultivos Tropicales, 2015, vol. 36, no. 2, pp. 131-141 DOI: 10.13140/RG.2.2.30260.45448
http://dx.doi.org/10.13140/RG.2.2.30260.45448 April-June

ISSN print: 0258-5936
ISSN online: 1819-4087

INCA
Ministry of Higher Education. Cuba
National Institute of Agricultural Sciences
http://ediciones.inca.edu.cu

MORPHOAGRONOMIC EVALUATION OF TRADITIONAL RICE CULTIVARS (*Oryza sativa* L.) COLLECTED IN GROWER FARM FROM PINAR DEL RÍO PROVINCE

Evaluación morfoagronómica de cultivares tradicionales de arroz (*Oryza sativa* L.) colectados en fincas de productores de la provincia Pinar del Río

Sandra H. Díaz Solís[1]✉, Rogelio Morejón Rivera[1], Donessa Lucinda David[2] and Rodolfo Castro Álvarez[1]

ABSTRACT. The research was conducted in Unidad Científico Tecnológica de Base (UCTB) Los Palacios belonging to the Instituto Nacional de Ciencias Agrícolas (INCA), with the aim of contributing to the enrichment and genetic diversity conservation of rice (*Oryza sativa* L.) by morphoagronomic characterization of traditional cultivars collected in grower farm from Pinar del Río province. Were evaluated a total of 13 cultivars, including 11 traditional and two improved using a randomized complete design with five repetitions. . In the development of the investigation twenty-five descriptors were used that included qualitative and quantitative characters, which were measured in flowering, ripening and postharvest stages crop. The obtained data were subjected to univariate and multivariate statistical analysis. Differences between cultivars for qualitative and quantitative characters were found. Were detected in the genotypes Andres, Bluebonnet, Estrella Roja and Caracol, interest characters such as earliness, plant erection, panicle length, compact and well emerged panicles, tillering capacity and slow senescence that could contribute to make progress rice genetic improvement.

Key words: rice, germplasm, traditional varieties, characterization, descriptors

RESUMEN. La investigación se desarrolló en la Unidad Científico Tecnológica de Base (UCTB) Los Palacios perteneciente al Instituto Nacional de Ciencias Agrícolas (INCA), con el objetivo de contribuir al enriquecimiento y conservación de la diversidad genética del cultivo del arroz (*Oryza sativa* L.) mediante la caracterización morfoagronómica de cultivares tradicionales colectados en fincas de productores de la provincia Pinar del Río. Se evaluaron en total 13 cultivares, de ellos 11 tradicionales y dos mejorados, utilizando un diseño de campo Completamente Aleatorizado con cinco repeticiones. Se emplearon 25 descriptores que incluyeron caracteres cualitativos y cuantitativos, los cuales fueron medidos en las etapas de floración, maduración y postcosecha del cultivo. Los datos obtenidos fueron sometidos a análisis estadísticos univariados y multivariados. Se encontraron diferencias entre los cultivares estudiados, tanto para los caracteres cualitativos como para los cuantitativos. Se detectaron en los genotipos Andres, Bluebonnet, Estrella Roja y Caracol caracteres de interés tales como precocidad, porte de la planta, longitud de la panícula, panículas compactas y bien emergidas, capacidad de macollamiento y senescencia tardía que pudieran contribuir a obtener progresos en el mejoramiento genético del arroz.

Palabras clave: arroz, germoplasma, variedades tradicionales, caracterización, descriptores

INTRODUCTION

Rice ranks second worldwide after wheat in area harvested; but considering its importance as a food crop, it provides more calories per hectare than any other crop of cereals. Rice is the staple food for about 50 % of the world population. Although this grain is

[1]Instituto Nacional de Ciencias Agrícolas (INCA), gaveta postal 1, San José de las Lajas, Mayabeque, Cuba, CP 32700.

[2]Ministerio de la Agricultura de Guyana. 18 Brickdam, Georgetown, Guyana.

✉ shdiaz@inca.edu.cu

produced and consumed largely in Asia, it is planted commercially in more than 100 countries and on every continent except Antarctica (1, 2).

Genetic diversity is the basis of the plant breeding progress and genetic resources include diversity contained in primitive cultivars, traditional, wild relatives and improved now and in the future may be used for food and agriculture. Plant genetic resources that are of vital importance are being seriously threatened worldwide traditional rice cultivars and wild rice species are being lost because of genetic erosion. Farmers often adopt new and modern rice cultivars that produce more grain in less time than traditional and not traditional cultivars planted they had cultivated for generations. Seeds of ancient cultivars often are forgotten and many of those traditional lost. However, in the future, plant breeders need genetic variation that traditional cultivars and wild relative genres have, to face many adverse factors, both biotic and abiotic, that put at risk rice production for this generation and future ones(3).

The narrow genetic base of rice grown in Cuba constitutes a barrier to the performance and sustainability of this culture, this genetic uniformity also limits the ability and plasticity to neutralize effects of biotic and abiotic changes to the culture is exposed. Strategies for improvement in modern plants of agricultural interest invariably require the incorporation of new cytoplasmic sources and new genetic basis of resistance (4).

In Cuba the cooperative and agricultural sector planting a considerable number of cultivars including traditional. The collection of these local varieties that producers have traditionally planted and preserved is the aspiration of breeders working in farming in order to increase the existing national gene center. The selection made by producers rudimentarily and almost unconsciously they have generated the existence of many cultivars that are exploited in this sector and possess appropriate genes for different biotic and abiotic conditions.

Given the above, this study aims to make a morphoagronomic assessment to traditional rice cultivars, to determine the most important variables for the characterization of genotypes and to identify characters, potentially important, to introduce or incorporate into new cultivars.

MATERIALS AND METHODS

Trial location

The test was carried out during the cold seasons 2010-2011 and 2011-2012 in the Scientific Technological Base Unit (UCTB) Los Palacios, belonging to the National Institute of Agricultural Sciences (INCA), on a Petroferric Nodular Gley soil (5).

Vegetable material

The plant material studied consists on a total of 13 genotypes, including 11 traditional cultivars of rice (*Oryza sativa* L.) collected in farms of three locations in Pinar del Rio province and also two improved cultivars were included, obtained in the scientific institution where the study was performed (Table I).

