# Mutation Breeding Newsletter

Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture

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## MESSAGE FROM THE EDITORS

This issue of the Mutation Breeding Newsletter brings our best wishes for the New Year with thanks for your valuable contributions during 1973. In fact, the contributions were so many that we decided to devote this issue almost entirely to them and leaving for the next issue an up-to-date list of commercial mutant varieties.

We are greatly encouraged by the enthusiastic response to this Newsletter and feel that it is probably meeting a greater need than we had anticipated.

Since we plan to circulate the next issue before the middle of the year, we would urge you to send in your contributions (very short abstracts, news of variety releases, new techniques, significant meetings, change in personnel etc.etc.) as soon as you can.

Björn Sigurbjörnsson
Alexander Micke
Margret Weiner

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## REPORT ON THE ACTIVITIES OF THE PLANT BREEDING AND GENETICS SECTION IN 1973

In spite of rather stringent financial limitations we were able to support research activities in mutation breeding methodology concerning almost all important crop plants. Improvement of grain protein and disease resistance are two of the major practical aims which we were able to follow because of the generous financial support from the Federal Republic of Germany (GSF) and the Swedish International Development Authority (SIDA). In 1973, research coordination meetings were organized on rice improvement (New Delhi, India), disease resistance (Novi Sad, Yugoslavia), grain protein (Ibadan, Nigeria). In January a panel on "Analytical Screening Methods for Seed Protein Content" was convened at Svalöf, Sweden, and in September we organized a panel in Vienna to discuss the "Physiological and Genetic Basis of Protein Synthesis in Seeds".

Trainees of the SIDA-sponsored Training Course on the Use of Radiation and Other Mutagen Treatments for Crop Improvement (Lund and Svalöf, Sweden, and Risø, Denmark, 1971) had the opportunity to participate in a "refresher"-seminar on Improvement and Production of Field Crops at Cairo, Egypt (1-20 September), likewise sponsored by SIDA. The first FAO/IAEA/SIDA Training Course on Plant Breeding for Disease Resistance Including the Utilization of Induced Mutation Techniques

which was planned to be held at Castelar, Argentina, in October 1973, regretfully had to be postponed. A similar type of training course, however, is now planned to be held in Italy during 1974. (Interested scientists will have to be nominated by their governments.)

As personnel news it may be added that Dr. R.A. Luse left the Joint FAO/IAEA Division in February to take over responsibilities for the Biochemistry Laboratory at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Dr. R. Rabson (USA) took his place and is now primarily serving the seed protein improvement programme. We enjoy having again Prof. C.F. Konzak (USA) working with us. He will stay in Vienna on Sabbatical Leave until the fall 1974. We regret the imminent departure of one of the MBNL editors, Dr. Björn Sigurbjörnsson, Deputy Director of the Joint FAO/IAEA Division and former Head of the Plant Breeding and Genetics Section, who will return to Iceland in March 1974 to become Director of the Agricultural Research Institute in Reykjavik. However, he will continue to serve as co-editor of the MBNL.

## FUTURE EVENTS OF INTEREST

### 1974

FAO/IAEA Research Coordination Meeting on Improvement of Vegetatively Propagated Crops and Tree Crops through Radiation-Induced Mutations (Ohmiya, Japan, or Wageningen, Netherlands).

FAO/IAEA/SIDA Training Course on Plant Breeding for Disease Resistance Including the Use of Induced Mutations (Casaccia, Italy).

FAO/IAEA Research Coordination Meeting on the Improvement of Mutation Breeding Techniques (Novosibirsk, U.S.S.R., or Vienna, Austria).

FAO/IAEA/GSF Panel on the Use of Induced Mutations for the Improvement of Protein in Legumes (probably Rome, Italy).

International Symposium on Haploids in Higher Plants; Advances and Potential (Guelph, Ontario, Canada, 10-14 June 1974).

Third European Wheat Aneuploid Co-operation Conference (Novi Sad, Yugoslavia, 12-15 June 1974).

Seventh Congress and General Assembly of EUCARPIA (Budapest, Hungary, 24-29 June 1974).

Fifth International Congress of Radiation Research (Seattle, Wash., U.S.A., 14-20 July 1974).

Nineteenth International Horticultural Congress (Warsaw, Poland, 11-18 September 1974).

### 1975

FAO/IAEA Symposium on Advances in Mutation Breeding Techniques and Practical Achievements (planned to be organized by FAO and IAEA in cooperation with EUCARPIA).

## Increase in mutation rate under the effect of combined treatment with mutagens and specific enzymes

When seeds are soaked in solutions of chemical mutagens, these penetrate through cellulose walls, cytoplasmic membranes into cell nuclei. Hence, it was suggested that it might be worthwhile to combine mutagens with specific enzymes (pectinase, lysocyme), to promote mutagen penetration into cells. Studies carried out in this laboratory on the barley variety Viner, known to have low mutability, have shown that soaking of air-dried seeds in 0.1 - 0.25 % aqueous solution of these specific enzymes increases mutation rate in $M_2$ by 3.5 - 4 times as compared with the rate observed when mutagen solutions are used alone. Combined treatment gives 80 - 90 % $M_2$ progenies with chlorophyll mutations.

