XA0201600

Mutation Breeding Newsletter

JOINT FAO/IAEA DIVISION OF ISOTOPE AND RADIATION APPLICATIONS
OF ATOMIC ENERGY FOR FOOD AND AGRICULTURAL DEVELOPMENT
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

Issue No. 28 September 1986

INIS-XA--493

'Prabhavati' an iron chlorosis tolerant semidwarf variety of rice developed through mutagenesis

We report here the release of an induced semidwarf mutant of rice directly as an improved variety for commercial cultivation on the vertisols. Sensitivity to iron deficiency of these soils had been a constraint for the cultivation of high yielding semidwarf varieties having the Dee-Geo-Woo-Gen dwarfing gene. These soils, common in the semi-arid to sub-humid regions of the Maharashtra State of India, are medium to deep black, clayey (about 40-65% montmorillonitic clay), calcareous (free $CaCO_3$>10%) and alkaline (pH 7.8 to 9.2).

The local tall cultivars, though tolerant of iron clorosis, are susceptible to lodging resulting in substantial yield losses. A large number of semidwarf and mid-tall mutants were selected in the M_2 generation from 3 tall local cultivars viz., Ambemohor local, Jalgaon 5 and Tuljapur 1 following seed treatment with gamma rays (10 and 20 Krad) and ethyl methanesulfonate (EMS 0.2, 0.4 and 0.6% aqueous solutions; 6 h treatment after 12 h presoaking). Some promising true breeding mutants were evaluated in the M_5 generation along with the check varieties (Nerkar and Misal, 1980). Mutants with good yield potential were further evaluated in multilocation uniform variety trials for 3 seasons (Nerkar et al., 1984). PBN1, one of the semidwarf and iron chlorosis tolerant mutants (obtained from 0.2% EMS treatment of Ambemohor local), yielded 3.3 t/ha as against 2.8 t/ha of Ambemohor local. In the minikit trials conducted on farmers' fields for 2 years, PBN1 and Ambemohor local yielded 2.5 and 2.0 t/ha respectively. Based on these data the mutant PBN1 has been released for commercial cultivation in 1984. The mutant has been officially notified under the name 'Prabhavati' by the Central Sub-committee on Crop Standards, Govt. of India. Characteristics of 'Phrabhavati' and the parental variety are presented in Table 1.

Table 1. Salient features of Prabhavati and Ambemohor local

Character	Prabhavati	Ambemohor local
Plant height (cm)	78.5	116.2
Lodging score (0-4)	0	4
Days to maturity (seed to seed)	110	105
No. of effective tillers/m^2	290	262
Panicle length (cm)	20.5	23.5
No. of grains/panicle	87	92
1000 grain wt (g)	23.8	22.9
L/B ratio	3.2	3.1

'Phrabhavati' has stiff straw, dark green leaves and medium slender, translucent grains retaining the scent of the parent variety. 'Phrabhavati' is non-lodging and responsive to nitrogen (Sawant, 1981). It fits well in the rice-wheat, rice-chickpea, rice-safflower or rice-chickpea/potato-summer, groundnut multiple cropping sequences in the canal command areas. Its cultivation has spread over an area of about 20,000 ha and is expected to cover 100,000 ha in the near future.

REFERENCES

NERKAR, Y.S. and MISAL, M.B., Evaluation of some induced semidwarf and midtall mutants of rice on the iron chlorosis prone black cotton soils. Nat.Acad.Sci. Letters, India 31(8) (1980) 227-228.

NERKAR, Y.S., MISAL, M.B. and MAREKAR, R.V., 'Prabhavati' a semidwarf rice for command areas of Maharashtra. Indian Farming 34(3) (1984) 3-4.

SAWANT, H.D., Yield performance of paddy varieties as influenced by seeding and nitrogen level. Dissertation submitted to Marathwada Agric. University, Parbhani, for partial fulfillment of M.Sc. (Agric.) degree (1981).

(Contributed by M.B. Misal and Y.S. Nerkar, Department of Genetics and Plant Breeding, Marathwada Agricultural University, Parbhani 431 402 (M.S.), India).

Dwarf mutant of winged bean

Winged bean (*Psophocarpus tetragonolobus*) is a tropical legume which was identified as one of the most promising plants of the future because of its protein and oil contents. Seeds, pods, leaves and tuberlike roots are edible by human beings or livestock.

A major limiting factor for wide acceptance of winged bean as a commercial crop is its growth habit. All the presently available types grow like twining vines requiring support (staking) in the field. They are also late in maturity and produce more of vegetative growth than beans and seeds.

A mutation breeding programme sponsored by the Food and Agriculture Committee of the Board of Research in Nuclear Sciences (BRNS) was initiated at the University of Agricultural Sciences, Bangalore by Dr. G. Shivashankar and Dr. B.G.S. Reddy. Seeds of Trivandrum local variety were exposed to gamma rays. Several semidwarf and early flowering mutants were found. The most promising mutant has a plant spread of 400 sqcms and produced more than 35 pods per plant. This mutant matured in 120 days compared to 160 to 180 days required for the parent type. Since it is semidwarf in its growth habit, it can be grown without support. The estimated yield potential of the semidwarf mutant is 1000 kg per hectare.

The dwarf mutants are now being tested in different parts of the country, but also in U.S.A., Philippines, Australia and Japan. It has been found that the expression of the dwarf habit is sensitive to planting date, daylength and temperature. (Reference: Nuclear India 23(5) (1985) and personal communication).

Attempt to improve some yield components and shattering resistance in wheat cv. "Azadi" by induced mutations

"Azadi" is one of the best Iranian wheat varieties, but is somewhat shattering. To improve some yield components as well as to reduce shattering, seeds have been gamma irradiated (^{60}Co) with 50 to 200 Gy in 1982. The M_1 generation was grown 1982/83, and for the M_2 generation, the main spikes of 900 plants were planted ear to row with 20 seeds from each spike. From the selected M_2 plants 30 seeds per spike have been planted for the M_3 generation.

The types and number of variants selected are presented in Table 1.

Table 1.

Objective	M_2	M_3	
	number of selected variants	number of mutants confirmed	number which already has genetic stability
Shattering resistance	18	3	-
Increased number of fertile tillers	12	5	5
Increased number of seeds/spike	13	2	2

From the non-shattering variants selected in M_2 only 3 were confirmed, but all showed segregation in M_3. Selection for increased number of fertile tillers and of seeds per spike appeared to be more successful (Table 2).

