the parent to the disease. The mutants were tested at different 'hot spot' locations of blast like Hazaribag in Bihar, Maruteru in Andhra Pradesh and Jagdalpur in Madhya Pradesh. In addition, they were also screened under greenhouse conditions at the Directorate of Rice Research, Hyderabad. Experimental data from all these centers support the earlier finding that variation for tolerance to blast exist in these mutant lines.

The relatively highly tolerant mutant lines were further evaluated under artificial screening at CRRI and highly tolerant individual plants with individual scores of 1 and 2 as against the parent variety score of 7 to 9 (in the IRRI disease score scale of 1 to 9) were selected. After seed multiplication, yield evaluation trials were conducted on fourteen different individual plant derived lines. The field evaluation data on the selected fourteen mutant lines i.e. CRM 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54 and 58) indicate that all these mutant lines yielded either at par or higher than the parent.

The mutants were further tested for their suitability in the replacement of the parent variety in the State of Assam. In the yield evaluation and adaptation trials conducted at Kokilabari Farm, Assam, the mutants performed consistently with a yield of over 3 t/ha. Further evaluation of CRM mutant lines over a four year period at Regional Agricultural Research Station, Assam Agricultural University, Diphu, Assam revealed that three mutant selections, i.e. CRM 49, 51 and 53, consistently yielded double that of the parent (2.5t/ha in comparison to 1.25t/ha for parent). Further, in the trials conducted at Zonal Agricultural Research Station of Indira Gandhi Krishi Viswa Vidyalaya, Jagdalpur, the CRM mutants performed well for both yield and the disease scores. Based on the performance of these mutants, the Government of Assam is proposing the release of three mutants namely, CRM 49, 51 and 53 and wishes to replace the parent cultivar IR 50 with these high yielding and blast tolerant mutants.

*(Contributed by **SARMA, N.P.*, G.J.N. RAO** and **K.V.S.R.K. ROW**, Central Rice Research Institute, Cuttack - 753 006, Orissa, India, *Present Address: Directorate of Rice Research, Rajendranagar, Hyderabad-500 030)*

INDUCTION OF DROUGHT TOLERANT MUTANTS OF RICE

The ultimate goal of crop breeding is to develop varieties with a high yield potential and desirable agronomic characteristics. In Egypt, the most important qualities sought by breeders have been high yield potential, resistance to major diseases and insects, and improved grain and eating quality. However, breeding efforts should concentrate on varieties with the potential to minimize yield losses under unfavorable conditions such as drought, and to maximize yields when conditions are favorable. Rice (*Oryza sativa* L.) in Egypt is completely irrigated and a significant portion of the rice cultivated area is subject to water deficit resulting from an inadequate or insufficient irrigation supply. Drought tolerance is a complex trait in that it results from the interaction of histological and physiological characters of plant with environmental factors, both above-ground and under-ground [2]. Accordingly, root characters are closely related to drought tolerance. Little attention has been paid in Egyptian breeding programs to root characters and their relation to shoot characters. Furthermore, induced mutations are considered as one of the most important methods to induce useful mutants, especially with improved root characters, to overcome the drought problem. The present investigation aimed to study the effect of different doses of gamma rays on several characters of three Egyptian rice varieties, i.e. 'Giza 171', 'Giza 175' and 'Giza 176' and to induce one or more mutants possessing drought tolerance.

In the 1991 season, five gamma-rays doses i.e., 100, 200, 300, 400 and 500 Gy, were used to treat the seeds of the above varieties from ^{60}Co source at the National Center for Radiation Research and Technology, Cairo, Egypt. Treated seeds, together with untreated ones, were directly grown in the nursery and all surviving seedlings were individually transplanted in the permanent field. At heading, the first emerged panicle of each plant was bagged and harvested individually. Viable mutations were selected in M_2 according to the significant differences between these mutants and the respective parent variety in visual drought symptoms, shoot dry weight, root dry weight, and root/shoot ratio. The procedures were followed till M_7 in 1997 when some selected mutants were tested in a randomized complete block design experiment with three replicates and irrigation water was applied every 14 days. The visual score of drought symptoms were recorded on the basis of visual scoring systems [1].

Seven mutants were selected from the three rice varieties (2 mutants from Giza 171, 3 mutants from Giza 175, and 2 mutants from Giza 176), which proved to be tolerant to drought conditions in comparison to the respective parent variety. Selected mutants showed an improved trend regarding the studied characters (Table 1).