Since this combined treatment increases significantly sensitivity to EMS, lower concentrations and shorter exposures are needed. The data obtained suggest that the application of specific enzymes, which act on the membranes of seeds and cells, in conjunction with chemical mutagens, makes possible a rapid "pulse-like" administration of mutagens into cells.

However, combined treatment with enzymes and base-analogues (5-aminouracil, 5-bromuracil and others) did not increase mutation rate, i.e. did not facilitate the penetration of analogues into the chromosomes of initial cells which form generative tissues in barley. Combined treatment with base analogues and growth substances ($\beta$-indolileacetic acid and $\alpha$-naphtylacetic acid) also failed to enhance mutagen efficiency.

(Contributed by N.D. Tarasenko, Laboratory of Cytogenetics, Institute of Cytology and genetics, Siberian Department, Academy of Sciences, Novosibirsk, U.S.S.R.).

## Early flowering mutant strains of rice

Two early flowering, high yielding strains of Basmati rice have been developed through mutation breeding from the most popular fine grain variety Basmati-370. Seed was exposed to 15, 20, 25 and 30 kR of gamma rays.

Selection for earliness and grain quality was done in the $M_2$ generation. The progenies of these plants were grown in $M_3$ lines for further screening and, in $M_4$, put in preliminary yield trials along with Basmati-370 and two other standard varieties Basmati-197 and Basmati-198 at Lyallpur and at the Rice Research Institute Kala Shah Kaku.

The two mutant strains were found to be earlier by three to five weeks. The grain yield of the mutants (EF-29-1 = 3650 kg/ha, and EF-29-2 = 3576 kg/ha)at Kala Shah Kaku was significantly higher than Basmati-370 (2488 kg/ha), Basmati-197 (2676 kg/ha) and Basmati-198 (2568 kg/ha). At Lyallpur, the grain yield of the mutant strains was not significantly higher than that of the parent variety Basmati-370. The yield of mutant strain EF-29-2, however, was significantly higher than that of Basmati-197 and Basmati-198, and the mutant strain EF-29-1 have significantly higher yield than Basmati-198.

The development of these early maturing and high yielding mutant strains of Basmati rice took less than four years.

(Contributed by G. Bari and M.A. Awan, Nuclear Institute for Agriculture and Biology, Lyallpur, Pakistan).

## Types of induced viable mutants in rice

A wide spectrum of viable mutants were recovered from segregating $M_2$ progenies following treatment of seeds of the rice variety Co.29 (Oryza sativa subsp. indica) with gamma rays, fast neutrons, EMS and NMH.

Most of the induced types were "macro-mutants" in which several morphological characters were altered simultaneously. In such mutants, desirable effects were often associated with undesirable ones. Mutants for individual characters such as growth duration, stature of plants, type of ear and size of grains were also isolated. Those in which stature was affected were mostly dwarfs and semi-dwarfs and those with altered duration were frequently late types.

The relative frequencies of the types of mutants induced by the different mutagens were slightly different. Macro-mutants were more frequently induced by fast neutrons and NMH. The proportion of erectoides among the macro-mutants was large after irradiation with fast neutrons. High frequencies of mutants with altered culm length following treatment with EMS, and mutants with altered duration after gamma irradiation were realized. Mutants with abnormal panicles and spikelets were of frequent occurrence after irradiation with fast neutrons. These differences, however, were statistically non-significant.

(Contributed by V. G. Nair, Department of Agricultural Botany, College of Agriculture, Vellayani, Trivandrum, India).

## Promising short culm mutants in rice

Short culm mutants, either spontaneous like Dee-geo-woo-gen or induced like Jagannath, have demonstrated remarkably their better yielding ability, nitrogen responsiveness and lodging resistance than the original talls from which they derived.

The promising short straw mutants obtained at Cuttack and reported here are from Mtu.17 and JBS.549 which are well adapted for upland conditions with a high degree of drought tolerance, and from Mashuri, a Malaysian introduction which is well suited for waterlogged conditions during kharif (June - December) season in India.

Seeds of Mtu.17 were treated with dES (0.2, 0.4, 0.6, 0.8 and 1.0 % in aqueous solution) for 12 hrs preceded by pre-soaking of 12 hrs in distilled water, JBS.549 with nitroso-guanidine (0.005, 0.01, 0.02 and 0.04 %) with 12 hrs pre-soaking in distilled water, and the variety Mashuri was treated with 10, 20, 30 and 40 Kr of gamma rays (dry seeds). The mutants were scored in $M_2$ and further evaluated in $M_3$ for their yield potential.

