Mutation Breeding Newsletter

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

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MESSAGE FROM THE EDITORS

The editors of this Newsletter thank all the readers who have sent comments on the first issue and contributions to the second issue. We hope that your interest will continue to help us make the Mutation Breeding Newsletter a valuable link among mutation breeders and a source of note-worthy information.

For the next issue please send us information and news items (new mutant varieties and lines, short abstracts of important results, coming events of interest, movement of personnel, etc.). We are also interested in knowing the acreage under mutant varieties in your countries and, if possible, the estimated annual value of the mutant crops. Please send this information to us before 1 May 1973.

Björn Sigurbjörnsson
Alexander Micke
Margret Weiner

Report on the Activities of the Plant Breeding and Genetics Section in 1972

The coordinated research programme on the use of nuclear techniques for seed protein improvement had its first full-scale coordination meeting at Neuherberg near Munich (FRG) from 26-30 June. All institutions participating in the programme were represented. The scientists reported very encouraging results with regard to selection of mutants having increased protein or lysine content. The proceedings are in press and will be available by mid-1973.

In order to further stimulate and promote progress in the development of better mutation breeding techniques, a new coordinated research programme has been initiated. Eleven scientists from 10 countries have signed research agreements and had a meeting in October at Bari, Italy, in connection with the EUCARPIA/FAO/IAEA Conference on Mutation and Polyploidy, to discuss the research needed in this field and to decide upon their own research plans.

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A panel of experts was convened in Vienna from 11-15 September to assess possibilities and prospects for using induced mutations to contribute to the much needed genetic improvement of vegetatively propagated crops and woody crop plants. The participants discussed breeding programmes in apple, apricot, banana, cacao, cassava, cherry, citrus, coffee, mulberry, oil palm, peach, pear, potato, roses, rubber, sugar-cane, and tea, and evaluated also the possible future utilization of tissue cultures, single cell cultures and haploids. Following the conclusions and recommendations of this panel, a coordinated research programme on the improvement of vegetatively propagated crops and tree crops through radiation-induced mutations is now being organized.

Twenty nine plant breeders from 27 different developing countries were invited to a study tour on the use of isotopes and radiation in genetics and plant breeding through the U.S.S.R. (4 July - 4 August). The scientists had the chance to visit research institutes in Moscow, Leningrad, Kiev and Novosibirsk, and to discuss breeding of wheat, rye, triticale, barley, potatoes, peas, beans, tomatoes, trees and forage plants in the U.S.S.R.

Other ongoing research programmes are concerned with the utilization of induced mutants in rice breeding and production and with induced mutations for disease resistance.

RESEARCH NEWS

Note: Contributors to this column are kindly requested to be brief in their presentation and to concentrate on newsworthy items. The editors will reserve the right to shorten or reject articles which do not fit into the scheme of "Research News".

A new cotton variety MCU 7 by X-irradiation

The new cotton variety MCU 7 was developed at Tamil Nadu Agricultural University, Coimbatore, India. The mutant plant was selected in M_2 after an 80 kr X-ray treatment and bred true for earliness in the successive generations.

Parentage of the variety MCU 7: The new variety MCU 7 was derived as a mutant arising from X-irradiation of the original culture No. L1143 EE which was isolated at the Cotton Research Station, Srivilliputhur through conventional hybridization, recombination and selection. L1143 EE involved a multiple cross parentage including U4/4, A12 and Kampala (African *hirsutum*), Co 2, MCU 1 and MCU 2 of Tamil Nadu.

Economic attributes of MCU 7 compared with P216F

Characters	P216F (control)	MCU 7 (mutant)	Percent increase over P216F
Kapas yield (kg/ha)	950	1250	30
Lint yield (kg/ha)	330	440	33
Ginning percentage	34	35	1
Staple length	29/32"	1"	3/32"
Spinning capacity (HSC)	37s	46s	9s
Duration of crop (days)	145-150	130	15-20 days earlier
Additional income (Rs/ha)	---	---	685/-

The new variety MCU 7 has now been identified as suitable for medium duration rice fallow areas of Thiruchirapalli, South Arcot, North Arcot and Chingleput districts for replacing P216F. By its cultivation, the production of long staple cotton is expected to increase by 18,500 bales in Tamil Nadu. At the current level of prices, the additional monetary return to be shared by the cotton growers in these districts alone would be of the order of Rs. 50 laks. Seeds of the new variety are being multiplied to meet the demands from the farmers.

