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ERNEST ROBERT SEARS
(1910-1991)

Ernie Sears was born in Bethel, Oregon on the 15th of October, 1910. He obtained his Bachelors degree from the University of Oregon and Ph.D. from Harvard in 1936. He then joined the U.S. Department of Agriculture as Research Geneticist at the University of Missouri, Columbia, where he continued as Professor Emeritus after official retirement in 1980. He died in his sleep early in the morning of 15 February, 1991.

Dr. Sears was renouned among the mutation breeding faternity for his illustrious transfer of *Aegilops umbellulata* chromosome segments carrying the gene for leaf rust resistance, to wheat. This was reported at the Brookhaven Symposium in 1956. It was the beginning of what is now considered as "Plant Genetic Engineering". Chromosomal engineering as the technique of induced translocations was referred in the late fifties and early sixties as an important part of the use of radiations for genetic improvement of crop plants. This approach, pioneered by Dr. Sears, has been followed by many wheat geneticists on all five continents to transfer useful genes from alien species to cultivated wheat.

Dr. Sears' most outstanding contribution to humanity, both conceptually as well as in the form of genetic stocks, has been the development of wheat aneuploids. Starting from the monosomic series in the wheat variety Chinese Spring, he painstakingly developed ditelosomics, nulli-tetrasomics, chromosomal addition and substitution lines and other aneuploids. They have been used in almost all wheat growing countries of the world and continue to be of immense importance not only for classical wheat geneticists but equally for molecular biologists today.

Dr. Sears' experiments on induction of mutations in wheat using ethyl methanesulfonate (Mutation Research 1: 387-399, 1964) and pollen irradiation of plants monosomic for chromosome 5B (Canadian J. of Genetics and Cytology 19

585-593, 1977) need special mention. In the first study he found that in hexaploid wheat "ethyl methanesulfonate had effects strikingly different from those characteristically obtained in irradiation experiments", which he attributed to a "change in (gene) function and release from the masking action of their duplicates". The second paper reported one of the most elegant experiments in mutation breeding to isolate a mutant of the gene (*Ph*) which suppresses the pairing of homoeologous chromosomes in wheat.

The Plant Breeding and Genetics Section of the Joint FAO/IAEA Division, at the initiative of C. Konzak, organized a consultants meeting in 1974 with the objective to explore the use of aneuploids, to obtain insight on the genetic control of endosperm proteins in wheat. Subsequently, a Co-ordinated Research Programme (CRP) on the use of wheat aneuploids and their derivatives for protein improvement was organized from 1975-1978. Under this CRP, in a co-operative experiment, ditelosomics of the variety Chinese Spring were grown in six different countries and analysed for grain protein. A large number of aneuploid stocks were analyzed at the Seibersdorf laboratory for their grain protein and amino acid composition. The programme contributed valuable information on chromosomal location of endosperm protein genes. Participants in the CRP had also recommended long term maintenance and preservation of the wheat aneuploid stocks. Dr. Sears was always prompt in sending seeds of the cytogenetic stocks developed by him. Now that the "father of wheat cytogenetics" is no more, the cytogenetic stocks developed by him remain as a heritage to mankind.

(Contributed by BHATIA, C.R.*, Bhabha Atomic Research Centre, Bombay 400 085, India)*

IMPROVING DISEASE RESISTANCE IN WHEAT BY INACTIVATING GENES PROMOTING DISEASE SUSCEPTIBILITY

Genes promoting resistance to rusts and mildew in wheat are often detected and classified by screening varietal seedlings with a series of race isolates of the disease. Although many of the identifiable race specific genes for resistance are active throughout the plants lifecycle their presence fails to explain all the variation in disease resistance detectable at the adult plant stage. This can be clearly demonstrated by yellow rust disease screening of the varieties Hobbit sib and Bezostaya Al and the series of intervarietal chromosome substitution lines where individual chromosomes of Hobbit sib are in turn replaced by their homologues from Bezostaya. At the seedling stage Hobbit sib can be shown to carry 3 genes for resistance to yellow rust, *Yr1, Yr2* and *Yr3/4a* located on chromosomes 2A, 7BS and 5BL respectively. Bezostaya carries no genes for resistance to UK races of yellow rust. At the adult plant stage however 13 of the 21 possible single chromosome substitution lines significantly alter levels of resistance compared to the Hobbit sib control (Fig. 1)