The mutants differ from their respective mother varieties with regard to plant height (shorter), number of ear-bearing tillers (slight) and panicle length (generally longer) which have contributed to higher single plant yield. However, heading date remained unaffected in the mutants. The results of 1973 experiments indicate that these mutants have retained the characteristics for which their mother varieties are preferred. Hence, there is great scope in India for rice varietal improvement through induced mutagenesis as it assures better productivity without disturbing the varietal preferences of the cultivators.

(Contributed by C. Gangadharan and R.N. Misra, Central Rice Research Institute, Cuttack, Orissa, India).

## Mutation breeding of wheat for powdery mildew resistance

Soft wheat seeds of the variety V.81-12 were treated with EMS (3 g/l). One mutant line (M 1046-4) resistant to powdery mildew (Erysiphe graminis f. sp. tritici) has been found in the $M_3$ generation. This line is also taller than the control, and consequently very lodging susceptible.

In order to use this resistance character, the mutant line was crossed with the initial variety and also with several mutant lines from the same origin. These mutants carry different yield characters but appear very mildew susceptible.

All the $F_1$ were susceptible. The hybrid between the M 1046-4 line and M 131-1 (a short mildew susceptible line) has segregated in $F_2$ independently for resistance and height. The short resistant plants were selected and crossed with the large seed mutant line M 2232, and also with mutant line M 2840 having highly fertile ears.

These new hybrids have given, after selection, mildew resistant short lines with equal or higher yield than control. These results lead to the following conclusions:

- Mildew resistance can be induced by mutagenic treatment.
- The induced resistance gene appears to be recessive.
- The factors for resistance and straw height are not linked.
- Combinations giving at least the same or higher productivity than the initial variety can be selected after crosses between mutants originating from this variety.

(Contributed by H. Touvin, Institut National de la Recherche Agronomique, Station d'Amélioration des Plantes, Dijon-Cedex, France).

## Induced mutations for rust resistance in bread wheat

"Lal Bahadur" is the first triple dwarf wheat variety released for commercial cultivation in India. The variety is characterized by a very high yield potential but its cultivation is primarily restricted to the State of Rajasthan because of its extreme susceptibility to black, brown and yellow rusts. A mutation breeding programme has been initiated to select for resistance combined with the high yield characteristics of "Lal Bahadur".

For this purpose pre-soaked seeds were treated with 0.02 % nitrosomethyl urea for six hours. $M_1$ generation was raised in 1972 at Wellington in the Nilgiri Hills as an off-season crop. 1000 $M_2$ plant progenies were grown at Delhi during winter of 1972-73 under conditions of artificial rust epiphytotic for screening induced mutants against a mixture of prevalent races of all three rusts. The development of rusts in the test plot was severe and this helped in identification of resistant plants. Segregation for resistance was observed in a few lines. The identified resistant plants were harvested and sown in the $M_3$ at Nilgiri Hills where black and brown rust infection on the field scale are very heavy. Observations over the last several years have shown that screening of resistant material in the Nilgiri Hills is a very reliable indication of wider genotypic resistance. Mutants selected for resistance in the $M_2$ have again shown resistance under heavy incidence of rust at Wellington in the $M_3$ generation indicating that a genetic change resulting in resistance has been induced by the mutagenic treatment. Further work on the nature of induced resistance and tests on the retention of agronomic superiority of "Lal Bahadur" in the mutants is in progress.

(Contributed by R.N. Sawhney, H.R. Mohindro and V.L. Chopra, Division of Genetics, Indian Agricultural Research Institute, New Delhi, India).

## Mutation breeding for improved protein quality in barley

Our screening for high lysine mutants in mutagenically treated barley by combined Kjeldahl nitrogen and DBC (dye-binding capacity) determinations has been terminated after the analysis of about 15000 lines. Twenty mutants with a changed relative DBC have been selected, and fifteen of these potential high lysine mutants have now been tested for lysine content in at least two generations. Of these fifteen, ten mutants have from 5 to about 40 % more lysine in the protein than the parent variety, while one mutant has about 10 % less lysine in the protein. Four mutants with only a small increase in relative DBC did not have a persistent increase in lysine content.

The mutant 1508 has the highest increase in lysine content, viz. about 40 %. The drastically changed seed protein composition (1) of this mutant is due to a single recessive gene (2). Compared with the parent variety Bomi, the mutant 1508 is further characterized by a small increase in the nitrogen content of the seeds, a 10 % reduction in seed size, and a reduction in kernel yield per unit area of about 18 %.

(1) INGVERSEN, J., B. KØIE and H. DOLL: Induced seed protein mutant of barley. Experientia 29 (1973) : 1151.

(2) DOLL, H.: Inheritance of the high-lysine character of a barley mutant. Hereditas 74 (1973): 293-294.

(Contributed by H. Doll, A. Andersen, J. Ingversen and B. Køie, Agricultural Research Department, Danish Atomic Energy Commission Risø, Roskilde, Denmark).