(Contributed by T. J. Cornelius, S.D. Peter, S.S. Narayanan, and S. Kamalanathan, Agricultural College and Research Institute, Coimbatore, India).

Mutation breeding for improved protein quality in barley

Mutagen-treated barley is being screened for high lysine mutants by combined analyses for dye-binding capacity and Kjeldahl nitrogen. Two EMS induced mutants having about 15 % more lysine in the protein than the mother variety Carlsberg II have been reported earlier (1). Another mutant with about 20 % more lysine has recently been found in the same variety after a gamma ray treatment. Screening for high lysine mutants in another Danish variety, Bomi, has so far yielded three mutants, which are being analyzed in detail. In a preliminary test one of these Bomi mutants, which was induced by ethyleneimine, appeared very promising since it had about 45 % more lysine in the protein than the mother variety.

The inheritance of the increased lysine content, and the composition (2) and the nutritive value of the seed protein is studied for the mutants and other high lysine barleys. The most promising mutants are utilized in a breeding programme for improved quality of the barley seed protein.

(1) DOLL, H.: Variation in protein quantity and quality induced in barley by EMS treatment. Induced Mutations and Plant Improvement, IAEA, Vienna (1972), pp.331-342.

(2) INGVERSEN, J. and B. KØIE: Protein patterns of some high lysine barley lines. Hereditas 69 (1971), pp.319-323.

(Contributed by Hans Doll, A. Andersen, B. Køie, and J. Ingversen, Agricultural Research Department, Atomic Energy Commission, Research Establishment Risö, Roskilde, Denmark).

Mutation breeding for improved straw characteristics of barley

With the aim to obtain lodging-resistant mutants, a mutation breeding programme was started in 1968 for selection of barley mutants with normal straw length and a normal spike, but with changed stem internode lengths. The programme also includes a selection of mutants with shorter straw, mutants with thicker straw, and mutants with a reduced number of stem internodes. A two-rowed, high yielding but lodging-susceptible variety of spring barley, Abed Bomi, is used as mother variety. The mutagens applied are gamma rays, thermal and fast neutrons, ethylmethanesulfonate, ethyleneimine and isopropylmethanesulfonate. Each year 10,000 M_1 plant progenies are space-planted on 5 x 15 cm. A British Spaced-Plant Seeder has been used with success. A selection procedure based upon selection of single plants from the harvested M_2 material has been outlined.

A great number of mutants have been selected. The determination of the agronomic value, grain yield, and lodging resistance was started in 1972 with M_5 generation material.

(Contributed by V. Haahr and D. von Wettstein, Agricultural Research Department, Atomic Energy Commission, Research Establishment Risö, Roskilde, Denmark, and Institute of Genetics, University of Copenhagen, Copenhagen, Denmark).

Mutation breeding of barley for powdery mildew resistance

The first barley mutant resistant to powdery mildew (Erysiphe graminis f.sp. hordei) was reported in 1942, and since then a number of other resistant mutants have been described. Ten independently induced mutants have recessive, functionally allelic mutant genes in the ml-o locus on chromosome 4 conditioning their resistance. These mutants are being tested for resistance on many locations all over the world. Up till now the mutants have been resistant to all the races and isolates of the pathogen tested for at the seedling stage and in nearly all field tests at the adult stage. This apparently universal resistance makes these mutants promising sources for powdery mildew resistance breeding of barley.

Three mutants selected from EMS-treated Carlsberg II spring barley have been tested in six field trials; in three trials in which the pathogen was absent due to fungicide treatments, the average grain yield of the mutants was 71 % of that of Carlsberg II; in the other three trials in which there was a weak, a moderate, and a severe attack of powdery mildew, respectively, the mutants yielded on an average 75, 81 and 98 % of Carlsberg II. This increase in the relative grain yield of the mutants with increasing disease severity proves the efficiency of the ml-o resistance genes under field conditions. The relatively low grain yield of the mutants in the disease-free trials may be ascribed either to the presence of other mutant genes induced by the EMS treatments or to pleiotropic effects of the ml-o resistance genes themselves. If the latter explanation holds true, it may hamper the utilization of these mutants in barley breeding.

(Contributed by J.Helms Jørgensen, Agricultural Research Department, Atomic Energy Commission, Research Establishment Risö, Roskilde, Denmark).