Table I. List of studied crops and their origin

No	Cultivars	Origin
1	Caracol Dima	Mantua
2	Caracol	Mantua
3	Pulla	Mantua
4	¾ Pulla	Mantua
5	Estrella Roja Especial	Mantua
6	220	La Palma
7	Agustín 1	La Palma
8	Agustín 2	La Palma
9	Andrés	La Palma
10	Frances	San Juan y Martínez
11	Bluebonnet	San Juan y Martínez
12	INCA LP-4	UCTB Los Palacios
13	INCA LP-5	UCTB Los Palacios

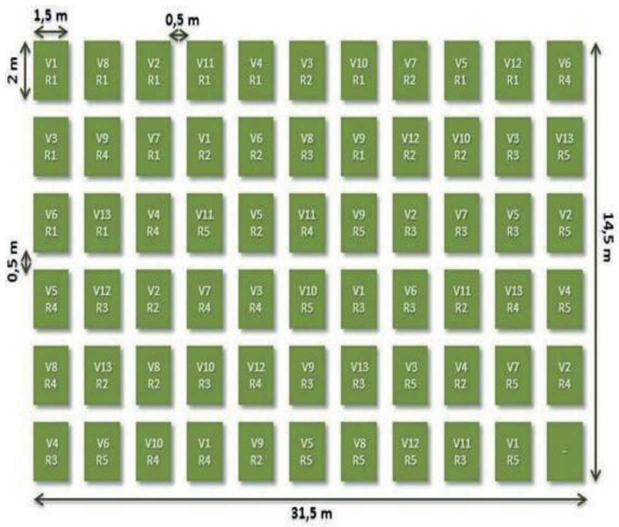
Experimental Design

A completely randomized design was used with five repetitions and cultivars were the treatments, they are sown in the field directly to trickle in plots of 2 meters long and 1,5 meters wide (3 m^2) at a distance 15 cm between rows and 50 cm between plots (Figure 1).

Field phase

Agro-technical work (land preparation, planting, fertilizing, irrigation and pesticide treatments) were performed in both campaigns during the crop cycle, according to the provisions of the Rice Technical Instructions (6).

Experimental design



(V = variety, R = repetition)

Figure 1. Design of the experimental area

Laboratory phase

Some field samplings were subsequently processed in the laboratory (observation of qualitative characters, counting, measuring and weighing of quantitative trait samples). Furthermore, it took effect tabulating the data and its statistical analysis.

Sample taking

25 variables at different stages of cultivation (flowering, ripening and post-harvest) were evaluated that included both qualitative and quantitative characters (Table II) using methodologies as: Standard Assessments System for Rice (7), CIAT Varietals Descriptors (8) and Varietal Description Form for Rice (9).

Whenever, observations were made in 10 randomly selected plants in each plot. For qualitative variables the mode value was taken and for quantitative variables was assigned the average value of made measurements.

Panicles per square meter also were sampled once per parcel, within a framework of 0,1 m^2. The remaining components (filled grains / panicle and 1000 grain mass) were determined in 20 plants randomly taken panicles and agricultural crop yield was calculated on an area of 1 m^2.

Table II. Variables evaluated in different stage of culture

Qualitative		Stage
1	Plant erection (PE)	Flowering
2	Intensity of color green leaf (IL)	Flowering
3	Tillering capacity (TC)	Flowering
4	Anthocyanin coloration (AC)	Flowering
5	Form of ligule (FL)	Flowering
6	Color of ligule (CL)	Flowering
7	Edges (ED)	Postharvest
8	Panicle exertion (PE)	Maturation
9	Density of panicle (DP)	Maturation
10	Lodging resistance (LR)	Maturation
11	Shatterring resistance (SHR)	Maturation
12	Leaf senescence (LS)	Maturation
13	Paddy grain color (GC)	Maturation
14	Flag leaf blade erection (FL)	Flowering
15	Panicle erection in relation to the stem (PS)	Maturation
Quantitatives		**Stage**
1	Panicle length (PL)	Postharvest
2	Number of filled grains per panicle (FG)	Postharvest
3	Number of unfilled grains per panicle (UG)	Postharvest
4	Length of flag leaf blade (LFL)	Flowering
5	Width of flag leaf blade (WL)	Flowering
6	Ligule Length (LL)	Flowering
7	Mass of 1000 paddy grains (MG)	Postharvest
8	Number of panicle per m2 (PM)	Maturation
9	Yield (YD)	Postharvest
10	Crop cycle (C)	Flowering

Data analysis and statistical methods

Upon completion of counting and measuring variables proceeded to the tabulation and data organization obtained for each experimental unit for analysis using STATGRAPHICS Plus v. 5 statistical program, which allowed for analysis of simple classification variance (ANOVA); stockings also underwent Tukey test at 5 %. On the basis of the divergence found, the array of quantitative obtained data (genotypes in the study per analyzed variables) was also submitted to Multivariate Principal Component Analysis and Cluster using the SPSS v.17 statistical program; addition Pearson correlations were determined. Qualitative variables are presented in tabular form and described to facilitate comparison among studied cultivars.

RESULTS AND DISCUSSION

Analysis of qualitative characteristics

Table III shows the characterization of the genotypes considering qualitative characteristics, in the same shows that these presented homogeneity in three of them, corresponding to the intensity of leaf green (dark green), the absence of anthocyanin coloration was not observed in any organ or part of the plant and the shape of the ligule in all varieties was split type. Differences for the other characteristics were found.