## A dwarf mutant oat

Gamma and fast neutron irradiation of a promising oat strain, OT184, made at the IAEA Laboratory in Seibersdorf, Austria, in 1970, and subsequent selection made at IAEA and Winnipeg have resulted in finding a number of height variants in OT184. A dwarf from a treatment of 1150 rads of fast neutrons has been the one most carefully studied. The dwarf is about 35 % shorter than the mother variety. The dwarf plants are fairly normal in appearance with a normal number of leaves and nodes. The upper internodes are shorter and the panicle barely emerges from the flag leaf sheath. Some dwarf plants lack one or two chromosomes but others are normal. All crosses to other varieties studied have 42 chromosomes.

A single completely dominant gene seems to control the dwarf character. Yields based on single plants in 1972 appeared very good but single plot yields in 1973 were less than the mother variety.

A number of crosses have been made with the dwarf in the hope that its very superior straw strength can be utilized in commercial oats.

(Contributed by P.D. Brown, R.I.H. McKenzie and K. Mikaelsen, Canada Department of Agriculture, Research Station, Winnipeg, Manitoba, Canada, and Joint FAO/IAEA Division, International Atomic Energy Agency, Vienna, Austria).

## Genetic analysis of EMS-induced mutants in maize*

In mutagenesis experiments on Zea mays which has many convenient genetic markers, many single locus mutants were obtained by EMS treatments. Among the marker gene used, waxy (wx) was the most convenient one in the further analysis

* reported to Gamma Field Symposia, 1972, Ohmiya, Ibaraki-ken Japan.

of the induced mutants. Its phenotype could be examined in pollen and intracistronic recombination could be observed relatively easily. Although the mutants analyzed were only a few, the radiation induced mutants seemed to show typical characteristics of deletions of considerable size, as seen by less survival and no or little recombination. Contrary to this, most of the EMS induced mutants showed higher survival, good segregation ratio and production of Wx recombinants in the heteroallelic hybrid. Among the 40 EMS induced wx mutants tested, 35 mutants produced Wx recombinant pollen as high as more than $2 \times 10^{-5}$ in the heteroallelic hybrid to the tester $wx^C$. These mutants were used in fine structure mapping of this locus and the preliminary mapping indicated that the size of the wx cistron might not deviate very much from about 0.2 map unit.

Pollen analysis revealed further the presence of leaky mutants. Of the 40 EMS induced wx mutants examined, 17 mutants showed various degrees of waxyness between wx ($wx^C$) and Wx (Wx recombinant). These results and presence of CRM in EMS induced sh1 mutants reported by Chourey and Schwartz (1971) suggest the possibility of induction of missense or base pair substitution mutations by EMS.

(Contributed by E. Amano, Department of Induced Mutation, National Institute of Genetics, 1,111 Yata, Misima, Sizuoka-ken, Japan).

## Pennisetum typhoides mutants

Two radiation-induced mutants affecting the reproduction process have been isolated in pearl millet, Pennisetum typhoides (Burm.) Stapf and Hubb. Stubby head, induced with a dual treatment of thermal neutrons and diethyl sulfate is a facultative apomict that produces an average of 20 % maternal types. Short head is a female sterile - male fertile mutant induced with thermal neutrons. Both mutants have potential use in hybrid production.

(Contributed by W.W. Hanna and G.W. Burton, USDA, Coastal Plain Experiment Station, Tifton, Georgia 31794, U.S.A.).

## Breeding for disease resistance in pearl millet

In the hybrid breeding programme of pearl millet in India, Tift-23A, developed by Burton, has served as the male sterile female parent of all the released hybrids. The line has been selected for its high combining ability for grain yield. During the past three years Tift-23A has been found to be highly susceptible to downy mildew disease (Sclerospora graminicola), with the result that the hybrid programme in pearl millet has suffered a serious setback in the country as a whole.

With a view to introducing disease resistance in this line, 1000 seeds of the B (maintainer) line, were treated with 35,000 rads of gamma rays. 450 $M_2$ progenies were planted in a disease nursery plot having very high infection of downy mildew. Tift-23B and 23A were used as controls after every 10 families. 15 families appeared to be segregating into resistant and susceptible plants, while the rest of the families including controls showed very severe infection. Eighty-four single plants selected from the segregating families were carried to $M_3$ generation. All 84 plants were again planted in the disease nursery; two $M_3$ families showed a high degree of resistance to downy mildew, 12 were still segregating for disease resistance and the rest of 70 families were completely susceptible to the disease.

The two resistant families, namely M 5069 and M 5071, were crossed to Tift-23A. The F1 showed a high degree of disease resistance and a backcrossing programme led to the evolution of two new male sterile lines, 5069A and 5071A, having agronomic characteristics of Tift-23A. These two male sterile lines are five days later in maturity than Tift-23A but compare with it in their combining ability. The male sterile lines are now being multiplied.

(Contributed by S.C. Pokhriyal and H.K. Jain, Indian Agricultural Research Institute, New Delhi, India).