Table 2.

Mutant line and controls	No. of plants	No. of fertile tillers	1000 kernel weight (g)	No. of seeds per spike	seed yield per plant (g)
Az-63-14	18	*14.2	35.5	47.5	23.9
Az-63-26	20	*14.7	37.7	51.0	28.1
Az-63-31	17	*14.8	30.9	53.2	24.4
Az-63-33-2	17	*15.3	36.0	54.8	30.2
Az-63-37	10	*15.2	31.7	52.1	25.1
Az-63-7	11	*12.5	31.3	*67.6	26.4
Az-63-33.1	18	7	36.1	*66.6	16.8
Controls I	15	7.9	33.3	44.3	11.6
II	14	9.5	33.2	57.7	18.2
III	21	10.5	33.9	61.0	21.7
IV	16	7.9	37.9	43.8	13.1

(Contributed by I. Naghedi-Ahmadi and F. Majd. Agricultural Department of NRC/AEOI, Tehran, Iran).

"Zyrianka" a mutant variety of sea buckthorn

Among Siberian woody fruit plants a special place is taken by sea buckthorn (Hippophaea rhamnoides L.) which has economic significance due to high nutritive qualities of fruits and valuable medicinal properties of its oil. Sea buckthorn is a new and little selected fruit tree. It would be a serious task for plant breeders to select high yielding varieties suitable for mechanized harvesting.

As a result of mutagenesis studies a wide spectrum of variation of quantitative and qualitative characters was produced at the Institute of Cytology and Genetics of the Siberian Branch of the USSR Academy of Sciences. N118 (Zyrianka) a large fruit form of the sea buckthorn was obtained through the treatment of seeds of "Altai" sea buckthorn by gamma-rays (15 krad) in M_1 and by nitrosomethyl urea (0.01%) in M_2. This mutant has been subjected to state tests since 1984. The new variety has a higher yield of fruits and an increased content of oil, sugar and carotenoids than the standard (Table).

Characteristic of sea buckthorn varieties in different years of harvesting

Characters	Zyrianka	Standard
100 fruits	61-64.1	45.5
Chemical composition of fruits:		
Sugar, %	4.9	3.6
Ascorbic acid, mg %	110	59.8
Carotinoids, mg %	19.7	14.0
Yield of fruits per tree, kg		
1980	4.5	0.8
1981	11.2	8.6
1982	13.9	7.6
1983	11.4	1.1
1984	12.5	12.0

"Zyrianka" has been tested at the I.V. Michurin Local Fruit Station since 1980 in Novosibirsk. The fruits are aromatic and have a pleasant sour-sweet taste. They can be used fresh or in the form of juice, jam etc. Testing values according to 5 score scale were 4.4 for "Zyrianka" and 3.5 for the standard variety.

(Contributed by G.F. Privalov, Institute of Cytology and Genetics of the Siberian Branch of the USSR Academy of Sciences, Novosibirsk).

Effect of gamma-ray treatment of wheat somatic tissue culture

Immature embryos from 52 genotypes of common wheat (Triticum aestivum) were used as explants in in-vitro culture for investigating the effects of gamma-ray irradiation on callus initiation and shoot differentiation. This study comprised four sets of experiments:

1. Dry dormant seeds of seven genotypes were exposed to 30 krad gamma-rays at 30 rad/min., then grown into M_1 plants, from which the immature embryos 15 days after anthesis were excised for in-vitro culture. On the average, the callus induction frequency was 40% higher, while the shoot differentiation frequency remained the same as the untreated control. On the other hand, calli derived from the treated embryos took about 10 days longer for plantlet regeneration. This altogether led to a 10% increase in seedling production.

2. Adult plants from four genotypes were exposed to 1 krad gamma-rays at either the proembryo stage or the young embryo stage (1 or 8 days after anthesis respectively). Immature embryos excised at the age of 15 days were cultured in-vitro. The cultures following treatment at proembryo stage had doubled the induction frequency, but half of the differentiation frequency as compared with the control, resulting in a decrease in seedling production. Cultures following treatment at the young embryo stage had an induction frequency similar to the control, but higher frequencies of both shoot differentiation and seedling production. Therefore, the second treatment seems preferable.

3. Calli derived from twelve genotypes were irradiated with 1 krad gamma-rays at the age of 66 days from incubation. A drastic reduction in shoot differentiation was observed, and nearly half the genotypes lost completely their regeneration ability. Microscopic examination was conducted at 100 days after treatment to detect the changes occurred at tissue and cell level. The irradiated culture was often characterized by a peculiar dark yellow colour, less proliferation of new callus and lower fresh weight, it also had larger cells. This was apparently the result of retarded cell divisions caused by the irradiation.

4. All the calli derived from 29 genotypes exposed to 5-100 krad gamma-rays produced no plantlet. 5 krad might be considered a critical dose at or above which severe damage would be caused to the regeneration ability of callus, even though it allowed the culture to stay alive for a long period. Since giant or huge cells appeared more frequently in old cultures, their presence may be a good indicator for the age of culture.

(Contributed by Gao Mingwei, Liang Zhuqing and Cheng Xiongying, Zhejiang Agricultural University, Hangzhou, People's Republic of China).

Radiosensitivity of callus of safflower, *Carthamus tinctorius* L.

Many observations have been reported on genetic instabilities in cultured plant cells, but few analyses have been made on *in-vitro* mutagen treatment. To develop methods of *in-vitro* radiation mutagenesis in cultured plant cells, the response of callus of safflower, *Carthamus tinctorius* L., to gamma-ray irradiation was examined. Callus was induced from a young leaf of a seedling and cultured on MS media with NAA 10^{-5}M and BA5 x 10^{-6}M. Callus was irradiated with gamma rays from ^{60}Co source at the rate of 1 kR/hr, and their effects of irradiation on growth were examined by measuring its fresh weight.

RD_{50} values of callus, seedling and seed were 12,6 and 40 kR respectively, when irradiated with the dose rate of 1 kR/hr. At lower doses, a considerable dose rate effect was observed, showing less suppression of growth at lower dose rates.

Pattern of growth curve of irradiated callus was similar to unirradiated callus except for decreased growth rate. Depression of growth rate had not recovered in the first subculture after irradiation, however, in the second subculture irradiated callus grew at similar or even higher rate than unirradiated callus.

A conspicuous difference of radiosensitivity was observed depending on the duration of preincubation (4-17d) of callus when checked three weeks after irradiation. But after (7-8 weeks) of culture, this difference in radiosensitivity was no longer observable due to recovery of callus growth.