Table III. Description of qualitative characters of 13 rice cultivars, studied in Pinar del Rio, Cuba

Cultivars	PE	IL	TC	AC	FL	CL	ED	PE	DP	LR	SHR	LS	GC	FL	PS
Caracol Dima	I	DG	S	AB	C	WY	PR	ME	I	I	I	I	ST	HZ	LC
Caracol	I	DG	S	AB	C	WY	PR	ME	I	I	I	T	PM	SE	LC
Puya	O	DG	S	AB	C	WY	PR	ME	I	I	DF	I	ST	HZ	STP
Estrella Roja	E	DG	S	AB	C	WY	PR	WE	I	R	DF	T	ST	SE	LC
220	O	DG	S	AB	C	WY	PR	ME	I	S	DF	TP	ST	SE	STP
¾ Puya	O	DG	I	AB	C	WY	PR	ME	I	R	DF	T	ST	HZ	STP
Agustín 2	I	DG	P	AB	C	WY	PR	ME	O	R	EA	TP	ST	SE	SE
Agustín 1	I	DG	I	AB	C	W	AB	ME	I	I	EA	I	ST	RC	ST
Andrés	E	DG	P	AB	C	WY	PR	EM	I	R	DF	TP	ST	E	SE
Frances	D	DG	P	AB	C	W	PR	EM	O	I	I	I	ST	SE	LC
Bluebonnet	O	DG	P	AB	C	WY	AB	ME	CP	S	I	I	ST	HZ	ST
INCA LP-4	E	DG	S	AB	C	WY	AB	WE	SC	R	DF	T	ST	E	LC
INCA LP-5	E	DG	S	AB	C	W	PR	WE	SC	R	DF	T	ST	E	SE

O: Open; WY: Whitish Yellow; AB: Absent; W: White; WE: Well Emerged; CP: Compact; D: Dispersed; DF: Difficult; E: Erect; EM: Emerged; S: Strong; ES: Easy; STP: Strongly pendant; C: Cloven; HZ: Horizontal; I: Intermediate; SLP: Slightly Pendant; ME: Moderately Emerged; P: Poor; ST: Straw; PM: Brown lists on straw; PR: Present; R: Resistant; RC: Recurved; S: Susceptible; SC: Semicompact; SE: Semierect; T: Tardive; EA: Early; LG: Light Green; DG: Dark Green

It is stated that one of the most heterogeneous phenotypic manifestations that occur in rice is the coloration variability of various organs or plant parts: small glumes, leaf and stem, stigma and the caryopsis pericarp.

The presence of anthocyanin pigments is a varietal character which is expressed in different ways, depending on environmental conditions, the pigment is confined to the epidermis or also reaches vascular bundles and it is not related to crop development, resistance, performance or other important character of growth or rice quality. In a similar study in India to characterize 782 accessions taking into account morphological and agronomic characters was also found that most of characters showed variation, but some like ligule shape, plus more than 80 % of cultivars was absent anthocyanin pigmentation in all plant organs and 60 % classified as dark green as to the intensity character of leaf green color (10).

With respect to variability in plant erection (PE) or the tiller, also named growth habit is observed that improved cultivars INCA LP-4 and INCA LP-5 alongside traditional ones as Estrella Roja and Andrés showed an erect plant. In the same amount open and intermediate erection (both with 30,76 %) they are represented. Only the Frances cultivar exhibited a dispersed erection. An erection with erect leaves is an important agronomic character to produce high yields because this type of plant tolerates high planting density and achieves a photosynthesis optimization, because solar radiation also insides lower leaves. Other authors when assessing the variability in the rice germplasm report that cultivars showed a greater tendency to plants with erect and semi-erect growth habit, whose opening angles are between 10 and 30° with respect to an imaginary perpendicular line passing through the plant center (11, 10).

Tillering capacity (TC) strongly characterizes more than 50 % of the genotypes with averages between 15 and 20 children per plant. Cultivars Agustin 1 and 3/4 Puya had an intermediate behavior with average between 12 and 14, while the poor tillering occurred between 7 and 10. The tillering is a determining factor in the production of panicles and therefore affects the performance. In addition, the varietal component is very important at this stage since the production of stems in rice cultivation largely responds to genotypic factors, distinguishing varieties with low and high tillering capacity. In different improvement programs has been considered this parameter as an element to consider in the design of a kind of plant very productive[A], also it states that the production of children is directly proportional to the density of the panicle, so it is very performance-related (12).

In relation to color of ligule character (CL), 10 cultivars showed a whitish yellow coloring while only Augustin 1, Andrés and INCA LP-5 showed white or whitish. It is known that both the color and the shape of the ligule unimportant for selection in genetic improvement programs; however, they are useful to differentiate plant rice seedling stage of some weeds, especially those with greater similarity with rice and *Echinochloa crusgalli* (*Arrocillo*), *Echinochloa colona* (Metebravo) *Leptocloa virgata* (nib), *Ischaenum rugosum.* (Leg Cao).

[A] Martínez Eixarch, María T. Caracterización y optimización del ahijado del arroz en el Delta del Ebro. [Tesis de Doctorado] Universidad Politécnica de Valencia, 2010. 296 pp.

Most cultivars had edges (ED) except Augustine 1, Bluebonnet and INCA LP-4; but it should be noted that generally were short and were located in terminal spikelets.

The presence of edges is an undesirable characteristic because they are hard, persistent and disadvantages for the shelling and milling, being conditioned by three dominant genes, where the recessive produce absolutely muticate genotypes, while their interaction determines a different degree of longitude and presence of edge, taking into account the influence of climatic factors governing the phenomenon extent, both in length and intensity (1).

With respect to the predominant exertion of panicle (PE), 61,5 % of moderately cultivars had emerged panicles, while Estrella Roja and commercial INCA LP-4 and INCA LP-5 well presented panicles emerged, meanwhile those of Andrés and Frances cultivars emerged classified as not meeting panicles included or partially included.

The exertion panicle is considered as an important character in the selection of cultivars because they fully emerge from the flag leaf is less prone to bad filled spikelet and pathogen attack on the base of the panicle. Environmental factors mainly low temperatures and fungal type diseases can contribute to this defect although it is commonly regarded as a genetic cause.

In the case of panicle density character (DP) Bluebonnet cultivar presented only compact panicles, INCA LP-4 and INCA LP-5 predominating semi-compact ones while other genotypes had panicles of intermediate type, except Augustine 2 and the Frances cultivars with open panicles. It states that the ideal is to obtain cultivars with compact panicles, which is regarded as feature selection by breeders.