Mutation breeding in cotton

A mutation breeding technique has been employed for rectification of some simply inherited undesirable traits in otherwise agronomically superior varieties of upland cotton (Gossypium hirsutum). Treatment with gamma rays and EI was given to seeds of three varieties (MCU 5, SV 213, H 14) and a large number of progenies screened for specific mutations. Mutants for photoperiod-insensitivity, tolerance to the insect jassid and short branch character are being evaluated for their yield performance and fibre quality.

(Contributed by R.N. Raut, R.S. Panwar, and H.K. Jain, Indian Agricultural Research Institute, New Delhi, India).

Mutation breeding for non-flowering in sugarcane

A programme aimed at inducing mutations for reducing or stopping flowering in some heavy flowering sugarcane varieties which are otherwise potentially high yielders, has been in progress for some time at the West Indies Central Sugarcane Breeding Station. With the coooperation of Brookhaven National Laboratory, New York, we have successfully treated some varieties with X-rays and gamma rays with doses from 3000R to 9000R. Attempts to induce mutations with chemical mutagens were unsuccessful.

The non-flowering mutants recovered earlier in the programme were no better than the parent varieties in sugar yield. Out of the recently isolated mutants, one non-flowering mutant gave 48 % more sugar per acre than the parent variety and one shy-flowering mutant gave 22 % more sugar per acre than the parent variety in the preliminary replicated yield trials. Both mutants are expected to do well in the high rainfall area where conditions for growth are good but where the parents flower heavily and yield less.

(Contributed by P.S. Rao, West Indies Central Sugarcane Breeding Station, Barbados, West Indies).

Mutation induction in soybean

A mutation induction programme using Glycine max. (L.) Merrill cv. "D68X127", a sib-line of the newly released "Forrest" variety, was initiated in 1971. The programme has the practical objectives to induce resistance to the soybean cyst nematode, Heterodera glycine Race 4, to improve protein quantity and quality with special emphasis on methionine content, and to recover and evaluate other mutants of agronomic interest. Mutagens used are fast neutrons ($N_f$), $^{60}Co$ gamma rays, ethylmethane sulfonate (EMS), and diethyl sulfate (dES).

Data relative to the sensitivity of the seed to the various mutagenic treatments were obtained under greenhouse and field conditions. Seeds containing 13 % water were irradiated with different doses (15 - 70 krads) of gamma rays, or $N_f$ (1.0 - 4.5 krads). Seeds, pre-soaked 16 hours in air-bubbled water at 22°C, were soaked 8 hours in air-bubbled EMS solution buffered at pH 7.5 at concentrations from .01 to .10 M. Similarly, seeds were soaked in a 0.15 % (V:V) solution of dES buffered at pH 7.5 at different time lengths (30 - 210 min.) with the solution being replaced every 30 min. because of the rapid hydrolysis of dES at room temperature.

An $M_2$ population was scored for the presence of chlorophyll-deficient and morphological mutants and the result, expressed as percent of progenies that segregated, were: for neutrons 8.6, for gamma 3.6, for EMS 7.4, for dES 5.2 as compared to the control value of 0.3 %.

Examples of the major mutant types observed in $M_2$ have been selfed and show no evidence of segregation in the $M_3$. Some of the mutants show a reduction in bean yield, others appear to yield equal to or better than the mother line. Some $M_3$ progenies from normal appearing $M_2$ plants have shown segregation of mutants. These are probably changes that do not appear in the $M_2$ generation because of the tetraploid nature of the soybean plant.

Our results indicate the following recommended seed treatments for soybeans: 1.5 - 2.5 krads $N_f$ and 20-30 krads $^{60}Co$ gamma rays for seeds with 13 % water planted within one day after irradiation; .025 - .05 M EMS (pH 7.5) for eight hours at 22° C, and 90 - 150 min. in .15 % by volume dES (solution replaced every 30 min.) using presoaked seeds. Chlorophyll deficiency and morphological mutant frequency indicate that fast neutrons and ethylmethane sulfonate were more effective than gamma rays and diethyl sulfate.

(Contributed by M.J. Constantin, W.D. Klobe, L.N. Skold, UT-AEC, CARL, and the University of Tennessee, Knoxville, Tennessee, U.S.A.).

## Mutation studies with soybeans

Since 1971 we have been selecting mutants from soybean seeds treated with 0.1 M EMS, using a local seed material derived from the variety Palmetto as parent. We have been selecting for dwarfness, sturdiness (by measuring the diameter of the stem at the base), and yield (by counting pod number, grain number, and grain weight per plant). Using the pedigree method, we are now in the $M_5$ generation. We have found that segregation occurs in the $M_3$ and $M_4$ generations, but the $M_5$ generation remains quite uniform.

We now have 21 mutant lines of different heights and maturities (the shorter the earlier), and will test their yield in the next season. We have observed that not only flowering date and maturity date, but also plant height vary considerably according to planting time. We have also started studies with gamma irradiated seeds.

(Contributed by Nguyen Van Mung, Biology Section, Dalat Nuclear Research Center, Dalat, Viet Nam).

