DEVELOPMENT OF NEW SEMIDWARF SOURCES FOR RICE WITH DIFFERENT CYTOPLASMS (CV BASMATI 370 AND GLORIA)

J.E. DEUS, E. SUAREZ
Instituto de Investigaciones del Arroz,
Bauta, Havana, Cuba

XA0101026

J.L. FUENTES, A. ALVAREZ, E. PADRÓN
Centro de Estudios Aplicados al Desarrollo Nuclear,
Miramar, Playa, Havana, Cuba

Abstract

In Cuba semidwarf rice varieties grow on 98% of the area. Virtually all carry the same Dee-geo-won-gen dwarfing gene. Also, most if not all the cultivars have the same cytoplasm. The induced mutations approach was undertaken in order to generate alternative genetic sources of dwarfing with different cytoplasms and to improve the grain quality of Cuban rice. The seeds of two varieties, Basmati 370 and Gloria, were irradiated with 200 and 300 Gy of ^{60}Co gamma rays. In several generations of selection, progeny testing and preliminary yield tests 10 mutants (6 from Basmati 370 and 4 from Gloria), whose yields exceeded the source cultivars, have been advanced to replicated yield trials. Some of the mutant lines are also resistant to lodging and to blast (*Pyricularis grisea*). It is concluded the induced mutations can be used successfully to improve plant type and other agronomic traits in rice. The induced mutants will be used also in hybridization programs.

1. INTRODUCTION

In Cuba, 98% of rice area is cultivated with semidwarf cultivars. Virtually all carry the same semidwarfing gene of IRRI varieties that comes from dwarf Chinese variety Dee-geo-won-gen (DGWG) [1, 2]. Cuban rice breeders adopted the semidwarf plant type concept, as a breeding objective in the early 70's, and the use of semidwarfs as parents intensified year by year, increasingly crossing semidwarf parents with other semidwarf.

Most of these parental varieties employed in the hybridization programs originated from the same maternal parent, implying that the components of their cytoplasm are similar [3]. This situation highlights the need for alternative sources of dwarfing and for broadening the maternal genetic base in the new cultivars.

During the last 20 years the selection pressure for cooking quality was not so strong. Today the rice cultivars present a good plant type, with a high yield potential, good resistance to the main pests and diseases and they also possesses good milling quality. The cooking quality and the different cytoplasm bases used in the hybridization programs, are not satisfactory. In addition, the gene for semidwarfness is transferred with other genes which reduce the grain quality.

Mutation breeding is an important tool to be used for such programs. This research has the following objectives: (a) To identify alternative genetic sources of dwarfing with different cytoplasmic bases by using mutation techniques. (b) To improve the grain quality of the Cuban rice varieties using the high grain quality Basmati 370 from India and Gloria from Cuba.

2. MATERIALS AND METHODS

The experiment was initiated in 1993 with the varieties of Basmati 370 and Gloria (Table I).

TABLE I. PRINCIPAL AGRONOMICAL TRAITS OF THE VARIETIES USED

Variety	Basmati 370	Gloria
Type	Tall indica	Tall indica
Yield potential	Low	Low
Maturity	Medium	Medium
Lodging	Highly susceptible	Susceptible
Aroma	Aromatic	Standard
Character to improve	Semidwarf, resistant to lodging	Semidwarf, resistant to lodging

The breeding scheme is shown in Fig. 1. The seed were exposed to 200 and 300 Gy of ^{60}Co gamma rays. The irradiated seeds (3600 seeds per treatment) were sown in a nursery and transplanted to the field, one plant per hill, spaced 15 × 15 cm apart. The first 2 panicles were harvested from each plant. The progenies from each M_1 were raised as the M_2 line, each M_2 population was transplanted and grown in a pedigree row (5 m long), one plant per hill, spaced 25 × 30 cm apart.

A total of 52600 M_2 plants per treatment in Basmati 370 variety and 43200 plants per treatment in Gloria variety were sown. At maturity the selection was made for following:

- Semidwarf and intermediate plant type.
- Earliness.
- Healthy plants.

The M_3 and M_4 generations were sown by direct seeding in 5 m rows. One control row of each of the respective source variety was grown every twenty rows of the mutant lines.

The observational yield trials were concluded in the M_5 and M_6 generations. Small plots with 8 rows 5 m long were utilized. Every ten plots three control varieties were sown, the source varieties Basmati and Gloria and the commercial cultivar J-104. They were planted in three locations to evaluate their field performances in different ecological zones.

3. RESULTS AND DISCUSSION

In the M_2 generation much variability was found, mainly in plant height. A total of 153 plants, 91 semidwarf and 62 intermediate plant type, were selected.

A higher degree of variability was found in the Basmati variety with a radiation doses of 200 Gy (Table II). Different types of mutation were identified such as types of grain (bold and medium long grain) and late maturity mutants.

On the basis of the data and visual comparison, 71 true breeding lines (58 from Basmati and 13 from Gloria) were selected for further screening and evaluation (Table III). Many of the M_2 selections segregated and did not breed true in the M_3.