As to lodging resistance (LR), six cultivars behaved as resistant and five showed intermediate resistance while Bluebonnet and 220 were susceptible, which could be due mainly to its great height and weak stems The lodging is influenced by excess nitrogen fertilizer, the action exerted on the stem some pathogens and climatic factors such as wind and rain, in addition to the intrinsic genetic characteristics of the variety. Others when they studied the behavior and the genetic control of different characters related to lodging resistance of rice, to analyze whether it is possible to increase efficiency in the selection of these characters so they can be appropriate for a program marker assisted selection (MAS), detected Quantitative trait loci (QTLs) that simultaneously affect several characters, they located areas of special interest that could be used to MAS and selection was effective in reducing the height, both the thickness and increase the length of the basal internodes and increase the number of panicles and the bending resistance (13).

Regarding resistance to shattering (SHR) seven cultivars classified as difficult threshing with a few grains detached four behaved as intermediates percentages between 25 and 50 and two were easy shattering with percentages over 50 %. It is known that this character is influenced by environmental conditions and it is considered important in Breeding Programs for yield losses occur. Similar results were obtained by other authors[A], suggesting that selection for this trait is directed to cultivars that are not easily shelled, types with intermediate resistance are ideal when the harvest is done mechanically, because they threshed better and less grain loss.

For the color of the grain (GC), all cultivars were had a straw coloring, except Caracol, presenting lists of brown straw color. In similar studies involving larger number of cultivars to assess, five types of grain coloration were observed, although the straw color predominated (15).

When the wearing of flag leaf blade (HB) was observed only improved cultivars INCA LP-4 and INCA LP-5 and traditional one, Andres showed an erection, five genotypes presented the semi-erect, while Caracol Dima, Puya 3/4, Puya and Bluebonnet horizontally and Augustin 1was recurved.

In this regard it is proposed that a plant erection with erect leaves is an important agronomic to produce high yields because this type of plant supports high planting density and basal nodes receive more solar radiation in these culture conditions. Erect leaves are caused by a gene conferring insensitivity brassinosteroids group hormones regulating cell division and differentiation. Several types of genes are currently used in rice breeding for regulating plant architecture (16). Also, it is known that for optimizing photosynthesis is necessary to select crops with leaves that are not fully horizontal to allow radiation also impinges on lower leaves.

In analyzing the panicle erection in relation to the stem (PS) no cultivar presented erect panicles. In this case INCA LP-5, Andrés and Augustin showed a semi erect position. Slightly pendant proved the INCA LP-4 and Frances, Estrella Roja, Caracol and Caracol Dima; while the strongly pendant had Puya, 220, 3/4 Puya, Agustin 1 and Bluebonnet.

ANALYSIS OF QUANTITATIVE CHARACTERISTICS

Statistical analysis showed significant differences for all characters (Table IV). The length of the panicle (LP) presented an average of 22,19 cm, minimum and maximum were 18,57 and 32,35 corresponding to Augustin 1 and Bluebonnet, respectively. Other studies also Bluebonnet cultivar has reached the highest values for this trait (17). These variations in the nature panicle length may be associated to characteristics of the parents that gave rise to cultivars and it is also found that this character can be highly influenced by the environment. In two studies of the same type wide ranges of variation for this trait stockings 22,56 and 27,13 cm are reported (11, 10).

The number of filled grains (FG) ranges between 53 and 81, being INCA LP-5 the best performing, although no significant difference INCA LP-4, 3/4 Puya, Estrella Roja and Bluebonnet. The remaining genotypes showed the lowest values for this character without significant differences among them. The number of filled grains per panicle is considered an important component for good yields and weather conditions may be the cause of a greater number of grains to form. Other authors have reported that filled grains per panicle showed the highest coefficient of phenotypic variation (18, 11).

Spikelets fertility is an obvious requirement for high yields. Several causes that provoke rice barren grains are known, among these are those related to plant health (different causal agents, use of hormonal herbicides in the fertilization stage and grain filling) but also appear, agrochemical (insufficiency or excess nitrogen, micronutrients deficiency), genetic (not full emergence of the panicles and capacity fertilization) and climate (relative humidity, strong and dry winds, drought and temperature).

In research conducted in India to assess seventy one local aromatic rice cultivars sterility percentage of 14,08 % was found (11).

The length of the flag leaf (LFL) has an average of 30,63 cm. The Caracol, Puya genotypes Bluebonnet and were the ones with the longest leaves and Augustin 1 had the smallest leaves, with a difference of 18, 78 cm from Puya.

Bluebonnet had wider flag leaves with significant differences with other cultivars and Puya reached the lowest value for this character. It argues that the flag leaf length is variable and can be affected by nutritional deficiencies and high densities. It is known that increased photosynthetic area may represent increased production of carbohydrates and consequently greater accumulation of these grains in panicle as starch, which promotes grain filling and therefore increased production.

Table IV. Variance Analysis of simple classification (ANOVA) for quantitative variables studied in 13 cultivars of rice in Pinar del Rio, Cuba