## Mutation studies in mung bean

The mung bean (Phaseolus aureus) shows relatively little variation, largely because it has been grown for centuries under marginal conditions. Under these conditions, only those genotypes which have the capacity to give some yield under

poor management have been selected. The mutation breeding programme was started with a view to develop strains which would respond to an improved level of management.

Seeds of two varieties, S.8 and Pusa Baisakhi, have been treated with comparable doses of gamma rays, HA, EMS and NMU. A large number of $M_2$ progenies have been screened from each of these treatments and a number of mutant plants identified. The selected mutant plants show one or more desirable characters. An increase in pod number associated with increase in single plant yield has been commonly observed. The pod number in the two control varieties has been found to vary from 25 to 55 while a number of mutant plants have shown pod numbers ranging from 100 to 150. Seed weight increase up to 70 % has been observed in some of the mutants. The other mutants include those showing early maturity, improved plant type in terms of higher harvest index, or dwarfness. Some of the induced variation shows a negative correlation with other yield components.

Not all the mutagens have been found to be equally effective. Thus, an increase in pod number has been commonly observed in EMS treatments while increase in seed weight was more commonly induced by gamma rays.

(Contributed by J.L. Tikoo and H.K. Jain, Indian Agricultural Research Institute, New Delhi, India).

## Anthocyaninless mutant of black gram (Phaseolus mungo)

All seedlings of black gram (Phaseolus mungo) varieties have been found to contain anthocyanin pigments in various plant parts. A mutant obtained after combined treatment of (40 kR X-rays + 0.3 % ethyl methane sulfonate) dry seeds of variety T-9 (pigmented type) was found to be anthocyaninless green in homozygous recessive form. The anthocyaninless mutant is distinguishable from the normal plants at all stages of growth and can be conveniently used as seedling marker to facilitate early and accurate separation after any hybridization. Absence of pigmentation in black gram has been determined to be due to recessive genes at one of the two loci which are complementary to each other.

(Contributed by M.K. Jana and S.A. Rao, Applied Botany Section, Indian Institute of Technology, Kharagpur, West Bengal, India).

## Release of X-ray induced groundnut variety TG-1

The Central Varietal Release Committee of the Ministry of Food and Agriculture, Government of India, decided to release the groundnut (peanut) variety TG-1. This is a bold seeded variety suitable for export market. The mutant was isolated in variety Spanish Improved treated with 55 kR of X-rays in 1958. The Committee also recommended another mutant variety TG-3 for evaluation in yield trials at the district level. In the trials conducted for three years at 14 locations under the Coordinated Oilseeds Improvement Project, TG-3 gave an average pod yield of 1588 kg/ha compared to 1520 kg/ha of variety Jyoti released in 1971.

(Contributed by S.H. Patil, Biology Division, Bhabha Atomic Research Center Trombay, Bombay, India).

## Jute mutants

Over 130 different, true breeding induced mutants in Corchorus olitorius variety JRD 632 have been isolated. Genetics of many of these mutants have been studied and work is in progress to assign these to specific linkage groups using

trisomics. Twentytwo cultures either isolated directly as mutants or in hybrid populations involving induced mutants, are being evaluated for their agronomic characters by the Indian Jute Industries Research Association.

(Contributed by N.S. Rao, D.C. Joshua and R.G. Thakare, Biology Division, Bhabha Atomic Research Center Trombay, Bombay, India).

Yellow seeded mustard

A yellow seeded induced mutant (TM-1) in normally black seeded Brassica juncea has been established. The mutant yields about three percent more oil than the parent variety Rai-5, and the oil is lighter in color. Consumers prefer lighter color mustard oil. Hybridization of this mutant with high yielding, black bold seeded variety Varuna has led to the selection of a strain (TM-4) which has bold, yellow seeds yielding about two percent more oil. These two strains along with three others with compact plant type and appressed pods have been passed on to the Coordinated Oilseeds Improvement Project for further evaluation.

(Contributed by G.G. Nayar, Biology Division, Bhabha Atomic Research Center Trombay, Bombay, India).

Mutations in medicinal plants

Mutation improvement was initiated in Atropa belladonna to isolate mutants which can grow in tropical plains and in Solanum khasianum to obtain mutants with less spines on stem and leaves for ease in harvesting the fruits.

Seeds of an induced mutant isolated in Atropa belladonna which grows well under Bombay conditions and of a curved-spine mutant in Solanum khasianum have been distributed to appropriate agencies for further evaluation of yield and quality of the alkaloids obtained.

(Contributed by N.S. Rao, D.C. Joshua, R.G. Thakare and (Mrs.) B.Y. Bhatt, Biology Division, Bhabha Atomic Research Center Trombay, Bombay, India).