Table 1. Means of studied characters for the selected mutants from the three rice varieties under drought conditions in M_7 generation

Entries	Visual drought symptoms	Shoot dry weight (g)	Root dry weight (g)	Root/shoot ratio
Giza 171 (Control)	7.31 ± 0.19	6.64 ± 0.55	1.35 ± 0.61	0.20 ± 0.01
G 171 M7-1	3.54 ± 0.81	10.81 ± 0.15	4.03 ± 0.31	0.37 ± 0.28
G 171 M7-2	3.02 ± 0.07	10.07 ± 0.15	3.99 ± 0.70	0.40 ± 0.22
Giza 175 (Control)	6.92 ± 0.08	7.92 ± 0.45	2.03 ± 0.11	0.26 ± 0.08
G 175 M7-1	2.56 ± 0.13	11.35 ± 0.17	5.61 ± 0.15	0.49 ± 0.42
G 175 M7-2	3.01 ± 0.24	10.92 ± 0.25	4.93 ± 0.07	0.45 ± 0.15
G 175 M7-3	2.67 ± 0.57	10.84 ± 0.11	5.88 ± 0.63	0.54 ± 0.24
Giza 176 (Control)	7.94 ± 0.22	5.83 ± 0.11	1.05 ± 0.15	0.18 ± 0.03
G 176 M7-1	3.15 ± 0.44	10.73 ± 0.66	4.89 ± 0.28	0.46 ± 0.73
G 176 M7-2	2.62 ± 0.06	10.89 ± 0.43	5.07 ± 0.57	0.47 ± 0.56

The visual drought symptoms ranged between 2.56 and 3.54 for the mutants G175 M7-1 and G 171 M7-1, respectively. However the same score was 7.31 for Giza 171, 6.92 for Giza 175 and 7.94 for Giza 176 indicating that all these selected mutants were more tolerant to drought conditions. In these mutants the highest shoot dry weight (11.35 g) was observed in G175 M7-1 and the lowest (10.07 g) in G171 M7-1. The same character differed from 5.83 g to 7.92 g for Giza 176 and Giza 175, respectively. In addition, the highest root dry weight (5.88 g) was found in the mutant G175 M7-3, which also showed the highest root/shoot ratio (0.54). In general, these selected mutants could be utilized as drought tolerant varieties and/or as a source of drought tolerance in the hybridization breeding program.

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*(Contributed by **EL-HISSEWY, A.A.** and **A. ABD ALLAH***, Rice Technology Training Center, Alexandria, *Rice Research & Training Center, Kaft El-Sheikh, Egypt)*

INDUCED MUTATION FOR TUNGRO RESISTANCE IN RICE

Tungro is the most serious virus disease of rice in South and Southeast Asia. It is a composite disease of two kinds of viruses, rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). Damage to the plant is mostly caused by RTBV, while RTSV acts to facilitate RTBV acquisition and transmission by insect vector. Both viruses are transmitted mainly by green leafhopper (GLH). Resistance to GLH is common in rice germplasm but extremely rare for the two viruses. To induce mutations for tungro resistance, a susceptible variety IR22 was treated with N-methyl-N-nitrosourea (MNH) following the procedure of Satoh and Omura [1]. The panicles of rice variety 'IR22' were soaked in 1 mM MNH solution for 45 minutes at 16 to 18 hours after flowering.

Two thousand six hundred and forty fertile M_1 plants were produced. From these plants M_2 lines with 10 or more seedlings were planted in the field to evaluate their reaction against tungro under natural conditions in the 1990 dry season on the IRRI central research farm, Los Banos, the Philippines. Of these, 124 M_2 lines were selected by visual evaluation. Five plants were harvested individually from each selected line. A bulk was also made from all the remaining plants in the line. In the M_3 generation, each family consisted of five sister lines and one bulked line. One line (M_3-723) showed no tungro symptoms and its related bulk segregated for resistance but all other M_3 lines from the same family were susceptible to tungro. The resistant line, M_3-723, showed low infection with RTBV and RTSV when leaves were tested by enzyme-linked immunosorbent assay (ELISA) to diagnose tungro infection. All M_4 lines from M_3-723 showed uniform resistance in the field. They were not infected with RTBV and were resistant to RTSV infection (Table 1). The reaction of these plants to the virus vector GLH was variable.

To investigate the resistance of the M_4 lines in the field, they were inoculated with viruliferous GLH at the 10-day-old seedling stage in the laboratory. The rate of tungro infection of these selections, at 14 days after inoculation, was as high as the susceptible variety IR22 (Table 1). When the lines were diagnosed at 30, 60 and 90 days after inoculation, the infection rate did not decrease with the sampling date (Table 1). This indicates that the mutant lines are susceptible to tungro infection at the seedling stage and the infected plants do not recover from the disease. To determine whether the resistant reaction in the mutants differ among the growth stage, the progeny of M_4 lines, that showed no infection with either RTBV or RTSV in the field but showed low level of antibiosis to GLH, were used. They were inoculated with viruliferous GLH at 10, 24, 38, 52, 66 and 88 days after seeding, respectively. Both RTBV and RTSV infection rate decreased rapidly with age in selected M_5 lines (Table 2). Those mutant lines slightly susceptible to RTSV at the seedling stage were resistant at early tillering stage 24 days after seeding. All the mutant lines were susceptible to RTBV at the young seedling stage but became resistant at maximum tillering stage (52-66 days after seeding). It was therefore concluded that these mutant lines have resistance to both RTBV and RTSV infection at the maximum tillering stage, and they possess adult plant resistance to tungro.