No.	Varieties	LP (cm)	GL (No.)	GV (No.)	LH (cm)	AH (cm)	LL (cm)	MG (g)	PM (No.)	RT (t ha^{-1})	C (days)
1	Caracol Dima	19,84 cd	56,21 e	19,17 bcd	26,66 ef	1,24 bcd	2,60 ab	27,07 e	220,0 f	3,10 e	160 a
2	Caracol	19,55 cd	53,54 e	17,56 cd	37,96 a	1,23 bcd	2,10 de	24,46 h	237,5 e	2,80 e	155 ab
3	Puya	21,26 c	63,37 cde	13,82 def	39,30 a	1,00 d	2,30 cd	25,64 fg	292,5 d	3,80 d	157 ab
4	Estrella Roja	21,07 cd	74,55 abc	8,23 f	28,70 cd	1,46 b	2,04 e	28,92 c	310,0 c	4,80 c	146 cd
5	220	21,48 c	64,65 cde	27,19 a	30,00 c	1,45 b	2,40 bc	29,63 bc	295,0 d	3,95 d	154 b
6	3/4 Puya	21,45 c	74,83 abc	18,83 bcd	27,70 de	1,10 cd	1,90 ef	24,92 gh	150,0 i	2,80 e	157 ab
7	Agustín 2	25,75 b	61,07 cde	23,74 abc	30,65 c	1,50 b	1,37 g	21,34 j	175,0 h	2,25 f	140 ef
8	Agustín 1	18,57 d	66,88 bcde	27,84 a	20,52 g	1,55 b	0,82 h	24,42 h	205,0 g	2,90 e	142 de
9	Andrés	19,54 cd	59,86 de	22,41 abc	25,13 f	1,30 bcd	1,45 g	25,92 f	160,0 i	2,00 fg	128 g
10	Frances	20,66 cd	56,80 e	25,15 ab	28,69 cd	1,44 bc	1,68 f	22,31 i	107,0 j	1,70 g	136 f
11	Bluebonnet	32,35 a	71,00 abcd	17,00 cde	38,30 a	2,15 a	0,92 h	28,10 d	115,0 j	3,80 d	148 c
12	INCA LP-4	26,40 b	79,00 ab	10,00 ef	35,50 b	1,20 bcd	2,80 a	34,00 a	325,0 b	5,30 b	140 ef
13	INCA LP-5	21,50 c	81,25 a	10,00 ef	29,10 cd	1,40 bc	1,68 f	29,80 b	375,0 a	6,10 a	127 g
Medium		22,19	66,39	18,53	30,63	1,38	1,85	26,66	228,2	3,48	145,4
Standard Error		0,472692	1,30419	0,877022	0,682154	0,0395819	0,0740681	0,414425	10,2954	0,158893	1,34945
CV (%)		17,177	15,8389	38,1503	17,9544	23,0732	32,2706	12,5344	36,381	36,7626	7,48331

Mean with the same letter do not differ (p≤0,05)

Regarding the length of the ligule (LL) cultivars were the INCA LP-4 and Caracol Dima who had the bigger, while smaller ones characterized Bluebonnet and Augustin 1 without significant differences between them, respectively. Ligule is considered a distinctive feature of grasses, consisting of a short, downy or membranous prolongation which is located between the sheath and the leaf blade; it can differ in size, color and shape depending on the cultivar. Its function remains unknown, but may serve to prevent moisture from entering the area between the stem and the sheath. Sometimes the absence of ligule is showed, as a particular gene expression (1).

The 1000 grain mass character (MG), also known as 1000 grain weight varied between 21, 34 g and 34, 00 g. The highest value was showed in INCA LP-4 improved farming and the lower one in Augustin 2. It is reported that the high weight of 1000 grains is a distinctive characteristic of the cultivar INCA LP-4, overtaking Cuba's current cultivars (19). In assessing the behavior of this nature in rice accessions, other authors found that most had weights between 21 and 25 g, although some cultivars showed higher 1000 grain weight (over 30 g) and one reached the value of 43,2 g.

The 1000 grain weight is a genetic trait, this trait is stable in good growing conditions and mainly depends on the cultivar, but an increase in yield can be achieved by selecting materials of higher grain weight.

The INCA LP-5 culture has the highest number of panicles per square meter (PM) with significant differences compared to other cultivars and behavior continued in INCA LP-4, in contrast, Frances and Bluebonnet had the lowest values, without statistically significant differences between them. Panicles per square meter are the most variable component and have been the main cause which has limited agricultural yields in Cuba conditions. Their values are closely related to the quality of soil preparation and planting, planting standard, tillering capacity of cultivars, water management and nitrogen fertilization (6).

As the cycle of cultivars (C), the average was 145 days, they stand with the shortest period, INCA LP-5 and Andrés, differing statistically from the rest, while the longer duration of the cycle was the common denominator in Caracol Dima, Caracol, and 3/4 Puya, Puya cultivars. It is known that the growth cycle begins with sowing and ends at the defined time horizon for 80 % of mature ears. Also it can divide the cycle into two parts: the first, from planting to flowering and the second, from flowering to ear maturation. Fertile conditions, temperature, photoperiod, etc, may change the rice growth cycle (1).

The rice germplasm varies widely in the total time required to maturation, allowing breeders to create appropriate conditions and cultural practices of each locality. It is stated that the life cycle of cultivars in the tropics is between 100 and 200 days; however, in commercial cultivars range between 100 and 150 days. Modern varieties have mostly a maturation time intermediate between early and late (20).

Yields (YD) had a large range of variability, with values ranging from 1,70 t ha^{-1} and 6,10 t ha^{-1}, corresponding to French and INCA LP-5 cultivars, respectively. They also showed good behavior in INCA LP-4 and Estrella Roja, followed by 220. In general, the rest of genotypes, yields were low, probably due to the few panicles per square meter and the high number of empty grains per panicle. Cultivars presented highly significant differences in yields, which may be due to the diversity of their genetic constitution.

In Table V correlations established among evaluated quantitative variables are presented. As can be seen the panicle length is correlated strong and positively with the wide flag leaf character. In other research in which it has also analyzed relationships among different characters correlation, these variables have found (17). The flag leaf width also was indirectly correlated with the ligule length. In this respect it is known that the "flag or panicular" leaf sometimes stays erect during flowering and it leans only in the full maturation.

Leaves at the base of the stem exert a trophic action essentially for the root system, flag leaf and the penultimate one play a greater extent than the others, a very important role for panicle and the grain (1).

Yield and its components had the highest correlations; it is strong and positively correlated with filled grains per panicle, the mass or weight of 1,000 grains and panicles per square meter. It also expressed a strong relationship, but reverse, with vain grains per panicle. In another study where the correlation between variables was analyzed, it was found that the yield was significantly associated with the number of panicles and the number of filled grains per panicle positively, this means that as more one increases the other too (21).