Mutation induction in soybeans

Soybean seeds of the Palmetto variety were treated with 0.1 and 0.2 M of EMS in a .1 Tris buffer solution at pH.8 for two hours at room temperature. The volume of the solution used was 200 ml for 200 seeds. Similar method was used with dES and the control was treated with Tris buffer alone.

After treatment, the seeds were washed twice with tap water, soaked for two hours and planted in the field the same day. The seeds treated with dES showed very poor germination but the seeds treated with EMS germinated about 50 %. M_2 seeds from the EMS treatment were planted in the greenhouse. The following types of mutations were observed:

Leaf color: (a) pale, yellowish leaf color in young stages.
(b) variegated leaf color becoming normal as the plants grew older.

Leaf shape: (a) lanceolate leaf shape
(b) small, twisted leaves. In both cases, leaf color somewhat paler than normal.

Cotyledon number: Plants having three cotyledons instead of two, and three first true leaves instead of two.

Juvenile leaves: Normal plants produce two simple juvenile leaves before the compound ones appear. The mutant had no juvenile leaves.

Stem: (a) the apical meristems degenerated, and the stem developed several lateral branches
(b) dwarfs, being about one fourth the height of the normal ones but having more branches.

(Contributed by Nguyen Van Mung, Mai Thi Su, and Tran Kim Thuy, Biology Section, Institute of Nuclear Research, Dalat, Viet Nam).

Two cases of radiation-induced gene mutations accompanied by chromosomal changes in barley

1. Male mutation accompanied by a reciprocal translocation. KM (Kmut) 21 b is a radiation-induced "male" (or ovary-less) mutant in a two-rowed cultivar Kanto-Bansei Gall. The mutant had almost completely degenerated ovaries and stigma and only a trace of female organs was recognizable, while anthers of the mutant developed as in normal sib plants. Thus, it was named "male" barley. This male mutant showed pleiotropic effects on various organs of the mutant: lack of main vein of the leaf blades which are narrower than normal plants, and very poor development of lemma and lack of lemma awn. The mutant is completely sterile. It was also found that this gene mutation is accompanied by a reciprocal translocation involving chromosome 6 (Tsuchiya, 1962, 1969). This translocation was analyzed with several translocation tester stocks and found that the translocation had occurred between chromosome 4 and 6. Trisomic analysis is underway to associate this male gene with one of barley chromosomes. Preliminary results showed that the "male" gene mutation occurred in chromosome 4 or 6.

2. White streak mutation accompanied by a paracentric inversion. Takahashi and Moriya (1969) reported a white streak mutant completely linked with uz gene of chromosome 3 and named wst 3. Another white streak mutant (wst) was located on the same chromosome 3 by Robertson (1967). The diagnostic traits of these two mutants are almost the same. When these two mutants were crossed reciprocally, all F_1 and F_2 hybrids showed the white streak character. Takahashi and Moriya (1969) were not able to detect any recombination between wst 3 and uz in F_2 population from the cross Wst 3 Uz x wst 3 uz. When wst 3 Uz was crossed with Wst 3 uz a considerable number of recombinants between wst 3 and uz were found. It was suspected, therefore, that an inversion could be involved in this case. F_1 hybrids between wst 3 uz and another variety showed a bridge-fragment configuration at anaphase I of meiosis. It is, therefore, safe to conclude that the wst 3 mutation is accompanied by a paracentric inversion in chromosome 3. The gene mutation wst 3 was induced by radiation in a six-rowed uzu type cultivar Akashinriki (Takahashi and Moriya, 1967).

These two findings and other cases of gene mutations accompanied by chromosomal aberrations suggest that many more cases may be found if research workers carefully study the chromosome behaviour of F_1 hybrids between mutant and normal plants. It is, therefore, recommended that the research worker dealing with induced mutations should study meiosis of F_1 hybrids between mutants and normal plants before they conduct any detailed genetic analysis.

ROBERTSON, D.W. (1967). Linkage studies of various barley mutations (Hordeum species). Crop Sci. 7:41-42.

TAKAHASHI, R. and I. MORIYA (1969). Inheritance and linkage studies in barley. IV. Ber. Ohara Inst. landw. Biol. 15:35-46.

TSUCHIYA, T. (1962). Radiation breeding in two-rowed barley. Seiken Ziho 14:21-34.