(Translation from article by O. Yatou in Technical News No. 27, Institute of Radiation Breeding, Ohmiya).

Early maturing induced mutants in high yielding rice varieties of Rio Grande do Sul State (Brazil)

Several early maturing mutants induced by gamma radiation were obtained from the semidwarf varieties BR-IRGA 409, BR-IRGA 410, CICA 8 and CICA 9. The mutants were 4 to 27 days earlier than the original varieties.

Associated changes were observed in all the early mutants. Some showed variation in plant height and/or grain shape and size, others modifications in leaf dimension, plant type and the presence of awns.

Evaluations on grain yield were made on the mutant 410 MU 30, derived from BR-IRGA 410. This mutant is 10 days earlier and seems to have retained the same high yielding potential as the original variety.

Another mutant, CICA 8 MU 53, is 17 days earlier than CICA 8 and, as the latter, possesses resistant reaction to blast (*Pyricularia oryzae*, Cav.). CICA 8 MU 53 is used in crossing with BR-IRGA 409 with the purpose of combining the former's blast resistance and the latter's superior grain quality.

Early mutants 409 MU 15, 410 MU 28 and 410 MU 30 were crossed with the original varieties (BR-IRGA 409 and BR-IRGA 410) aiming to remove negative traits associated with earliness. Another cross was made between the early mutant CICA 9 MU 37 and BR-IRGA 409 in order to combine earliness and good grain quality.

(Contributed by P.S. Carmona, Instituto Rio Grandense do Arroz, Porto Alegre, Brazil).

Mutagenesis of lettuce with ethyl methanesulphonate

Seed treatment of lettuce, Lactuca sativa L., with ethyl methanesulfonate (EMS) has been found to be a very effective means of inducing mutants. Seed were soaked in 0.5, 1.0, and 2.0% EMS for 2, 4 and 6 hours at 15, 20 and 25°C. Presoaking the seed in water for different intervals before immersion in EMS did not increase the effectiveness of the treatments. The greatest number of mutants were recovered in the M_2 generation of the treatment with 0.5% EMS for 4 hours at 20°C. Eighty percent of the 89 M_2 lines tested for this treatment segregated for seedling mutants. Excessive physiological injury resulted in sterility or death of many M_1 plants grown from seed treated at 25°C or with 2% EMS. In a subsequent experiment, it was confirmed that 0.5% EMS for 4 hours at 20°C was an effective mutagenic treatment, but poor germination and severe physiological injury resulted from treatment with the same concentration at the same temperature, except for 8 instead of 4 hours.

In a preliminary test, no resistant mutants were found among 220 M_2 lines inoculated with Sclerotinia sclerotiorum. Numerous seedling mutants useful for genetic studies were obtained. Many different types of chlorophyll deficient mutants occurred, ranging from albinos dying in the cotyledon stage to chlorotic but vigorous and fertile plants with easily recognized phenotype in all stages of development. Several different leaf shape mutants were obtained. One mutant of particular interest flowered only a month after seed sowing, in contrast to untreated plants which did not flower until they were more than three months old. Another mutant had greatly enlarged cotyledons and leaves, and may be useful for breeding.

(Contributed by R.W. Robinson, Department of Horticultural Sciences. New York State Agricultural Experiment Station, Geneva, NY, USA).

A radiation-induced cucumber mutant with marked pleiotropic effects

Glabrous (gl), a single recessive gene, was induced by thermal neutron irradiation of 'Lemon' cucumber seed for 15 hours at Brookhaven National Laboratory, Upton, New York. The cultivar Lemon was chosen for mutagenesis because of its andromonoecious sex expression, which permitted the use of open-pollinated seed from M_1 plants to recover recessive mutants at a higher frequency than would be possible with monoecious or gynoecious cultivars which have lower rates of natural self-pollination.

'Glabrous' is an excellent seedling mutant for genetic studies, since it is fertile and easily recognized on the day of seedling emergence and any time thereafter by the lack of trichomes on its hypocotyl, cotyledons, stem and leaves. Fruit of glabrous mutants are devoid of warts and spines, suggesting that fruit spines and warts are derivatives of trichomes modified during evolution.

There has been interest in using gl in cucumber breeding because of the attractive appearance of the smooth, nonwarty fruit and also because of the glabrous foliage, lacking harsh trichomes that can be bothersome and which can promote the spread of viruses when trichomes are broken and plant sap spread to other plants during harvesting.

The 'glabrous' gene is also of interest to cucumber breeders because of its effect on insect resistance. Pulliam and Lower [4] reported that gl cucumber plants are resistant to the pickleworm. Germplasm homozygous for gl has been released [3] as a biological means of controlling white flies. Cucumber plants lacking trichomes due to gl are not resistant to white flies. On the contrary, *Cucumis* species with the lowest density of trichomes are the most susceptible to white flies [1], and white flies find gl cucumber plants attractive. But a parasitic wasp *Encarsia formosa*, is more mobile and achieves better parasitization of white flies on glabrous cucumber plants [3].

The glabrous mutant is being used in breeding greenhouse cucumber cultivars, but it can have a detrimental effect on cucumber plants grown in uncontrolled environments. When grown in the field at Geneva, New York, gl plants grow vigorously early in the season when the temperature is moderate and soil moisture is adequate. In midseason, however, the stress of high temperature and low soil moisture often results in stunted growth of gl plants. Chlorosis of younger leaves, evidently symptomatic of a mineral element deficiency, was induced in gl but not in gl^+ plants by high temperature (30°C) in a growth chamber. Root hair development was suppressed by gl. The reduced root hair development by gl is considered to restrict uptake of minerals and water, resulting in poor growth of gl plants when grown under stress conditions, but sufficient water and minerals are absorbed under near optimum conditions for good growth and development. This problem can be overcome by the use of F_1 hybrid cultivars heterozygous for gl, which have a reduced density of trichomes [2].

REFERENCES

[1] KOWALEWSKI, E. and ROBINSON, R.W., White fly resistance in *Cucumis* species. Cucurbit Genet.Coop. Report 1(3) (1978) 8.

[2] INGGAMER, H. and DE PONTI, O.M.B., Intermediate inheritance of glabrousness (gl) in cucumber. Cucurbit Genet.Coop. Report 8 (1983) 8-9.

[3] DE PONTI, O.M.B., Breeding glabrous cucumber varieties to improve the biological control of the greenhouse white fly. Cucurbit Genet.Coop. Report 2 (1979) 5.