Law *et al.*, demonstrated the importance of aneuploid stocks in elucidating the complex nature of yellow rust resistance at the adult plant stage [1]. By field screening monosomics of the varieties Cappelle-Desprez and Bersee, they demonstrated that chromosomes carrying genes for resistance could be detected by elevated levels of infection associated with halving the dosage of genes for resistance when the critical chromosome was hemizygous. The short arm of chromosome 5B in particular was shown to carry genes for increased resistance at the adult plant stage because in the absence of this arm, plants were very susceptible. They also showed by using a wider range of aneuploids available in

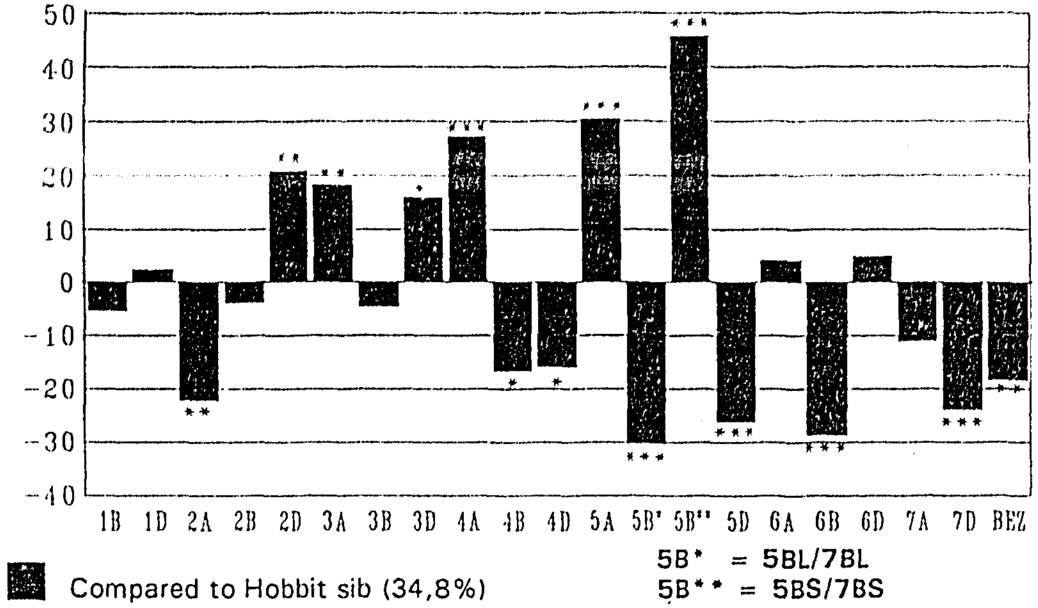

Figure 1: Hobbit 'sib' (Bezostaya) substitution lines. Percent of flag leaf infected with yellow rust compared to Hobbit sib control. (BEZ = Bezostaya)
*P = 0.05-0.01; **P = 0.01-0.001; ***P = <0.001

the variety Chinese Spring, and in contrast to much of the work with other monosomics, that the long arms of the group 5 chromosomes appeared to carry genes for susceptibility. Increased dosage of these arms gave increased susceptibility whereas their absence produced improved levels of resistance. These results were confirmed by showing that the short arms of all the group 5 monosomics were involved in promoting resistance whilst the long arms of the group 5 chromosomes carried opposing genes that either inhibited resistance or promoted susceptibility [2]. Interestingly, in this work the resistance gave similar changes in levels of infection to both yellow rust and mildew.

Screening the monosomics available in Hobbit sib to yellow rust infection showed that reduced dosage of many chromsomes significantly alters levels of disease resistance (Fig. 2). Reduction in dosage of some chromosomes particularly 5BS/7BS and 6B produces elevated levels of infection indicating the presence of genes promoting resistance. Conversely monosomics of other chromosomes, in particular 4B, 4D, 5BL/7BL and 5D gave reduced levels of infection suggesting these chromosomes carry genes for promoting susceptibility.

From this it could be predicted that improved levels of resistance could be achieved by replacing the chromosomes carrying genes promoting susceptibility by homologous chromosomes from other varieties that carry less potent genes for this character. Indeed, the substitutiuon of each of the four Hobbit sib chromosomes carrying such genes by their homologues from Bezostaya confirms this prediction since improved levels of resistance occurs in all four cases, indicating the alleles for susceptibility are less potent in Bezostaya.

