REPORT NO. IAEA-R-2839-F

TITLE

The use of mutant stock for semi-dwarf plant type and early maturity as cross-breeding materials in rice (coordinated programme on semi-dwarf mutants for rice improvement in Asia and the Pacific Region - RCA)

FINAL REPORT FOR THE PERIOD

1981-04-01 - 1985-11-30

AUTHOR(S)

Ponchai Pookamana

INSTITUTE

Rice Research Institute
Department of Agriculture
Bangkok
Thailand

INTERNATIONAL ATOMIC ENERGY AGENCY

DATE November 1985

RC. 2839

Final Report

# The Use of Semidwarf Mutants as Breeding Materials in Rice[1/]

## Introduction

With a Total rice area of about 8 million hectares, 90 percent of rice grown in Thailand is under rainfed condition. Traditional rice varieties are tall (about 1.5 to 2.0 meters in height photoperiod sensitive, weak strawed, mostly susceptible to common diseases and insects, and show relatively poor response to high rate of fertilizer which caused in low yield. Nevertheless, these local varieties are still widely popular among farmers due to their excellent grain quality, sensitive to phoperiod, and wide adaptability under adverse conditions. Since 1965, the introduced semidwarf materials from Taiwan and the International Rice Research Institute (IRRI) have been widely used in rice breeding program which resulted in release of several high yielding semidwarf varieties.

The semidwarf Dee-geo-woo-gen (DGWG) gene from Taiwan materials was assumed to be in about 80 % of the crosses analyzed for 1974-1975 in 7 Asian nations (1). This may create a risk in terms of vulnerability towards pests, diseases and other hazards. Chang (2) emphasized the importance of identifying alternate sources of major semidwarf genes.

A project between Rice Division (Rice Research Institute) and International Atomic Energy Agency (IAEA) in Vienna, Austria was begun in 1980 the aim is to identify and make available new sources of semidwarf type for cross-breeding programs.

## Materials and Methods

During the period 1965-1979, serveral tall traditional Thai rice varieties were treated with ionizing radiation. The aims were to improve one or a few defective characters of economic importance such as better yielding performance, blast and brown planthopper resistance and glutinous endosperm which were emphasized in the screening of the irradiated populations. Shorter heights of six.

---

1/ Final report in connection with Research Contract No. 2839/RB by Ponchai Pookamana, Pricha Khambanonda, Asanee Sarigabutr, Phontwang Senawong, Rice breeders, Rice Research Institute (formerly Rice Division, Department of Agriculture, Bangkok 10900 Thailand (November 1985)

mutants found in the three tall varieties Khao Dawk Mali 105 (KDML 105), Niaw Sanpah Tawng (NSPT) and Leaung Awn 29 (LA 29) in that time period but were not closely evaluated since short height was not a major objective. Instead, they were placed in the germplasm collection. The parent KDML 105 variety is a popular non-glutinous type which has good yield, good eating quality and aromatic grain but weak straw. NSPT has glutinous endosperm with excellent eating quality, wide adaptability and high yield. LA 29 is a non-glutinous type with long clear grain and excellent eating quality. The original varieties, KDML 105 and NSPT are still very popular among farmers, but LA 29 was discarded due to weak straw, blast and bacterial leaf blight susceptibility. During this period, none of these semidwarf mutants were used for the breeding program because the IRRI semidwarf varieties had been widely used as parents in crosses with the Thai varieties. The 6 semidwarf mutants were approximately 30 cm. shorter than the parent varieties. Two semidwarf mutant lines of LA 29 which show better plant type, stiff straw, and more erect leaves are sensitive to photoperiod and similar to their parent variety.

Genetic segregation and allelism test for semidwarf character in these mutants is under investingation, one mutant line from KDML 105 and two lines from LA 29 were crossed back to their original parent and two ordinary semidwarf varieties containing the DGWG gene (RD 1 and IR 36). Parent plants were grown on each side of the $F_1$ plants of each cross in order to make precise measurement for height and other characters. The number of $F_1$ plants ranged from 13 - 18. Approximately 400 $F_2$ embryos per cross were planted to study segregation patterns for height.

Results and Discussion

Agronomic characters of the Thai semidwarf mutants were evaluated in an observation trial with some of the introduced varieties from the International Rice Research Institute, Taiwan, People's Republic of China, France and The United States. The results showed that most of the introduced varieties were poor in agronomic characters and gave lower yields than the local mutants. Poor adaptation to tropical conditions caused high sterility (3).

Genetic analysis had been observed, one line of KDML 105 semidwarf and two LA 29 semidwarf mutants were crossed with their original tall varieties. Data indicate complete dominance for tall height. The $F_2$ plant ratio of tall to semidwarf of each cross was

close to the expected 3 : 1 by separating height distribution at 115 cm. for the cross semidwarf KDML 105'65-$G_3$U-84-338 and its original KDML 105, P = 0.10 - 0.50 ; separating height distribution at 120 cm. for the cross semidwarf mutant LA 29'73-$NF_1$U-9-2-2-1 and its original tall LA 29, P = 0.1; and separating height distribution at 105 cm. for the cross semidwarf mutant LA 29'73-$G_1$CO-16-6-2-1 and its original tall LA 29, P = 0.25.