[4] PULLIAM, T.L. and LOWER, R.L., Investigations on the effects of plant type and morphology of the cucumber on infestation by the pickle worm, *Diphania nitidalis* Stall. Cucurbit Genet.Coop. Report 2 (1979) 16-17.

(Contributed by R.W. Robinson, Horticultural Sciences Dept., New York State Agricultural Experiment Station, Geneva, NY, USA).

Progress in utilization of yellow seeded Trombay mustard in breeding programmes

As reported previously [1,2] a number of promising cultures with yellow seed coat colour (TM-4, TM-9, TM-12, TM-17) were developed at this centre. According to Vanaspathi Manufacturers Association Oilseed Research and Development Institute's (VORDI) reports [3] from the years 1979-83, they distributed 6256 kg seeds of TM-4 (yellow seeds) for cultivation in Rajasthan State. TM-4 is preferred by farmers in the region, as it is dwarf and matures 25-30 days earlier compared to the local varieties. All India Co-ordinated Research Project on Oilseeds (AICORPO) reports [4] from 1978-85 further indicate that from 1977 onwards the yellow seeded TM-strains have been used in 376 crosses at all major centres for mustard improvement programmes in the country. They have been used mainly to introduce earliness and yellow seed colour. The reports show that at least six cultures developed using TM-4 at Durgapura station in Rajasthan reached state trials during 1984-85 and two were entered in the AICORPO trials during 1983-84 from Berhampore station.

REFERENCES

[1] ABRAHAM, V., BHATIA, C.R., Utilization of yellow seeded Trombay mustard mutants in cross breeding. Mutation Breeding Newsletter (1985) no. 25:3-4.

[2] ABRAHAM, V. and BHATIA, C.R., Development of strains with yellow seed coat in Indian mustard (*Brassica juncea* Czern and Coss). Z. Pflanzenz. (1986) in press.

[3] VORDI, Rapeseed and Mustard, Research and Development Programmes from the years 1979-83.

[4] AICORPO, Annual Progress Reports from the years 1978-85 of All India Co-ordinated Research Project on Oilseeds, Rapeseed-Mustard Research Workers Group Meetings.

(Contributed by V. Abraham and C.R. Bhatia, Nuclear Agriculture Division, Bhabha Atomic Research Centre, Trombay, Bombay 400085, India).

Mutants obtained after gamma irradiation of Jerusalem artichoke cv. Violet de Rennes (*Helianthus tuberosus* L.)

Tubers of Jerusalem artichoke cv. Violet de Rennes (*Helianthus tuberosus* L.) were irradiated at 3000 rads of gamma rays (^{60}Co). The material consisted of dormant tubers preserved after harvesting in cold storage at 4°C for about three months, and of tubers stored at room temperature for the same period. Before irradiation all visible tuber eyes were removed to a depth of 5-20 mm and the tubers were dried for one night to stimulate production of a thin protective layer to prevent rotting. After irradiation, de-eyed tubers were planted in humid sand, in April 1984. Sprouting from the callus occurred wihtin 20-40 days. The tubers were planted in the field in June 1984.

In the first cycle M_1V_1 (June - November 1984) we observed 65% plant survival, the same in the treated and control material. Ten percent of treated plants flowered, but none in the control. Adult plants from treated tubers showed some morphological deviation in leave shape and size, but not in branching or plant height, all plants having reached 150-160 cm.

The tubers were kept in the field, until weather conditions were favourable for harvest in April 1985. Most of the plants had tubers with red purple skin, the same as control; a few plants had white skinned or chimeric tubers with red purple and white colour: these were also smaller in size and lower in weight.

Tubers were sown in the second cycle M_1V_2 (April - November 1985) according to this scheme:
a) white skinned tubers as plant progenies
b) pieces obtained by cutting one red purple skinned tuber
c) untreated red purple skinned tubers as control.
After harvest in November 1985, tubers were washed, weighed, classified and stored at 4^oC.

Plants developed from white tubers had unbranched, thinner stems compared to control, but they showed no difference in leaf colour and shape or height, in fact the average height of all plants was 2.5 metres as in the control. As regard to the colour of tuber skin we observed one plant which produced uniform white skin tubers, two plants with white skin and red purple halo and one plant having 54 uniform white tubers, 36 white with red purple halo and 2 red purple tubers. The last one flowered a little later than the others. Plants arising from red purple tubers were very similar to control and produced red purple tubers.

The most important differences observed in M_1V_2 plants were:

- The M_1V_2 plants frequently showed changes in morphology, such as unbranched types which are suitable for dense planting.

- Plants coming from irradiated tubers in many cases were able to flower and produce seeds, other ones only produced flowers. The control plants were able to produce floral buds without proceeding to flower or seeds. The possibility of mutants to produce seed in a typical vegetatively propagated crop opens a perspective of exploring the genetic variability through sexual reproduction.

- A large variability caused by the radiation treatment was observed concerning the number and the weight of tubers. On these parameters, selection is foreseen.

- Some biochemical modifications of the white tuber mutants were detected, influencing the carbohydrate metabolism. We can assume that the reserve metabolism of plants has been modified in favour of high free sugar percentage, with the loss of hig carbohydrates reserve.

(Contributed by Fiorenza Coppola, Division FARE/TER-COM, ENEA, C.R.E. Casaccia, Rome, Italy).

<u>Mutagenesis of upland rice at IRAT</u>

The intensification of upland rice growing makes it necessary to obtain varieties resistant to lodging. The semi-dwarf gene used in the breeding of lowland rice may be appropriate only in certain particularly favourable conditions. Resistance to lodging, however, should not be accompanied by a reduced resistance to stress conditions, e.g drought or blast infection. A solution to the problem could be mutagenesis applied to traditional varieties of upland rice with the aim of obtaining a shorter plant height. Other characters obtained by mutagenesis may of course also be of interest.

IRAT* has been using the technique of mutagenesis with the assistance of the Montpellier Station of INRA** (Mr. Marie), which has a gamma irradiator and applies mutagenic treatments since 20 years. The treatment is given to batches of approximately 5000 seeds per variety at a dose of 25-30 krad over 30-60 days. IRAT has also used the chemical mutagen EMS in liquid or gas phase (Mr. Arraudeau).