TSUCHIYA, T. (1969). Characteristics and inheritance of radiation-induced mutations in barley. Induced Mutations in Plants. IAEA STI/PUB/231:573-590

(Contributed by T. Tsuchiya, Department of Agronomy, Colorado State University, Fort Collins, Colorado, U.S.A.).

Low outcrossing in mutagen-treated cereals

The wheat varieties Neepawa and Svenno, the oat varieties Harmon, OT184, and Weikus, and the barley varieties Keystone,Union and Quantum plus were utilized in an outcrossing experiment of mutagen-treated material carried out jointly at the IAEA Laboratory Seibersdorf, Austria, and the Canada Department of Agriculture, Research Branch, Research Station Winnipeg, Canada.

The mutagenic treatments consisted of 300-500 R N_f, 10-40 Krad gamma rays, and 0.5-1 kr EMS. To promote outcrossing, the varieties were grown in alternating rows. Outcrossing on the average was, however, only 0.08 %. It can be concluded that the risk of disturbance of practical mutation breeding projects by outcrossing is very small and will be negligible if simple precautions like distant planting are taken.

(Contributed by R. McKenzie and S.C. Hsieh, Canada Department of Agricultur Research Branch, Research Station Winnipeg, Manitoba, Canada, and Joint FAO/IAEA Division, IAEA Laboratory Seibersdorf, Austria).

Mutation breeding for resistance to downy mildew in Pennisetum

Mutation breeding for resistance against downy mildew and ergot in pearl millet has been organized in two directions, namely: (a) mutational rectification of the existing male steriles Tift 23A, which is highly susceptible to downy mildew but a good combiner, and (b) development of an alternate source of male sterility from the highly resistant West African Country.

The rectification of inbred 23B, the fertile counterpart of the Tift 23A male sterile line, has yielded fruitful results in the M_4 and M_5 generations. From a total of 166 M_3 progenies with more than 66,000 plants, 65 single plants which were agronomically good, were advanced to the M_4 generation. Among these, 21 progenies were completely free from the disease under severe incidence in the field. Among 123 progenies carried forward to the M_5 generation, two lines, ML22 and ML23 were found to be completely free of the disease while the check was 100 % killed, and the other M_5 progenies showed a varying proportion of 20 - 80 % infection. The above lines maintained the sterility in the corresponding crosses of 23A. Based on tests with artificial inoculation for two seasons in two different laboratories, the All India Coordinated Millet Programme has recommended their multiplication for release to replace the existing male sterile line Tift 23A which is the female parent of the four pearl millet hybrids released in India.

(Contributed by B.R. Murty, Indian Agricultural Research Institute, New Delhi, India).

LIST OF MUTANT VARIETIES

Name of new variety	Place and date of release (or approval) and name of principal worker and institute	Kind and date of mutagenic treatment/ [Parent variety]	Main improved attributes of variety
BARLEY			
Haya-Shinriki	Japan, 1962 T. Ota, K. Suzuki, Shizuoka Prefectural Agric. Exp. Station, Japan	Air-dry seeds 40 krad ^{60}Co gamma rays (1957) [Aka-Shinriki]	Earliness, good quality
Nirasaki 2-jyo No.8 (previous Gamma No.8)	Japan, 1965 Kirin Brewery Co., Ltd. Japan	Selection from Gamma No.4 x early mutant from Kirin Choku No.1	Early maturity (4-5 days), shorter culm (20 cm)
Amagi 2-jyo No.1	Japan, 1970 Kirin Brewery Co., Ltd. Japan	Air-dry seeds 20 krad X-rays (1965) [Fuji 2-jyo]	Earlier maturity (2-5 days), shorter culm (10-15 cm)
RDB-1	Rajasthan, India, 1972 R.P. Chandola, Government Agric. Res. Station Durgapura, Rajasthan, India	Pile neutrons (1960) 4.5×10^{12} NP/cm^2 [R.S.-17]	Dwarf, early, high grain yielding capacity, non-lodging, less water requirements
RICE			
Nucleoryza	Hungary (approved 1972) Z. Sajo, National Institute of Agrobotany, Tapioszele (in cooperation with K. Mikaelsen, IAEA Laboratory Seibersdorf)	Fast neutrons (1966) [Cesariot]	Earliness, with maintained blast resistance and improved yield