Table V. Matrix of phenotypic correlations among quantitative characters

	PL	FG	UG	LFL	WL	LL	MG	PM	YD
FG	0,358								
UG	-0,235	-0,598*							
LFL	0,550	0,007	-0,461						
WL	0,634*	0,119	0,180	0,020					
LL	-0,198	0,004	-0,394	0,307	-0,668*				
MG	0,279	0,658*	-0,597*	0,213	0,014	0,489			
PM	-0,187	0,475	-0,599*	0,158	-0,364	0,549	0,666*		
YD	0,244	0,788**	-0,754**	0,262	0,022	0,338	0,838**	0,839**	
C	-0,032	-0,266	0,031	0,327	-0,222	0,426	-0,052	-0,035	-0,101

* The correlation is significant at 0,05 level
** The correlation is significant at 0,01 level

Similarly, the vain grains per panicle showed an indirect relationship to the mass of 1000 grains and panicles per square meter characters, in turn, the latter also was correlated with the mass of 1000 grains. Also, full grains presented direct and indirect correlation with the mass of 1000 grains and vain grains respectively, that is, with increasing grain filled 1000 grain mass also increases, but decreases vain grains.

Table VI shows own values, contributions and cumulative percentages of components 1 and 2, considering the Principal Component Analysis that lets fix and graph the material under study in a small number of dimensions (22).

Table VI. Own values, contribution and cumulative percentages of C1 and C2 components and correlations with the original variables

	C1	C2
Own values	4,1481	2,3641
% contribution	0,415	0,336
% accumulated	41,5	75,1
PL	-0,122	0,494
FG	-0,358	0,268
UG	0,415	-0,018
LFL	-0,197	0,050
WL	0,083	0,577
LL	-0,269	-0,457
MG	-0,429	0,067
PM	-0,407	-0,195
YD	-0,466	0,103
C	-0,001	-0,294

The two components obtained explained 75,1 % of the total variation, the first component contributed more than 40 % of the total variance explained. Correlations with original variables indicate that filled grains per panicle, the mass or weight of 1,000 grains, panicles per square meter and yields were the variables that contributed negative and positively, vain grains per panicle. The second component contributed with more than 33 % of the total variance and variables as length of panicle, flag leaf width and ligule length, the latter negatively, they had the highest contribution. This indicates the usefulness of these variables may have in the differentiation of cultivars, to present the highest values of correlation to the main axes.

In Figure 2 a graphical representation of the components and cultivar and variable distribution is shown. By the position of the 13 evaluated cultivars, four groups were formed, the second located at the left end of component 1 is characterized by having individuals with values as yield, 1000 grain mass, filled grains per panicle and panicles per square meter, also have fewer vain grains per panicle. It is important to note that Estrella Roja had the highest similarity with commercial cultivars. Conversely cultivars that are in the group III were those who achieved highest values for vain grains per panicle.

Bluebonnet cultivar away from other genotypes at the upper end of component 2 (group IV) has the longest panicles and broader leaves.

The genotypes that are on the negative side of component 2 (group I) have longer ligules and a longer duration of cycle.

Variables with higher contribution, being more distant of origin, were found to be: yield, mass of 1000 grains and vain grains, followed by panicles per square meter full grains. The association degree between variables, determined by the angular separation forming projections, shows that the best partnerships are made up yield with the mass of 1000 grains.

In order to substantiate the grouping of genotypes, a Cluster Analysis was performed by allowing the search as homogeneous as possible similar groups to group items under study. Coinciding with the reading was performed in Figure 2. Average per variables and genotypes belonging to each formed class are observed in Table VII and the associated dendrogram appears in Figure 3.

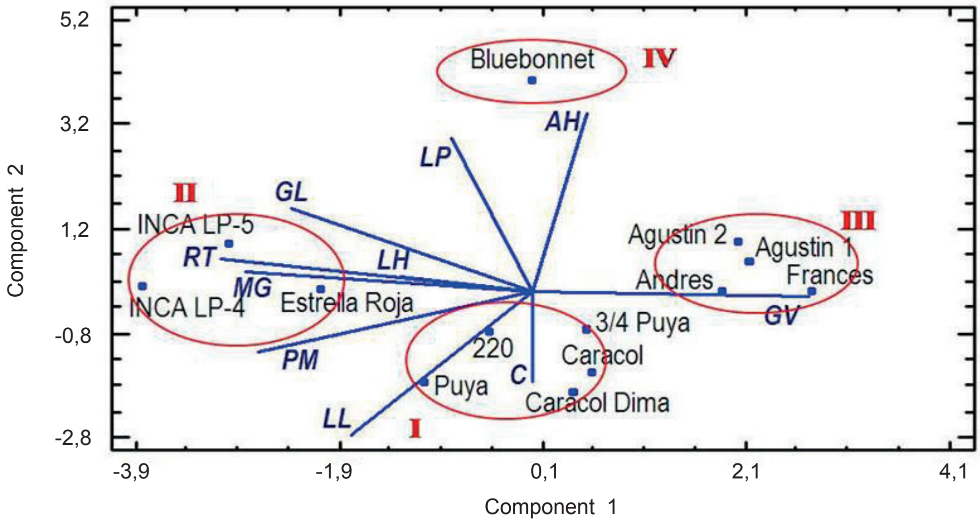


Figure 2. Distribution of cultivars and studied variables for the first two components

Table VII. Genotype distribution and average per class, depending on Cluster Analysis

Type	PL	FG	UG	LFL	WL	LL	MG	PM	YD	C
I	20,72	63	19	32,32	1,20	2,26	26,34	239	3,29	157
II	22,99	78	9	31,10	1,35	2,17	30,91	337	5,40	138
III	21,13	61	25	26,25	1,45	1,33	23,50	162	2,21	137
IV	32,35	71	17	38,30	2,15	0,92	28,10	115	3,80	148

Type	GENOTYPES	EFFECTIVE
I	Caracol Dima, Caracol, Puya, 220, 3/4 Puya	5
II	Estrella Roja, INCA LP-4, INCA LP-5	3
III	Agustín 2, Agustín 1, Andrés, Frances	4
IV	Bluebonnet	1