The main varieties treated with gamma rays were as follows:

Name	Origin	Year of treatment
63-83	Selection in Senegal	1971
IAC 25	Selection in Brazil	1974
Moroberekan	Variety from Côte d'Ivoire	1974
IAC 5100	Selection in Brazil	1978
Early Pratao	Variety from Brazil	1978
Makouta	Variety from Côte d'Ivoire	1978

It should be noted that all these varieties are of the morphological group javanica, which is genetically similar to the japonica group. The main variety treated with EMS was Kagoshima Hakamuri from Japan. Usually, from M_1 one panicle per plant was harvested for M_2 progenies; deviant plants (assumed to be mutants) were harvested and sown as M_3 lines and M_4 families.

With all the varieties mentioned above, numerous mutants have been obtained, some of which are of agricultural interest, in particular those with shorter plant height. There are 35 mutants recorded so far in the IRAT catalogue of upland rice cultivars, as follows:

Parent	Mutants	Place of selection
63-83	IRAT 13	Côte d'Ivoire
	IRAT 78	Côte d'Ivoire and Cameroon
	IRAT 79	Côte d'Ivoire and Cameroon
	IRAT 101	Côte d'Ivoire
Moroberekan	IRAT 113-117	Côte d'Ivoire
IAC 25	IRAT (or IREM) 191-196	Guyana and Brazil
	IRAT 239 and 240	Guyana and Brazil
IAC 5100	IRAT 241-249	Guyana and Brazil
Early Pratao	IRAT 250-256	Guyana and Brazil
Makouta	IRAT 257 and 258	Guyana and Brazil

(In the reports on variety experiments, certain mutants are still called by their original selection number. For example, Sel IRAT 194.1.1 is written instead of IRAT 78 in the ADRAO tests).

* IRAT: Department of Food Crops of CIRAD (Centre for International Co-operation in Agricultural Research for Development), France.

** INRA: National Institute for Agricultural Research, France.

Various characters have been selected in the mutants mentioned above, e.g.:

- Medium height (100-120 cm, instead of 130-150 cm in the parent), in particular: IRAT 13, IRAT 114, IRAT 194, IRAT 242, IRAT 250, IRAT 257;
- Better specific adaptation to certain environments: IRAT 79; or greater adaptability: IRAT 101.

Other mutants obtained have not been entered in the catalogue of cultivars but are kept in a collection. Of particular interest would be the following mutants derived from 63-83:

- M 312 A: semi-dwarf height, good panicle exsertion (as a result of a small reduction in the length of the upper internodes);
- M 65 and M 327 A: two identical mutants of semi-dwarf height with strong tillering, but with the thick roots with few ramifications like the parent;
- M 1352: short height, panicle of the "wheat type", sensitivity to green smut.

Genetic studies have been made for some of the mutant characters:

- The semi-dwarf type of IRAT 13 is controlled by the recessive allele of single gene;
- The semi-dwarf character of M 312 A is controlled by a single recessive gene which is different from that of Taichung Native 1 and identical to one in a presumable mutant of Century Patna 231 (obtained in the United States and kept in Madagascar);
- The semi-dwarf and strong tillering characters in M 65 or M 327 A and the characters of short height and sensitivity to green smut in M 1352 are transmitted together (the mechanism has still to be elucidated).

REFERENCES

JACQUOT, M., Short plant height and good panicle exsertion in rice. Agron. Trop., 30(3) (1975) 241-244 (in French).

JACQUOT, M., "Rice breeding for unfavourable upland conditions", Proc. Int. Rice Res. Conf., IRRI (Los Baños, Philippines, 1-5 June 1985) (1985).

MARIE, R., Experimental mutagenesis, Agron. Trop. 29(9) (1974) 892-900 (in French).

(Contributed by M. Jacquot, Institut de Recherches Agronomiques Tropicales et des Cultures Vivrièresm Avenue du Val de Montferrand - BP 5035, 34032 Montpellier Cedex, France).

Applied mutation research in field crops at Tamil Nadu Agricultural University

Mutagenesis has been applied for crop improvement at the Tamil Nadu Agricultural University, Coimbatore, India since 1965. Upto 1986, fifteen mutant varieties have been developed and released for cultivation (Table).

Crop species	Mutant variety	Year of release	Mutagen and dose	Parental variety	Special features
sorghum	Co.21	1977	X-rays (40 kR)	CSV.5	Tall and high yielding grain cum fodder type with sweet stem, tolerant to major insects and diseases
pigeonpea (redgram)	Co.3	1977	EMS (0.6%)	CO.1	A bold seeded high yielding and higher shelling mutant with field dormancy for 15-20 days
redgram	Co.5	1984	Gamma rays (16 kR)	Co.1	Early maturity, daylength insensitive, drought tolerant
blackgram	Co.4	1978	MMS (0.02%)	Co.1	Early maturing, erect, compact, short, statured, determinate and daylength tolerant
greengram	Co.4	1982	Gamma rays (20 kR)	Co.1	High yielding, early maturing (85 days) drought resistant
dolichos Lablab	Co.10	1983	Gamma rays (24 kR)	Co.6	High yielding, bushy with greenish white tubular pods
groundnut	Co.2	1984	EMS (0.2%)	POL.1	A bold seeded high yielding and higher shelling with field dormancy for 15-20 days
cotton	MCU.7	1972	X-rays (80 kR)	L1143 EE	Medium staple, short duration, suitable for rice fallows adaptable, open plant type
cotton	MCU.10	1982	Gamma rays (30 kR)	MCU.4	Long staple (25 mm), drought tolerant, resistant to black arm, Rhizoctonia and Alternaria
tomato	Co.3 (Marudham)	1981	EMS (0.1%)	Co.1	Compact dwarf determinate, lending itself for higher density planting (60 x 60 cm). Fruits round and smooth, rich in vitamin C (25 mg/100g) performs well in summer season also
turmeric	Co.1	1983	X-rays (5 kR)	Erode local	Bright orange yellow attractive rhizome with higher curing per cent (19.5) and curcumin content (2.65-3.13%) field tolerant to common diseases

Crop	Mutant variety	Year of release	Mutagen and dose	Parental variety	Special features
turmeric	BSR.1	1986	X-ray (10 kR)	Erode local	Orange yellow, thick and long internode, high curcumin content and increased curing percentage
chillies	MDU.1	1977	Gamma rays (30 kR)	K.1	Compact plant type with cluster flowering and fruiting, long dark shinning fruit. Increased yield of 20.3% over parent and more pungent than K.1
bhendi	MDU.2	1978	DES (0.04%)	Pusa Sawani	Attractive light green long fruits. Increased yield over Pusa Sawani (12.3%). Less of crude fibre (12.3%) compared to 14.7% in Pusa Sawani
forage cowpea	Co.5	1986	Gamma rays (30 kR)	Co.1	More nutritive, shorter duration, higher yielding (16%) forage legume. Compatible for inter cropping with fodder cereals

(Contributed by S.R. Sree Rangasamy, School of Genetics, Tamil Nadu Agricultural University, Coimbatore 641 003, India).