COTTON			
MCU 7	Tamil Nadu, India, 1971 T.J. Cornelius, S.D. Peter, S.S. Narayanan and S. Kama-lanathan, Agric.College and Res. Inst., Coimbatore, India	X-rays (1965) 40, 60 and 80 krad [L1143EE]	Earlier maturity (10-15 days), higher yield, increased spinning capacity
PEPPERMINT			
Todd's Mitcham	U.S.A., 1971 M.J. Murray, A.M. Todd Co., Kalamazoo, Michigan, U.S.A.	X-rays and neutrons (1955-59) [Mitcham]	Darker green herbage color, smaller leaves, more erect and less branched plant habit, earlier maturity (5-10 days)
LETTUCE			
Evergreen	Japan Hyogo Prefectural Agr. Exp. Station, Japan	^{32}P [Butterhead]	Heat tolerance
Giantgreen	Japan Hyogo Prefectural Agr. Exp. Station, Japan	^{32}P [Butterhead]	Heat tolerance
ORNAMENTALS			
Carnation			
Sim Feu Follet	France, 1972 P. Pereau-Leroy, C.E.N. Cadarache, France	Gamma rays (1965) 5000 r [Sim Jacqueline]	Large yellow flower with broad red stripes
Alstroemeria			
White Wings	Netherlands, 1971 M.C. van Staaveren, Aalsmer (in cooperation with Assoc. EURATOM-ITAL, Wageningen)	X-rays (1967) [Orchid Flower]	

LIST OF MUTANT VARIETIES (cont'd)

Name of new variety	Place and date of release (or approval) and name of principal worker and institute	Kind and date of mutagenic treatment/ [Parent variety]	Main improved attributes of variety
ORNAMENTALS (cont'd)			
Dahlia			
Motive	Netherlands, 1971 C. Broertjes Ballego en Zonen, Leiden (in cooperation with EURATOM-ITAL, Wageningen)	Dormant tubers, 2 krad X-rays (1963) [Arthur Godfrey]	
Achimenes			
Early Arnold	Netherlands, 1971	[Paul Arnold]	
Springtime	Netherlands, 1971	[Paul Arnold]	
Compact Arnold	Netherlands, 1971	[Paul Arnold]	

PLEASE NOTE: The apple variety "McIntosh 8F-2-32" printed in our Issue No.1 has not yet been named and should be taken out of the list. Furthermore, we apologize for an error in the same list: the variety "Early Blenheim" is an apricot and not a cherry, as erroneously stated. The Lezpedeza variety "Hi-way" as printed in the list of mutant varieties which was attached to our Issue No.1 has been re-named "Interstate". Please make the necessary amendments on your list.

FUTURE EVENTS OF INTEREST

Date	Place	Title of Meeting
1 - 4 March 1973	New Delhi India	FAO/IAEA Research Coordination Meeting on the Use of Radiation-Induced Mutations in Rice Breeding and Production
4 - 8 June 1973	Novi Sad Yugoslavia	FAO/IAEA Research Coordination Meeting on Induced Mutations for Disease Resistance in Crop Plants
1-20 Sept 1973	Cairo Egypt	Seminar for Plant Breeders trained under FAO/SIDA or IAEA/SIDA Cooperative Programmes
8-12 Oct*) 1973	Wageningen *) Netherlands	FAO/IAEA Research Coordination Meeting on Improvement of Vegetatively Propagated Crops and Tree Crops through Radiation-Induced Mutations
22 Oct-30 Nov 1973	Castelar Argentina	FAO/IAEA/SIDA Training Course on Plant Breeding for Disease Resistance including the Use of Induced Mutations
5 - 9 Nov 1973	Ibadan Nigeria	FAO/IAEA Research Coordination Meeting on the Use of Nuclear Techniques for Seed Protein Improvement

*) tentative date and location

NEW PUBLICATIONS

Year of Issue	Title of Publication	Price
1972	Neutron Irradiation of Seeds III (STI/DOC/10/141)	US $ 5.00
1972	Rice Breeding (Proceedings of a Conference held at IRRI in September 1971). Order from: Information Services, IRRI, P.O.Box 583, Manila, Philippines	US $15.00

PLEASE NOTE....

We would like to compile a list of suitable doses of various mutagens to different plant species. Therefore, we would appreciate receiving information from our readers with regard to mutagenic treatments which resulted in about 50 % survival to maturity. (Please specify species, variety, treated plant parts, age of seeds, mutagen used, mutagen energy or concentration, modifying treatments, cultural conditions such as greenhouse, seed box, field, etc.). Please send such information, as soon as possible, to the Mutation Breeding Newsletter.

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