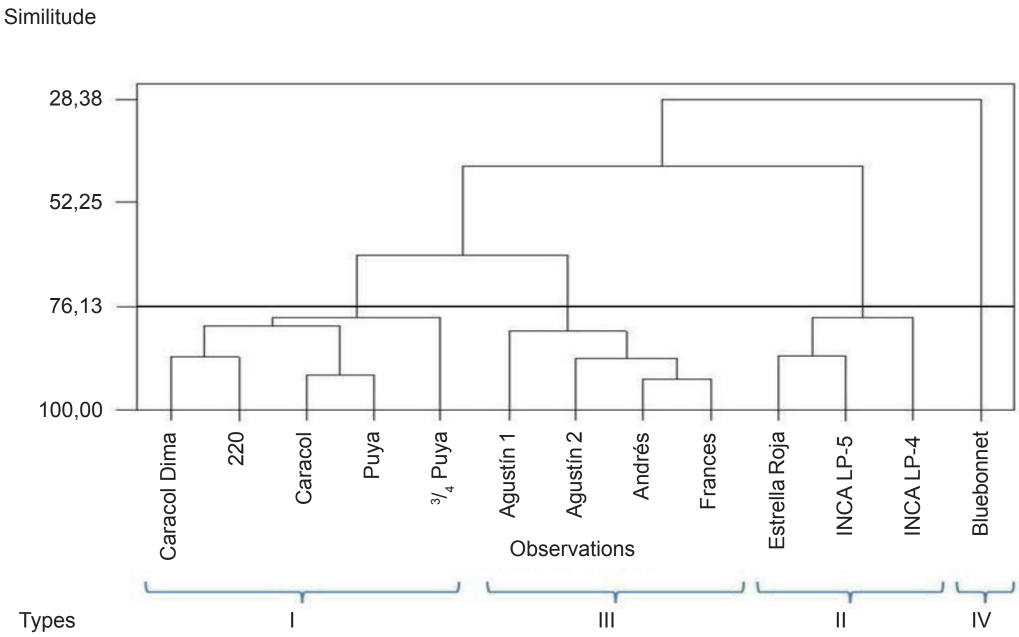


Figure 3. Dendrogram obtained from Cluster Analysis

Table VII shows that the Type I (Caracol, Caracol Dima, Puya "220" and ¾ Puya) in addition to the above, it was characterized by shorter panicles and the smaller width of flag leaves. In general, the members of the type II (Estrella Roja, INCA LP-4, and INCA LP-5) proved to be the best performers for yield and its components and also with type III had the lowest cycle time.

Type III (Augustin 2, Augustin 1, Andrés and Frances) presented the lowest number of filled grains and the largest number of vain grains per panicle, contrasting with members of the class II and also had shorter leaves, the lowest value for the mass 1000 grains variable and lower yields. Spikelets fertility is an obvious requirement to obtain high yield and the percentage of filled grains or fertility that determines the number of spikelets. Apparently, when the number of panicles per plant tends to increase the percentage of panicles fertility decreases as a reaction to the plant compensation. The percentage of filled and fertile grains is determined by two characters: the number of fertilized grains and plant capacity to fill them. It is considered that the normal spikelet sterility is between 10 and 15 % (17).

In class IV was located independently, farming Bluebonnet and was noted for having the largest panicles and longer and wider flag leaves with a difference of 12 to 0,95 cm, regarding to type of smaller value for these indicators. In turn, it presented shorter ligules and showed the least amount of panicles per square meter, with a difference of 222 panicles respect to class II, which was the best result for this variable.

In other characterization works conducted in Japan (15) Bluebonnet 50 expressed the highest values for panicle length, length and width of the flag leaf characters, which suggests that it is the same cultivar as in Cuba during the '50 rice predominant cultivars were American type and among the most cultivated were Blubonnet 50, Bluebelle, Century Patna, among others. Similar research has developed other authors, confirming the existence of great genetic diversity in evaluated cultivars and grouping them in type (23, 24).

Native and traditional cultivars have been grown for long periods of time by farmers and have developed adaptive capabilities to local conditions, so that several authors have agreed on the importance of this type of study for breeders and farmers, in order to identify and select beneficial genes for crop improvement. The extension of large-scale modern high-yielding cultivars has replaced the traditional irrigated rice cultivars, reducing its genetic base and increasing their vulnerability (15, 10).

CONCLUSIONS

Under this trial conditions was possible to distinguish the studied rice cultivars with 22 morphoagronomic descriptors of the 25 used. The analysis of qualitative and quantitative evaluated traits revealed the existence of differences among cultivars, constituting an important genetic source for use in Program Improvement Rice, especially Andrés, Bluebonnet, Estrella Roja Caracol cultivars showing traits of interest as precocity, plant erection, panicle length, compact and well emerged panicles, tillering capacity and senescence, used as progenitors could contribute to make progress in the offspring. Estrella Roja genotype had greater similarities with improved cultivars INCA LP-4 and INCA LP-5 included in the study both quantitative to qualitative characters.

RECOMMENDATIONS

Using traditional rice crops in the Breeding Program to increase the various sources of progenitors and variability of improved genotypes and incorporate them the Germplasm Bank to ensure their conservation and future use.

BIBLIOGRAPHY

1. Franquet Bennis, J. M. y Borras-Pamies, C. Economía del Arroz: Variedades y mejora. [en línea]. Universidad de Málaga. Biblioteca Virtual de Derecho, Economía y Ciencias Sociales, 2010. ISBN-10:84-689-7762-4. [Consultado: 4 de mayo de 2010]. Disponible en: <http://www.eumed.net/libros/2006a/fbbp/index.htm>.
2. Jiménez, Odáliz; Silva, R. y Cruz, J. Efecto de densidades de siembra sobre el rendimiento de arroz (*Oryza sativa* L.) en el municipio Santa Rosalía Estado Portuguesa, Venezuela. *Rev. Unell. Cienc. Tec.*, 2009, vol. 27, pp. 32-41. ISSN: 1012-7054.
3. Hamilton, R. S.; McNally, K.; Guzmán, F.; Reano, R.; Almazan, S.; Alcántara, A. y Naredo, E. Conservación de los recursos genéticos del arroz. 2011. [en línea]. [Consultado: 24 de diciembre de 2011]. Disponible en: <http://cropgenebank.sgrp.cgiar.org>.
4. Almarales, O.; Suárez, E.; Mesa, H.; Reinoso, J. y Rodríguez, S. Creación de variabilidad genética mediante cruzamientos en el Programa de Mejoramiento Genético del Arroz. [CD-Rom]. En: Encuentro Internacional del Arroz. (IV: 2008, 2-6 jun.: La Habana). Palacio de las Convenciones, 2008. ISBN: 978-959-282-076-0.
5. Hernández, A.; Ascanio, M. O.; Morales, M. y León, A. Clasificación de los suelos de Cuba. La Habana : Editorial Felix Varela. 2006. 98 pp. ISBN 959-07-0145-0.
6. MINAG. Instructivo Técnico del Arroz. La Habana: Instituto de Investigaciones del Arroz. Ministerio de la Agricultura, 2008. 113 pp.
7. IRRI. Standard Evaluation System for Rice. 4 ed. Manila: IRRI, 2002. 51 pp.