An alternative approach would be to inactivate or delete genes promoting susceptibility by induced mutation. This was attempted by treating 6,000 seeds of Hobbit sib with fast neutrons at the IAEA, Vienna.

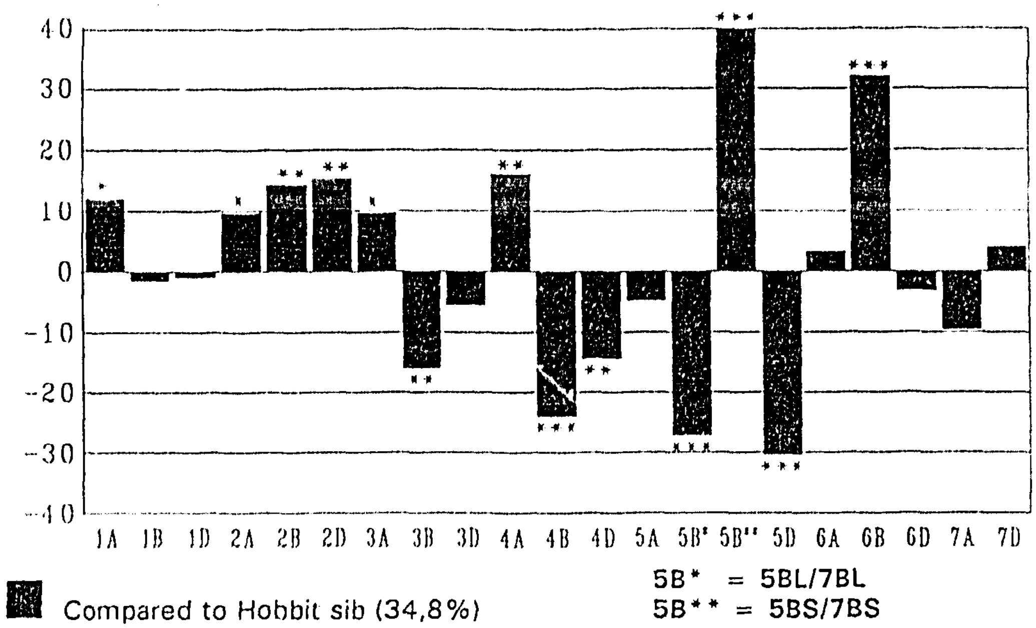

Figure 2: Hobbit 'sib' monosomics. Percent of flag leaf infected with yellow rust compared to Hobbit sib control.
*P = 0.05-0.01; **P = 0.01-0.001; ***P = <0.001

Table 1: Hobbit sib disease mutant lines showing levels of infection of flag leaves to yellow rust and mildew and the chromosomal location of the mutation where identified by monosomic analysis or molecular RFLP analysis.

		Flag leaf infection (%)			Chromosomal location of mutation	
Line		Yellow rust	Brown rust	Mildew	Monosomic analysis	RFLP analysis
Hobbit sib (Control)		68.3	13.0	7.5	---	---
Mutant	13-21	37.5^{***}	+	+	---	5BL
	13-27	16.7^{***}	2.5^{***}	4.5^{***}	---	---
	13-32	48.7^{***}	2.0^{***}	3.5^{***}	5D	5D
	13-33	30.0^{***}	+	+	---	5BL
	13-43	33.3^{***}	2.0^{***}	6.5^{*}	---	---
	13-48	10.3^{***}	1.0^{***}	2.0^{***}	4D	---
	13-49	9.0^{***}	+	+	---	---
	13-54	7.7^{***}	1.0^{***}	0^{***}	4B	---
	13-58	52.1^{***}	+	+	4BS	---

+ Disease reaction not available
Significant difference from Hobbit sib control
*P = 0.05-0.01; **P = 0.01-0.001; ***P = <0.001

After initial selections at the M_1 generation, 40 resistant lines were selected from 5,000 ear rows at M_2. Following progeny testing to remove aneuploids and electrophoretic checks to verify that none of the lines had resulted from outcrossing, 20 of the lines were retained for further screening. Monosomic analysis of the more resistant lines identified two 4B, one 4D and one 5D mutants (Table 1). All three chromosomes identified are potential carriers of genes promoting susceptibility as recognised by the corresponding monosomics showing reduced levels of infection. A current programme to identify the mutation sites through the recognition of restriction fragment length polymorphisms (RFLP) has demonstrated that two of the mutant lines carry point deletions at a locus on the long arm of chromosome 5B, the fourth chromosome thought to carry genes promoting susceptibility. Another RFLP occurs for chromsomes 5D in line 13-32 and confirms the location of this effect on 5D by monosomic analysis.