"Hja 366", a mutant with good cookability from the "Rondo" pea

A mutant line "Hja 366" was selected from the $M_2$-population of the ethylene oxide treated Dutch pea variety "Rondo". (Treatment: EO gas from aerosol bottle, 40 min. in a pressure tube, pre-soaked seeds.). Its seed characters are similar to those of Knavel's "drak green testa" (variety "Perfection", X-ray treatment, cf. Blixt 1972). The general habit of the mutant is close to that of "Rondo". the stem length varies from 30 to 40 cm, seeds are somewhat smaller and the growing time is approx. 3 days longer. Because the yielding ability of this mutant has been lower than that of "Rondo" and the recommended Finnish cultivars, "Hja 366" does not seem to be of direct economic importance.

Cooking experiments made from three harvests under Finnish conditions have shown that the cookability of "Hja 366" is much better than that of "Rondo", and even better than that of "Kalle", a standard variety of pea in Finland.

In 1972 the mutant was cooked almost completely in 20 minutes whereas all other material tested by the authors has taken at least 40 minutes to cook

properly. Because easy cookability is an important quality characteristic, at least for dried stored peas, the mutant "Hja 355" is now used in crossing programmes.

BLIXT, S. (1972); Mutation genetics in Pisum. Agric. Hort. Gen. 30.

(Contributed by E.I. Kivi and S. Hovinen, Hankkija Plant Breeding Institute, Hyrylä, Finland).

Male sterile mutants in sweet pepper (Capsicum annuum).

After irradiation of dry seeds of the cultivars Pazardjchka kapia 794 and Kalinkov 800/7 with 12 krad X-rays, and the cultivar Golden Medal with 13.5 krad gamma rays, six male sterile mutants were discovered in the $M_2$ generation.

The genetical analysis and the allelic test reveal that these are non-allelic recessive mutants. The genes responsible for the male sterile phenotype are denoted as follows: $ms_3$, $ms_4$, $ms_5$, $ms_6$, $ms_7$ and $ms_8$.

The anthers of male sterile plants which possess the genes $ms_3$, $ms_6$ and $ms_8$ are shrunken and do not contain any pollen grains. The expression of male sterile phenotype is very stable both under greenhouse and open field conditions. The anthers of male sterile plants which possess the genes $ms_4$ or $ms_7$ are not as shrunken and contain a small quantity of both sterile and fertile pollen grains. The anthers of male sterile plants which possess the gene $ms_5$ are shrunken and do not contain pollen grains when grown in the open field. However, under greenhouse conditions the anthers did produce a small quantity of both sterile and fertile pollen grains.

These mutants are of great interest for heterosis breeding. On the basis of the male sterile line P. kapia 794 $ms_3$, a new method for hybrid seed production was developed and successfully tested in the praxis.

On the basis of one of the male sterile mutants a new heterosis cultivar has been released.

(Contributed by S. Daskaloff, Institute of Genetics and Plant Breeding, Sofia-13, Bulgaria).

Induction of somatic mutations in Jerusalem thorn (Euphorbia splendens Bojeri)

Cuttings of Jerusalem thorn were exposed to gamma rays at 1.0, 1.5, 2.0 and 3.0 krads and planted under intermittent mist spray in the greenhouse bench filled with small gravel stones. Out of 30 cuttings in each treatment, 23 survived in the group treated with 1.0 krads, 18 with 1.5 krads and 4 with 2.0 krads. There were no survivals in the groups treated with 2.5 and 3.0 krads. In the non-irradiated control group, 24 out of 30 cuttings survived.

To force out new shoots from leaf axils, several cut-backs were made on the surviving plants. Mutant types began to appear in new shoots after 3-4 cut-backs and some of the mutated branches so far propagated appear to retain the mutant types. In the 1.0 krad treated group, the mutant types recovered include one small leaf, one small narrow lanceolate leaf, and one irregularly edged leaf with variegation. In the 1.5 krad treated group, the mutant types recovered include one narrow lanceolate leaf, two small leaves, and one minute leaf. All seven mutants show modifications either in shape or color of the leaf.

(Contributed by F.K.S. Koo and J. Cueavas-Ruiz, Tropical Agro-Sciences Division, Puerto Rico Nuclear Center, Mayaguez, Puerto Rico).

## Progress in breeding self-compatible sweet cherries

About 20 years ago, Lewis and Crowe produced the first mutants in the self-incompatibility allele, S, of sweet cherry, Prunus avium L., by ionizing radiation treatment of pollen mother cells in undetached blossom buds. The irradiated pollen was used in normally self-incompatible crosses and self-pollinations; only the mutant pollen grains effected the fertilization of ovules and resulted in self-compatible (self-fertile) plants.

The original few self-compatible genotypes have been used by cherry breeders in Europe and North America to incorporate the self-compatibility alleles in their breeding material and new cultivars. Canada Agriculture Research Station at Summerland, British Columbia, has used self-compatible parents in cherry breeding since 1958. The station introduced the first self-compatible commercial cultivar Stella in 1968. Stella has been used extensively in crosses, and the second generation seedlings from various crosses are at fruiting age. The performance of self-compatible seedlings in comparison to that of self-incompatible ones indicate that self-compatibility is not linked with any undesirable characteristic in the sweet cherry. Since self-compatibility is a definite asset to a cherry cultivar, it appears desirable that all sweet cherry breeding in the future is based on self-compatible parent material.