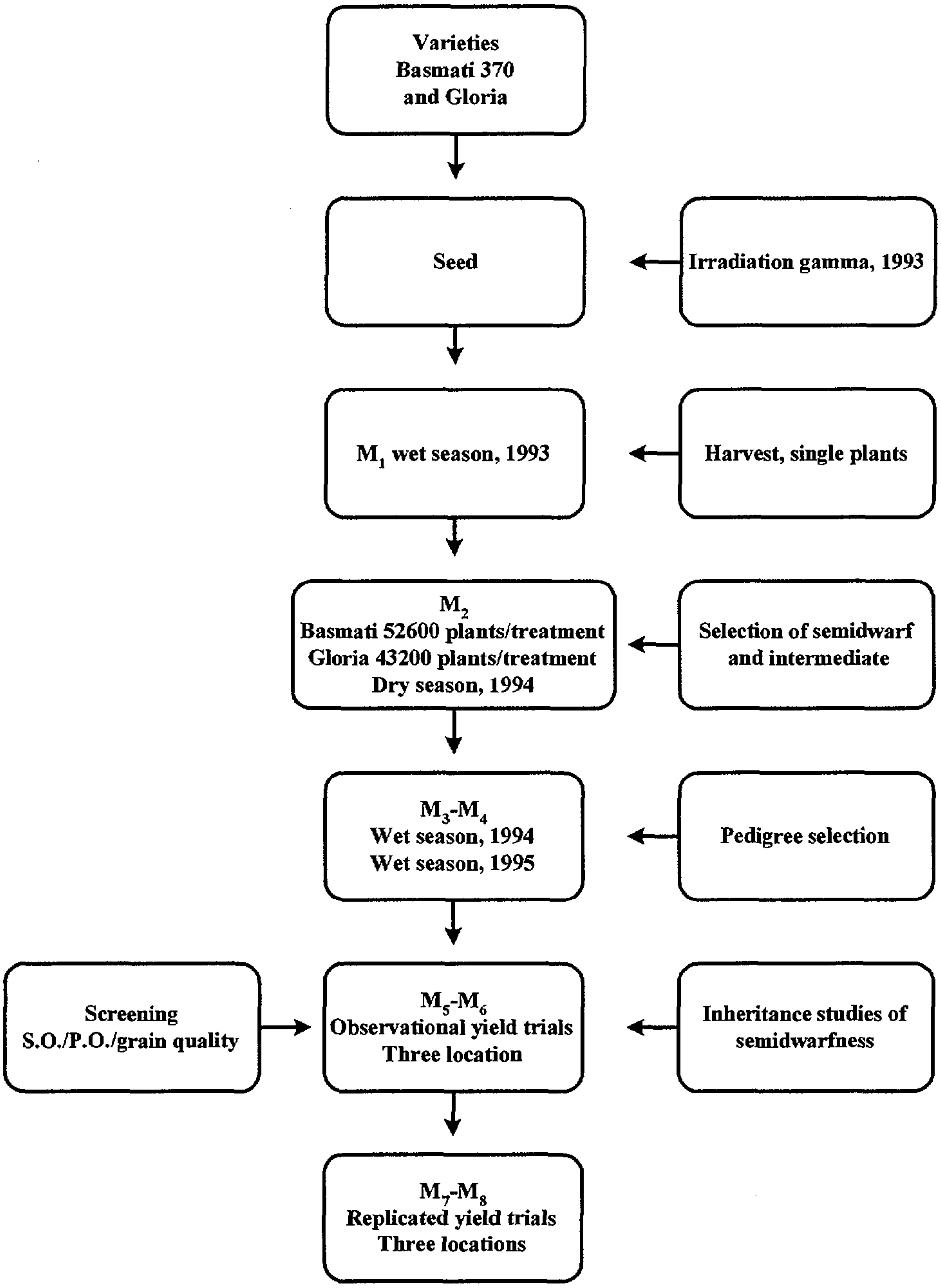

FIG. 1. Breeding scheme.

TABLE II. NUMBER OF SELECTED M_2 PLANTS AND THEIR PROPERTIES, DRY SEASON

Variety	Gamma dose (Gy)	Plants selected, number			
		Semidwarf	Intermediate	Early	Total
Basmati 370	200	38	35	6	79
Basmati 370	300	23	19	8	50
Gloria	200	19	3	2	24
Gloria	300	11	5	5	21
Total	---	91	62	21	174

TABLE III. NUMBER OF TRUE BREEDING M_3 MUTANT LINES SELECTED FOR REDUCED HEIGHT AND EARLINESS

Variety	Gamma dose (Gy)	Semidwarf	Intermediate height	Early	Total
Basmati 370	200	36	3	4	43
Basmati 370	300	17	2	4	23
Gloria	200	7	1	4	12
Gloria	300	5	-	3	8
Total	---	65	6	15	86