Detailed disease screening of the mutant lines shows no seedling race specific differences between the mutants and parental control. Most significantly, levels of resistance at the adult plant stage showed large improvements in resistance of the mutant lines not only to mildew and yellow rust but also to brown rust, further demonstrating the general nature of the resistance.

Thus an important type of gene that reduced levels of resistance at the adult plant stage has been demonstrated and located. Deletions or inactivation of these genes improves resistance to a number of different diseases suggesting that the absence of these genes may be a basis for non-specific resistance and possibly durability to disease. Using RFLP markers it should be possible to 'tag' these mutated susceptibility genes and to thereby introduce them rapidly into breeding populations. Such 'tags' may also be useful in identifying less potent genes for susceptibility in other varieties. Before the true value of these results to wheat breeding can be assessed it will first be necessary to establish that the induced changes are not associated with adverse effects on other agronomic characters.

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(Contributed by WORLAND, A.J. and C.N. LAW, Cambridge Laboratory, IPSR. Colney Lane, Norwich, UK, NR4 7UJ)

BOLD SEEDED MUTANT IN BLACK GRAM

Black gram (*Vigna mungo* (L.) Hepper) is one of the most important legumes in India. This country has a unique position in respect to black gram cultivation in the world because it is the primary centre of origin. T_9 variety of black gram released in 1948 and suitable for cultivation on the plains of Uttar Pradesh, in rotation with wheat, was used as a parent for mutation experiments. The crop yields 0.8-1.0 tons of grain per hectare, which is the lowest among the major legumes.

Dry seeds (12.2% moisture content) of black gram cultivar T_9 were irradiated with 10, 20 and 30 kR of gamma rays and then treated with freshly prepared EMS (0.25% in 0.1 M phosphate buffer, pH 7.0, for 6h at 30±1°C). M_1 generation was grown in loam soil. A bold seeded mutant was selected in M_2 generation. 20 plants of M_3 were used for description and evaluation of mutant. Mutant plants showed vigorous growth in comparison to the control. Leaves were larger and thicker. The mutant showed an increase in plant height, number of leaves and pods per plant (Table 1).

Table 1: Agronomic characters of black gram mutant in M_3 and M_8 generations*

Variety or Mutant	Plant height (cm)	Pods/ plant (g)	Test weight (g)	Grain yield/ plant
T_9	50.8	41.6±5.34	1.53±1.95	8.98±0.87
Mutants:				
M_3	60.9	54.6±7.28	2.89±0.08	16.8±2.67
M_8	62.2	50.8±0.03	2.88±0.01	16.2±1.40

* mean & SE based on 20 plants

Changes in flower morphology have already been described [1]. Seeds of the mutant were larger and heavier, with a test weight double that of the control. The total seed yield per plant was also increased. Total protein content increased in comparison to the control from 21.1±0.23 to 22.2±0.06 in the mutant. The study of the mutant up to M_8 generation clearly indicated its stable and true breeding nature. This is the next mutation related to improvement of agronomic characters of black gram [2,3].

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(Contributed by SINGH, R.H. and S.S. RAGHUVANSHI, Plant Genetics Unit, Department of Botany, University of Lucknow, Lucknow - 226 007, India)

INCREASED MUTATION FREQUENCIES IN THE M_2 GENERATION DERIVED FROM IRRADIATED *in vitro* COTYLEDONARY PLANTS OF MUNGBEAN (*Vigna radiata* L. Wilczek)

M_1 plants were raised from mungbean seeds exposed to 40 kR gamma rays either directly or from *in vitro* culture of excised cotyledons. Distinct chlorophyll and viable mutations were scored in the M_2 progenies of such plants and the viable mutants were checked for their breeding behaviour in the M_3.

The frequency of mutations in the two treatments is given in Table 1. In the 40 kR *in vitro* M_2 population, 15 out of 56 plant progenies segregated for mutations in comparison to 10 out of 85 plant progenies in 40 kR seed raised plants. In a parallel experiment on somaclonal variation in cotyledonary plants, 10 out of 70 (14%) progenies segregated for chlorophyll and viable mutations [1]. The number of mutants per 100 M_2 plants was also higher in the progenies of *in vitro* raised cotyledonary plants as compared to the seed grown plants. This could be due to additive effect of gamma rays and *in vitro* culture (somaclonal variation). Amplification of mutated cells is yet another possibility.