The identification of alternative sources of the semidwarf character arising from other than DGWG gene was also attempted by crossing two putative mutant lines of LA 29 with RD 1 and IR 36, the height of $F_1$ and $F_2$ generations compared with their parents are given in Table 1. The $F_1$ data of the cross LA 29'73-$NF_1$U-9-2-2-1 with RD 1 and IR 36 were similar to the mean parents while the crosses of the line LA 29'73-$G_1$CO-16-6-2-1 with RD 1 and IR 36 expressed some heterosis in height. The results suggest that these two semidwarf mutant line of LA 29 have the same semidwarfing gene as DGWG, although they may have modifier (s) which increased the culm length. (4) Chang et al. (2) have identified and classified the gene systems in the new semidwarf into 3 categories.

1. Indentical with $sd_1$ locus: $F_1$ plants and all $F_2$ plants are semidwarfs, although the effect of modifying genes may be detected.
2. Sharing a complex locus with $sd_1$ : $F_1$ plants are semidwarf; great majority of the $F_2$ plants are semidwarfs; only a small number of $F_2$ plants (less than 1%) are intermediate-tall or tall.
3. Non-allelic gene. (s): $F_1$ plants are taller than either parent distinct segretation for plant height is observed in the $F_2$ populations.

The semidwarf line KDML 105'65-$G_3$U-84-338 was also crossed with RD 1 and IR 36 to identify the non-allelic gene but the data have not yet bean completed. Although the semidwarfing gene in the two Thai mutants seemed to be allelic to DGWG, these mutants still will be useful for the rice breeding program. Their desirable characters are due to ability to withstand adverse climates (especially floods and drought) toxic soil properties, tolerance to local injurious insects and disease resistance, proper muturity and preferred grain.

Further efforts to induce additional semidwarf mutants using other traditional tall varieties which have exhibited good performance under farmer conditions are being made, The irradiated populations are under selection in the non-sensitive lowland rice,

Leamng tawng and in the floating rice Leb Mue Nahng 111,49 and 35 semidwarf lines were selected respectively. These semidwarf lines are now being closely investigated in the fields. The other induced populations of RD 6 (glutinous and aromatic grain) and Hawn Om (non-glutinous and aromatic grain) are also being investigated aiming at inducing semidwarf type with aromatic grain.

It is anticipated that the semidwarf mutants of local varieties might play a significant role in rice breeding program in Thailand in the near future due to their original desirable characters plus shorter plant height with stiff straw.

Acknowledgements

The authors are extremely grateful to the Agricultural Technologists of the Rice Research Institute for their valuable help in conducting many aspects of the tests.

Special appreciation is extended to the International Atomic Energy Agency (IAEA), for financial assistance to carry out part of this program.

References

(1) Chang, T.T. "The Genetic basis of wide adaptibility and yielding ability of rice varieties in the tropics." Intern. Rice Comm. Newslett. XVI 4 (1969) 5.

(2) Hargrove, Y.R. "Ancestry of locally developed semidwarf rices used as parent in Asian rice breeding programs in 1974-75. Intern. Rice Comm. Newslett. 3 3 (1978) 5.

(3) Khambanonda, P., A. Sarigabutr, S. Awakul, "Mutation breeding in rice for high yield and batter blast resistance. Paper presented at Jakarta, Indonesia, 10 - 14 October 1977, On Improvement of Rice Production through Research Using Nuclear Techniques.

(4) Khambanonda, P., P. Pookamana, A. Sarigabutr, P. Senawong, "Inheritance of induced semidwarf mutants of rice in Thailand." Paper presented at Katsuta, Ibaraki-ken, Japan, 20-24 May, 1985. Second research co - ordination meeting on semidwarf mutants for rice improvement in Asia and The pacific region.

Table 1. Height of $F_1$ and $F_2$ progenies compared with parents in the cross between semidwarf mutant lines with RD 1 and IR 36 grown at Pathum Thani Rice Research Center, 1982-1983 Wet Season.

| No. | Female parent | Male parent | Average height (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $P_1$ | $P_2$ | MP | $F_1$ | $P_1$ | $P_2$ | MP | $F_2$ |
| 1 | LA 29'73-$NF_1$U-9-2-2-1 | RD 1 | 78 | 81 | 80 | 80 | 84 | 91 | 88 | 97 |
| 2 | LA 29'73-$NF_1$U-9-2-2-1 | IR 36 | 86 | 75 | 81 | 82 | 84 | 77 | 81 | 92 |
| 3 | LA 29'73-$G_1$CO-16-6-2-1 | RD 1 | 88 | 87 | 88 | 93 | 77 | 77 | 77 | 86 |
| 4 | LA 29'73-$G_1$CO-16-6-2-1 | IR 36 | 84 | 79 | 82 | 96 | 77 | 73 | 75 | 85 |

$P_1$ = female parent

$P_2$ = male parent

MP = midparent