8. Muñóz, A. G.; Giraldo, Guillermo y Fernández de Soto, José. Descriptores varietales: arroz, frijol, maíz, sorgo. CIAT. Cali, Colombia, 1993. pp. 1-5.
9. MINAG. Formulario de Descripción Varietal para Arroz (*Oryza sativa* L.). Dirección de Certificación de Semillas. Registro de Variedades Comerciales, 1998. 12 pp.
10. Sarawgi, A. K.; Subba Rao, L. V.; Parikh, M.; Sharma, B. y Ojha, G. C. Assessment of Variability of Rice (*Oryza sativa* L.) Germplasm using Agro-morphological Characterization. *Journal of Rice Research*, 2013, vol. 6, no. 1, 14 pp. ISSN: 2375-4338.
11. Parikh, M.; Motiramani, N. K.; Rastogi, N. K. y Sharm, B. Agro-morphological characterization and assessment of variability in aromatic rice germplasm. *Bangladesh J. Agril. Res.*, 2012, vol. 37, no. 1, pp. 1-8. ISSN 0258-7122.
12. Baderinwa, A. A. Potentials of agrobotanical characters of some local rice germplasm (Oryza sativa Linn) for improved production in Nigeria. *Journal of Science and Science Education*, 2012, vol. 3, no. 1, pp. 111-117. ISSN 0795135-3.
13. Torró, Isabel. Análisis de los factores que determinan la resistencia al encamado y características de grano en arroz (*Oryza sativa* L.) y su asociación con otros caracteres, en varias poblaciones y ambientes: bases genéticas y QTLs implicados [en línea]. Biblioteca digital Arístides Rojas. 2012. [Consultado el 20 abril de 2012]. Disponible en: <http://www.bibliodar. mppeu.gob. ve/?q=doc_categoria/arroz>.
14. García, Aymara; Dorado, Madelyn; Pérez, Isel y Montilla, E. Efecto del déficit hídrico sobre la distribución de fotoasimilados en plantas de arroz (*Oryza sativa* L.). *Interciencia*, 2010, vol. 35, no. 1, pp. 47-54. ISSN: 0378-1844.
15. Rao, L. V.; Shiva Prasad, G.; Chiranjivi, M.; Chaitanya, U. y Surendhar, R. DUS Characterization for Farmer varieties of rice. *IOSR Journal of Agriculture and Veterinary Science* (IOSR-JAVS), 2013, vol. 4, no. 5, pp. 35-43. ISSN: 2319-2380. [Consultado: 15 dic 2012]. Disponible en: <http://www.iosrjournals.org>.
16. Olmos, S. Apunte de morfología, fenología, ecofisiología, y mejoramiento genético del arroz. [en línea]. Corrientes: UNNE. Facultad de Ciencias Agrarias, 2006. [Consultado: 12 de julio de 2011]. Disponible en: <http://www.acpaarrozcorrientes.org.ar/ Informacion_Academica.html>.
17. Díaz Solís, Sandra; Cristo Valdés, Elizabeth; Morejón Rivera, Rogelio; Shiraishi, Masaaki y Dhanappala, Madduma. Evaluación morfoagronómica de germoplasma de arroz de diferente origen y grupo varietal. *Cultivos Tropicales*, 2011, vol. 32, no. 4, pp. 56-64. ISSN: 1819-4087.
18. Pandey, Praveen y John Anurag, P. Estimation of genetic parameters in indigenous rice. *Advances in Agriculture and Botanics*, 2010, vol. 2, no. 1, pp. 79-83. ISSN: 2067-6352.
19. Díaz, Sandra; Morejón, R.; Castro, R. y Pérez, Noraida. Evaluación de Variedades de arroz (*Oryza sativa* L.) para la época de primavera en Pinar del Río. *Cultivos Tropicales*, 2004, vol. 25, no. 4, 71-81 pp. ISSN: 1819-4087.
20. CIAT. Producción Eco-Eficiente del Arroz en América Latina [CD-ROM] Cali, Colombia: Centro Internacional de Agricultura Tropical (CIAT). 2010. 487 pp. ISBN: 978-958-694-103-7.
21. Morejón Rivera, Rogelio; Hernández Macías, Juan J. y Díaz Solís, Sandra H. Comportamiento de tres variedades comerciales de arroz en áreas del complejo agroindustrial arrocero «Los Palacios». *Cultivos Tropicales*, 2012, vol. 33, no. 1, pp. 46-49. ISSN:1819-4087.
22. Morejón Rivera, Rogelio y Díaz Solis, Sandra. Combinación de las técnicas estadísticas multivariadas y el diseño aumentado modificado (DAM) en la selección de líneas de prueba en el programas de mejoramiento genético del arroz (*Oryza sativa* L.). *Cultivos Tropicales*, 2013, vol. 34, no. 3, pp. 65-70. ISSN:1819-4087.
23. Bosetti, Fátima; Imaculada Zucchi, Maria y Baldin Pinheiro, José. Molecular and morphological diversity in Japanese rice germplasm. *Plant Genetic Resources*, 2011, vol. 9, no. 2, pp. 229-232. ISSN: 1479-2621.
24. Chakrabarty, S. K.; Joshi Monika, A.; Singh Yogendra, Maity Aniruddha y Vashisht Veena, Dadlani M. Characterization and evaluation of variability in farmers varieties of rice from West Bengal. *Indian Journal of Genetics and Plant Breeding*, 2012, vol. 72, no. 2, pp. 136-142. ISSN: 0019-5200.

Received: March 11th, 2014
Accepted: December 11th, 2014