(Contributed by K.O. Lapins, Pomology Section, Agriculture Canada Research Station, Summerland, B.C., Canada).

## Effects of irradiation on coconut "Makapuno" embryos cultured in vitro

The objectives of our study were to determine the optimum dosage of irradiation and the most suitable stage of embryo development for induction of mutations.

Embryos were irradiated with 0.1 - 3.0 krads of gamma rays either shortly after the start (one week) or at the termination (8 weeks) of the first liquid culture.

Irradiation appeared to have no effect on the growth of the embryos during the initial liquid culture. During the subsequent culture the adverse effects of irradiation became apparent. Inhibition of seedling growth, especially of the root, was very marked. Germination, however, was relatively unaffected except at the highest dose (3 krad). The results were similar for embryos irradiated at one or at 8 weeks of age. A dose of 3 krad was almost lethal, particularly if the embryos were retained in the irradiated media. Many types of morphological abnormalities were found.

(Contributed by E.V. de Guzman and G.C. Manuel, University of the Philippines, Department of Agronomy, Los Baños, Philippines).

## Radiation-induced somatic mutations in Kalanchoe (Kalanchoe laciniata)

Five doses of gamma radiation, i.e. 1,2,3,4 and 5 krads at a dose rate of 72 rad/min were used to produce somatic mutations in Kalanchoe through leaf petiole cuttings. Many different mutants were produced from irradiated petioles and maintained by means of vegetative propagation. These mutants mostly exhibited changes in leaf structure, e.g. leaf margins and leaf shapes and color. They are easily classified by visual inspection.

Mutant plants obtained from the treatments of 2 and 3 krads have nearly round leaves with entire margin while the control has ovate leaf shape with crenate margin.

Doses of 4 and 5 krads yielded mutants with great changes in form, color and structure of the leaf. One mutant from the 4 krad treatment is a dwarf plant with purplish color and curly leaves. It has not yet produced a flower.

(Contributed by A. Nakornthap, Atomic Energy Laboratory, Kasetsart University, Bangkok, Thailand).

Mutation breeding on the hybrids of Rhododendron simsii Planch. (Azalea indica L.)

Spontaneous flower color bud-sports within the hybrids of Rhododendron simsii Planch. (Azalea indica L.) have made a very important contribution towards the development of new commercial cultivars: 30 % of them are spontaneous bud-sports. As Azalea indica L. still remains export plant number one for Belgian horticulture and yearly some 20-25 millions of them are cultivated in Belgium alone, the economic value of flower color sports that are introduced as novelties cannot be denied. With the aim of obtaining new flower colors within those relatively young commercial cultivars, that up to now have not shown any spontaneous flower color sports, a mutation breeding programme was started in 1965.

Recurrent ionizing radiation (soft X-rays: 50 kV - 30 mA; $^{60}$Co gamma rays) was applied to the meristems of dormant axillary buds at the moment of pinching either the vegetative shoots or the flowers. Normally flower color sporting is from "blue-red" over "blue-red with white edge" towards "white" or from "blue-red" over "intense red", "yellow-red" and "yellow-red with white edge" towards "white".

Out of a total of 34 "blue-red" cultivars that were irradiated, 13 mutated towards "yellow-red", "intense red" or "blue-red with white edge". Among the 15 irradiated "yellow-red" cultivars, two mutants towards "purple red" were obtained. A very valuable mutant obtained from a cultivar (De Waele's Favorite) that represents some 10 % of the commercial assortment of the Ghent region, will be commercialized as a novelty in 1974. The mutation is from "blue-red with white edge" towards "yellow-red with white edge". At the monthly flower shows in Ghent it received already twice a first-class certificate. At the third and final presentation it will receive its name.

(Contributed by R. de Loose, Laboratorium voor Bestralingen van het I.W.O.N.L., Rijksstation voor Sierplantenteelt, Melle, Belgium).

## NEW PUBLICATIONS

Nuclear Techniques for Seed Protein Improvement (Proceedings of a Research Coordination Meeting at Neuherberg, FRG, 1972). STI/PUB/320, IAEA, Vienna, 1973.

Induced Mutations in Vegetatively Propagated Plants (Proceedings of a Panel, Vienna 1972). STI/PUB/339, IAEA, Vienna, 1973.

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Polyploidy and Induced Mutations in Plant Breeding (Proceedings of a Meeting jointly organized by FAO, IAEA and EUCARPIA, Bari, Italy, 1972). STI/PUB/359, IAEA, Vienna, 1974. (In press.)

Isotopes and Radiation in Agricultural Research in the Soviet Union (Report of IAEA Study Tours in 1971 and 1972). STR/5, IAEA, Vienna, 1973.

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