Growing mungbean as a catch crop using early maturing and high yielding mutant varieties

Mungbean is an important pulse crop of Pakistan and many Asian countries. By virtue of its short duration and flexibility in terms of adaptation to different sowing seasons mungbean can fit very well in wide array of niches available in the existing crop rotation practices. As an example, an extra crop of mungbean can be obtained in the fallow period (May-June) between wheat harvest and rice or maize plantation on from fallow fields preceding major crops such as cotton, provided very early maturing (60-65 days) and high yielding varieties become available. The native mungbean cultivars do not fit in the above niche due to their late maturity and are usually caught by monsoon rains during pod filling if sown after wheat harvest. They also suffer the drawbacks of indeterminate excessive growth and asynchronous maturity. With the objective of evolving very early maturing and high yielding genotypes which could fit in the above niches, mutation breeding of mungbean was initiated at NIAB, Faisalabad in 1977.

Dry dormant seeds of mungbean variety 6601 and strain Pak 22 were treated with gamma rays from 5 Krad to 80 Krad. The M_1 was grown in Spring 1977 and M_2 in the following summer. Out of nearly 83,000 M_2 plants from 1625 M_1 plant progenies plants with desired characters were selected and further evaluated in M_3. In M_4, 71 selections were subjected to preliminary yield trials and seed protein analysis.

selection was continued in subsequent generations. During the years 1980-84 performance of the best mutants along with their parents was studied in the fallow period after wheat at NIAB and in multi-location trials through the Department of Agriculture. The salient features of the most promising mutants namely NM13-1 (derivative of var. 6601, 10 Krad) and NM20-21 (derivative of strain Pak 22, 40 Krad) are presented in tables 1 and 2.

Table 1. Comparison of important agronomic characteristics of mutants with parents when sown in the fallow period between wheat harvest and rice/maize planting (average of four crop seasons 1980-1983)

Characteristic	Mutant NIAB Mung 13-1	Parent 6601	Mutant NIAB Mung 20-21	Parent Pak-22
Crop duration (days)	56	76	58	75
Plant height (cm)	56	74	47	72
No. of pods per plant	26.3	21.5	30.2	23.8
Pod length (cm)	7.6	7.6	7.5	7.5
No. of seeds per pod	11.9	11.8	11.2	12.2
Pods with less than 50% filling (%)	14.6	19.2	11.8	18.8
Harvest index	28.0	13.2	31.2	12.9
Per day productivity (kg/ha)	24.7	13.0	25.9	13.2
Thousand seed weight (g)	40.5	37.5	38.6	35.9
Seed protein contents (%)	23.7	23.0	22.8	23.0
Seed colour/surface		green/shiny		
Pollen fertility	96.1	96.5	94.9	94.8
Disease reaction:				
Mungbean yellow mosaic virus	mod.tol.	mod.tol.	tol.	mod.tol
Cercospora leaf spot	mod.susc.	mod.susc.	mod.tol.	mod.susc.

Table 2. Average yield performance of mutants and their parents in multilocation trials conducted in the fallow period between wheat harvest and rice/maize planting during 1980-1983.

Mutant/ Parent	Average yield (kg/ha) 1980 1 loc.	1981 1 loc.	1982 8 loc.	1983 19 loc.	4 years av. yield of 29 loc. (kg/ha)	% increase or decrease over check var. 6601
Mut. NM13-1	1090	1471	1122	1400	1271	43.9
Mut.NM20-21	1472	1511	1149	1368	1375	55.7
Strain Pak-22	568	1051	776	-	798	-9.6
Var.6601 (check)	757	1004	780	991	883	-

When grown soon after wheat harvest both the mutants mature very early (55-58 days). They are characteristically short statured with erect, compact and determinate growth habit. The mutants mature uniformly, bear a higher number of well filled pods, produce grains of uniform size, give higher yield and the crop can be lifted in a single harvest operation before the onset of monsoon rains. Mutant NM20-21 is relatively more short statured, highly tolerant to mungbean yellow mosaic virus MYMV, gives about 57% higher yield than standard var. 6601 and is preferred in maize growing areas. Mutant NM13-1 possesses the same level of tolerance to MYMV, gives about 44% higher yield than the parent var. 6601 and finds favour with the growers as a very early maturing variety in rice growing areas. The farmers do not only fetch additional income by growing an extra crop from the same piece of land but also the fertility of their fields is improved to benefit the succeeding crop. When grown in spring preceding cotton the mutants take about 60 days to mature leaving sufficient time to prepare the land for cotton. Both the mutants have recently been approved by the Punjab Seed Council as commercial varieties under the names of NIAB Mung 13-1 and NIAB Mung 20-21 respectively and released for general cultivation.

(Contributed by Ilyas Ahmad Malik, Ghulam Sarwar and Yousaf Ali., Division of Mutation Breeding, Nuclear Institute for Agriculture and Biology, P.O. Box 128, Faisalabad, Pakistan).

Erectoides mutant in serradella (Ornithopus sativus)

In 1971 a new mutant called erectoides was selected as the result of seed treatment of serradella cv. "Mazurska Biala" with ethyl methyane-sulphonate (EMS). The mutated plants are characterized by a deep situated root neck, a great number of shoots and especially vertical growth. The flower colour is white as in the initial variety. Because of the characteristic phenotype the mutant was given the name "bunchy"-erectoides type. Morphological characteristics of the mutant compared with the intial line cv. Mazurska Biala are shown in Table 1. Segregations in M_2, M_3 and M_4 indicated that the mutation is monogenic.

In 1975 the mutant was crossed with the variety 'Warta'. The F_2 and F_3 progenies were negatively selected for white-flowering plants. The pink-flowering plants were measured, estimated for their mass and number of stems. The material was divided into 6 types. The results presented in Table 2. suggest that the biomass of plants increases from bunchy forms through bunchy intermediate to half-standing forms. The mass of rosette plants was much higher than of bunchy plants, but smaller than of intermediate half-standing ones.