TABLE IV. YIELDS OF SEMIDWARF MUTANT LINES SELECTED FROM OBSERVATIONAL YIELD TRIALS IN THREE LOCATIONS (D = DRY SEASON; W = WET SEASON)

Mutant lines	Source	Yield t/ha							
		I.I.A.		*S. Spirits*		Jucarito		Mean	
		D	W	D	W	D	W	D	W
B_{300}-10-1-3-1	Basmati γ300Gy	7.9	5.6	6.9	4.9	6.7	5.0	7.2	5.2
B_{300}-4-2-1	Basmati-γ300Gy	6.6	5.4	4.2	4.0	7.2	5.1	6.0	4.8
B_{200}-15-3-1	Basmati-γ200Gy	5.5	5.0	6.0	4.7	5.2	4.7	5.6	4.8
B_{300}-10-2-2	Basmati-γ300Gy	4.9	4.6	7.0	4.4	4.1	4.0	5.3	4.3
B_{300}-10-1-4	Basmati-γ300Gy	5.4	4.9	6.0	4.3	6.1	4.3	5.8	4.3
B_{200}-14-2-1	Basmati-γ200Gy	5.0	4.7	5.3	5.1	5.5	4.4	5.3	4.7
G_{300}-10-2-1-7	Gloria-γ300Gy	5.2	4.5	7.9	5.0	4.0	4.1	5.7	4.5
G_{300}-10-2-7-3	Gloria-γ300Gy	4.4	4.1	6.3	4.8	4.5	3.9	5.1	4.3
G_{300}-10-2-2-3	Gloria-γ300Gy	4.6	4.2	5.2	4.7	5.1	4.1	5.0	4.3
G_{200}-10-2-1-6	Gloria-γ200Gy	5.5	4.4	4.4	4.6	5.0	4.0	5.0	4.5
Control varieties									
Basmati 370	Unknown	1.9	1.3	1.5	1.2	1.7	1.0	1.7	1.2
Gloria	Unknown	3.1	2.2	3.0	2.1	2.7	1.9	2.9	2.5
J-104	IR480-5-9-3/ IR930-10-1	8.4	6.1	8.9	6.3	8.5	6.2	8.6	6.2

In the observational yield trials, performed in three different locations, 22 lines from Basmati-370 and 12 from Gloria, showed higher yields than the source cultivars (between 2.2 and more than 3.5 t/ha).

On the basis of their field performance and yield data, ten mutants were selected for further evaluation in replicated yield trials (Table IV). The mutant line B10-1-3-1 showed the highest yield with good resistance to *Pyricularia grisea* and lodging.

The high frequency of semidwarf mutants in this experiment demonstrated that induced mutations can be successfully used to improve plant type in rice as has been reported previously [4, 5, 6, 7].

Induced mutations generated new semidwarf germplasm with useful agronomic traits. These new lines will be used for hybridization breeding as semidwarf parents with different cytoplasms and genetic background.

TABLE V. AGRONOMIC DATA FOR THE TEN SELECTED SEMIDWARF MUTANT LINES, MEAN VALUES OF THREE LOCATIONS (D = DRY SEASON; W = WET SEASON)

Material	Source	Vigor[a]	Lodging[b]	Tagosodes[c] LE	Maturity (days)		1000 grain wt. (g)	Plant height (cm)	Panicle length (cm)
					D	W			
B_{300}-10-1-3-1	Basmati γ300Gy	4	R	MR	132	112	23.9	84	26.2
B_{300}-9-2-1	Basmati-γ300Gy	4	R	MR	136	112	23.8	91	25.2
B_{200}-15-3-1	Basmati-γ200Gy	4	MR	MR	135	111	25.7	93	26.4
B_{300}-10-2-2	Basmati-γ300Gy	4	MR	MR	134	113	23.1	91	24.3
B_{300}-10-1-4	Basmati-γ300Gy	4	MR	MR	138	113	24.1	90	25.0
B_{200}-14-2-1	Basmati-γ200Gy	4	MR	MR	133	112	23.7	92	26.5
G_{300}-10-2-1-7	Gloria-γ300Gy	2-3	R	MR	130	110	26.4	100.2	25.8
G_{300}-10-2-7-3	Gloria-γ300Gy	2-3	R	MR	128	110	27.2	100.5	27.4
G_{300}-10-2-2-3	Gloria-γ300Gy	2-3	R	MR	136	113	26.8	101.2	27.2
G_{200}-10-2-1-6	Gloria-γ200Gy	2-3	R	MR	131	111	26.9	97.3	24.2
Control varieties									
Basmati 370	Unknown	3-4	HS	MR	136	112	23.4	147	27.2
Gloria	Unknown	2-3	S	MR	132	111	27.2	154.0	26.7
J-104	IR480-5-9-3/ IR930-10-1	3	HR	MR	145	118	31.2	95.5	25.1

[a]a higher score denotes higher vigor.
[b]R = resistant, MR = moderately resistant, HR = highly resistant, S = susceptible, HS = highly susceptible.
[c]Reaction to *Tagosodes onizycoles*.

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