In subsequent years, further selection was made. "Bunchy plants, intermediate type 1" appeared to be the most stable phenotypically. That type was included into trials as strain WTD-8006. The results of experiments at the Plant Breeding Stations Kosieczyn and Wiatrowo 1979-1982 are presented in Table 3. Later, among segregants from the same

Table 1. Characters of the erectoides mutant

	Mean for Ornithopus sativus	Mean for the mutant erectoides
Number of shoots	2-5	18-24
Height of the plant	50-70 cm	48-54 cm
Number of the leaflets of one leaf	5-15 pairs	8-14 pairs
Length of the leaflets	8-12 mm	6-9,5 mm

Table 2. Characters of F_4 plants from the cross "erectoides" x "Warta" (1977)

Plant type	Green mass g	Green mass g	Ratio of the mass of stems to the mass of plants in %
Mutant erectoides	193,4	65,6	33,9
Bunchy plant - intermediate type 1	300,2	105,4	35,1
Bunchy plants - intermediate type 2	312,0	121,0	38,8
Half-standing, type 3	369,0	163,4	44,3
Half-standing, type 4	473,8	246,2	52,0
Rosette plant	344,6	138,8	46,1

Table 3. The green mass yield of serradella at Kosieczyn and Wiatrowo (1979-82)

Variety/strain	Green mass yield, t/ha				
	1979	1980	1981	1982	Mean
Mazurska Biala	24,25	50,08	24,15	29,49	31,99
Bydgoska	22,35	40,94	30,24	21,99	28,88
Lacerta	21,58	40,06	31,02	33,79	31,61
WTD-8006	24,02	44,69	31,85	28,39	32,24

Table 4. The green mass yield of serradella at two dates of cutting (Wiatrowo 1984).

Variety/strain	Green mass yield, t/ha date of cutting		Mean
	a	b	
Mazurska Biala	42,6	77,2	59,8
Lacerta	45,0	75,0	60,0
Bydgoska	41,7	80,1	60,9
KOB - 4189	42,9	83,1	62,0
WTD - 8008	49,2	82,6	65,9

a = beginning of flowering
b = end of flowering

cross, the intermediate, half-standing form strain WTD-8008 was selected. The plants have a large number of stems and branches. However the stems are thicker, and the leaves bigger than in the typical "bunchy" mutant. The performance presented in Table 4. indicates a good potential of the strain WTD-8008 to become a variety.

(Contributed by A. Czerwinska, T. Michalski, Z. Paszkiewicz, Plant Breeding Station, Wiatrowo, Poland).

NEW PUBLICATIONS

Mutagenesis: Basic and Applied (Proceedings of a Satellite Symposium following the Genetics Congress 1983, Delhi)
Print House, P.O. Box No. 3345, Lucknow 226001, India

Barley Register
(contains about 8000 cultivar names with references, pedigrees etc.). May be purchased through scientific bookstores or by post from the Canadian Government Publishing Centre, Supply and Services, Ottawa, Ontario K1A 059, Canada.
Please refer to catalogue no. A53-1783/1985.

The Biochemistry of Host Resistance to Diseases and Insects
(1985 Plant Science Lectures at Iowa State University published in May 1986 issue of Iowa State Journal of Research). Copies can be purchased for $ 9.00.- from Darlene Kauffman, Agronomy Department, Iowa State University, Ames, IA 50011, USA. Cheques payable to Iowa State Journal of Research. From outside USA use international money order.

LIST OF VARIETIES

The Plant Breeding and Genetics Section of the Joint FAO/IAEA Division undertakes the collection and dissemination of information on commercially used agricultural and horticultural varieties developed through the utilization of induced mutations. This list does not claim to be comprehensive. Its content is strictly based on information transmitted by the breeders themselves and/or other institutions involved. Listing of a variety does not imply its recommendation by FAO/IAEA.

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] or mutant crosses (mutant underlined)	Main improved attribute of variety
Avena sativa L. (oats)			
Dolphin	Australia, 1984 A.R. Barr South Australia Dept. of Agric. Adelaide and J.D. Oates Plant Breeding Inst. Sydney	cross West x OT207	Culm length 71 cm compared with West 100 cm. Short culm from mutant OT207 developed by R. McKenzie at Manitoba, Canada. Yield exceeds West by 24%. 1985 sown on ca. 4700 ha.
Echidna	Australia, 1984 A.R. Barr South Australia Dept. of Agric. Adelaide	cross West x OT207	Short culm from mutant OT207 developed by R. McKenzie at Manitoba, Canada (shorter than Dolphin). Yield exceeds West by 32% in 1985 sown on ca. 23000 ha.
Cajanus cajan L. (pigeon pea)			
TAT 5	India, 1984 S.E. Pawar, R.G. Thakare G.R. Fulzele, A.N. Patil, A.R. Kshirsagar K.B. Wanjan P.K.V. Akola Nuclear Agriculture Division BARC, Bombay	seed fast neutron, 1,5 krad 1972 [T-21]	ca. 50% larger seed size TKW 100-117 g early maturity (140 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] or mutant crosses (mutant underlined)	Main improved attribute of variety
TAT 10	India, 1985 S.E. Pawar, K.B. Wanjari A.R. Kshirsagar, G.R. Fulzele P.K.V. Akola Nuclear Agric. Division BARC, Bombay	cross of mutants TT-2 (large seed compact) x TT-8 (early) both induced by 2,5 krad fast neutron 1972 [T-21]	Medium large grain, extra early maturity (115-120 d)
Hibiscus moscheutos			
Shirasagi-no-Yume	Japan, 1985 H. Hasegawa H. Toratani M. Maeda Radiation Center of Osaka Prefecture Shinke-cho Sakai, Osaka Pref.	seeds, gamma rays 30 krad 1981 [Sakai-no-hana]	Variegated flower colour pink/ white, sterile
Hordeum vulgare (barley)			
Empress	Canada, 1983 J.H. Helm, D.F. Salmon D.H. Dyson, W.M. Stewart J.D.M. Skramstad, C.A. Goettel G.C. McKinnon and N. Burwash Alberta Agric.Crop Res., Cereal Breeding Programme Lacombe, Alberta	Cross (66-289-1509 (spont. mutant) x Luther x Conquest	Six-rowed spring feed barley adapted to higher yield areas outyields best local by 8-15% shorter culm
Advance	USA, 1979 R.A. Nilan, A.J. Lejeune C.E. Muir and S.E. Ullrich Wash.State Univ. Agric.Res. Centre Pullman, WA	reselection from cross [(Foma x Triple Bearded Mariout) x White Winter] x Blazer	Six rowed spring barley yield 11-14% more than Blazer, 13 cm shorter

Hippophaea rhamnoides L. (sea buckthorn)			
Zyrianka	USSR, 1985 G.E. Privalov, N.S. Shchapov, L.P. Solonenko Inst.of Cytology and Genetics Siberian Branch USSR Acad.Sci. Novosibirsk G.M. Vorobiova I.V. Michurin Local Fruit Station Novosibirsk	seeds, 15 kr gamma rays 1959 and NMU 0.01% 1965 [wild form from Altai]	Higher yield of fruits, increased content of oil, sugar, ascorbic acid and carotenoids
Lagerstroemia indica L. (crapemyrtle)			
Centennial Spirit	USA C.E. Whitcomb Dept. of Horticultural and Landscape Architecture Oklahoma State Univ. Stillwater OK	seeds, 4% EMS, 1 hr, 1978 selection from 2nd generation of open pollinated mutants	Smaller, thicker leaves, mildew resistance, little flower discolouring, strong stem, erect, cold tolerant till -20°C and drought tolerant
Prairie Lace	USA C.E. Whitcomb Dept. of Horticultural and Landscape Architecture Oklahoma State Univ. Stillwater OK	seeds, 4% EMS, 1 hr, 1978 selection from original treated seedlings population	Sterile
Oryza sativa (rice)			
M-202 (PI 494105)	USA, 1985 C.W. Johnson, H.L. Carnahan S.T. Tseng, J.J. Oster and J.E. Hill Calif.Coop. Rice Res.Found. Biggs CA and Dept.of Agronomy and Range Science, Univ. of California Davis CA	cross (IR-8 x Cs-M3) x (10-7 x M-101)	Photoperiod-insensitive, early, semidwarf, yield ca. 10 t/ha suitable to replace "M9" in cooler areas

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] or mutant crosses (mutant underlined)	Main improved attribute of variety
Calmochi-101	USA, 1985 H.L. Carnahan, C.W. Johnson S.T. Tseng, J.J. Oster and J.E. Hill Calif.Coop. Rice Res.Found. Biggs CA and Department of Agronomy and Range Science Univ. of California Davis CA	cross Tatsumi mochi x (<u>M7</u> x S6)	Photoperiod-insensitive, very early, semidwarf, 4 cm shorter than M-101, better grain size than Calmochi 202 and 17 days earlier, expected to replace Calmochi 202 waxy endosperm
<u>Phaseolus vulgaris L</u>. (bean)			
Ouray	USA, 1982 D.R. Wood Colorado State University Fort Collins Co. 80523	cross (<u>Sanilac</u> x U.I.111) x rust resistant pinto selection	Bush habit derived from mutant variety "Sanilac". Resistant to bean common mosaic virus and some races of <u>Uromyces</u> <u>phaseoli</u>
<u>Rhododendron simsii</u>			
Osta	Fed.Rep. of Germany, 1986 O. Stahnke 3177 Sassendorf in co-operation with F. Walther, Fed.Res.Center for Horticultural Plant Breeding 2070 Ahrensburg	X-rays, 25 Gy rooted cuttings, 1983 [Bertina]	Flower colour: white with red centre

Rosa sp.			
Pink-Ilseta	Fed.Rep.of Germany, 1985 Rosen-Tantau D-2082 Uetersen in co-operation with F. Walther & A. Sauer Fed.Res.Center for Horticultural Plant Breeding 2070 Ahrensburg	X-rays, 25 Gy in vitro derived micro-shoots, 1983 [Perl-Ilseta]	Flower colour: intense pink flower type: Ilseta
Vigna mungo L. (black gram)			
TAU 1	India, 1985 S.E. Pawar, R.G. Thakare A.R. Kshirsagar, P.B. Ghawagawe G.R. Fulzele, K.B. Wanjari P.K.V. Akola	cross, T-9 x 4-196 (mutant induced by gamma rays 1976) [No. 55]	Yield 8,6% over T-9 and 24.4% over no. 55, larger seed size moderately resistant to powdery mildew
Vigna unguiculata (L.) Walp. (cowpea)			
ICV 11 (Reg. no. 62)	Kenya, 1985 R.S. Pathak J.C. Olela ICIPE Nairobi	seed, gamma radiation [ICV1]	Semi-erect, large leaves, green stems, green pods matures in 65 d, yield 1100 kg/ha, resistant to cowpea aphids
ICV 12 (Reg. no. 63)	Kenya, 1985 R.S. Pathak J.C. Olela ICIPE Nairobi	seed, gamma radiation [ICV 1]	Similar to ICV 11 but slightly higher yield, resistant to cowpea aphids

FUTURE EVENTS

1987

2nd International Mungbean Symposium, Phitsanulok, Thailand, March
Contact: S. Shanmugasundaram
AVRDC
P.O. Box 42, Shanhua
Tainan 741
Taiwan

Arabidopsis - model and tool of molecular and classical plant breeding. A special meeting to be held in conjunction with the 14th International Botanical Congress Berlin (West), 24 July - 1 August
Contact: Prof. A.R. Kranz
Botanisches Institut
Goethe Universität
Postfach 111932
D-6000 Frankfurt/M
Fed. Republic of Germany

International Botanical Congress, Berlin, 24 July - 1 August
Contact: 15th International Botanical Congress
Königin Luise St. 6-8
D-1000 Berlin (West)

16th Pacific Science Congress, Seoul, Republic of Korea, 20 - 30 August
Secretariat: Pacific Science Association
P.O. Box 17801
Hanolulu-Hawai 96817
USA

1988

3rd Intern. Symposium on Genetic Aspects of Plant Mineral Nutrition, Braunschweig, Fed. Republic of Germany, 19 - 23 June
Contact: Institute of Crop Science and Plant Breeding
F.A.L.
Bundesallee 50
D-3300 Braunschweig
Fed. Republic of Germany

3rd International Oat Workshop, Lund, Sweden, 4 - 8 July
Contact: Bengt Mattsson
Svalöf AB
S-26800 Svalöf
Sweden

Mutation Breeding Newsletter
Joint FAO/IAEA Division of Isotope and Radiation
Applications of Atomic Energy
for Food and Agricultural Development

International Atomic Energy Agency
Vienna International Centre
P.O. Box 100, A-1400 Vienna, Austria

Printed by the IAEA in Austria
September 1986

86-04306