The spectrum of mutations obtained in the two populations was more or less similar except for a new seed coat colour obtained in one progeny of the 40 kR cotyledonary plant. In maize, the tissue culture derived variation was qualitatively similar to that obtained following treatment with physical and chemical mutagens [3].

Table 1: Chlorophyll and viable mutants in the M_2 generation of irradiated *in vitro* cotyledonary and seed raised plants of mungbean

Treatment	Number of progenies		Number of plants		Mutation frequencies	
	Scored	Segregating	Scored	Mutants	Segregating progenies	Mutants per 100 plants (%)
Cotyledon explant, 40 kR	56	15*	1511	67*	26.8*	4.4**
Seed, 40 kR	85	10	3334	68	11.8	2.0
Seed, Control	19	0	999	0	0	0

* Significantly different from seed 40 kR treatment by Chi square method (Chi square 10.44).

** Significantly different from seed 40 kR treatment at p=0.01 by the method of Kastenbaum and Bowman [2].

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(Contributed by MATHEWS, H.[1], P.S. RAO and C.R. BHATIA, Bhabha Atomic Research Centre, Bombay 400 085; 1. Present address: Department of Agronomy, University of Georgia, Athens 30601, USA)

HIGH FREQUENCY OF BARLEY DH-MUTANTS FROM M_1 AFTER MUTAGENIC TREATMENT WITH MNH AND SODIUM AZIDE

It was expected that doubled haploid techniques could provide a unique tool for fast homozygotization of induced mutations [1, 2]. This experiment demonstrates the practical possibility of the use of anther cultures for production of DH-mutants in barley. For mutagenic treatment inter-incubation germination (iig) was applied [3]. M_1 progeny (line H930-36) after mutagenic treatment of seeds with MNH (0.5 mM x 3h - 6h iig - 0.5 mM x 3h) or with sodium azide and MNH (1.5 mM NaN_3 x 3h - 6h iig - 0.7 mM MNH x 3h) served as the donor plants for anther culture. Anthers with microspores in mid-uninucleate stage were plated on BAC3 Ficoll medium supplemented with maltose [4]. After 5-6 weeks embryoids were transferred to BAC3 solid medium for plant regeneration. Spontaneous diploidization occurred in 121 of 162 regenerated green plants grown to maturity. Mutagenic treatment has decreased the frequency of responding anthers and the total number of regenerated plants but only slightly affected the percentage of green plantlets (Table 1).

Table 1: The response of anther culture from M_1 plants

Donor plants	No. of anthers plated	Responding anthers (%)	Plants/100 anthers plated		
			Albino	Green	Total
H930-36	886	56.5	40.3	9.4	49.7
M_1 (MNH)	1188	31.5	13.0	11.4	24.4
M_1 (NaN_3 + MNH)	1089	21.4	8.2	6.4	14.6

The progeny of 5 spikes from each DH_1M_2 plant were planted for the second generation (spike/row). 40 DH_2 lines from the control and 20 DH_2M_3 lines from treated material were observed. Dwarf, semi-dwarf, chlorina and two uniculm independent mutations were found in treated progenies. Additionally, 6 other lines in the treated material, but also 2 in the control, indicated a significant delay in plant development. From 60 observed DH_2 lines only one, derived from the control, segregated for albino-viridis mutation. Other lines indicated homozygosity. These preliminary results indicate that the use of M_1 as donor plants is a promising way to produce homozygous mutants in a very short cycle. The production of DH plants from mutated gametes can help to avoid a chimerism which usually appears when mutagenic treatment is applied on multicellular structure in *in vitro* cultures.

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(Contributed by UMBA DI-UMBA, M. MALUSZYNSKI**, I. SZAREJKO and J. ZBIESZCZYK, Department of Genetics, Silesian University, 40-032 Katowice, Poland. */IAEA Fellowship ZAI/8901 - FAO/IAEA Group Training 1990, Katowice, permanent address: Comissariat General a l'Energie Atomique, B.P. 868, 184 Kinshasa XI, Zaire; **/Joint FAO/IAEA Division, 1400 Vienna, Austria)*

PHYSICAL AND CHEMICAL MUTAGENESIS OF EARLY MUTANT OF INDICA RESTORERS IN "WA" (WILD ABORTION) HYBRID RICE SYSTEM AND GENETIC ANALYSIS OF MUTANTS IN HETEROSIS UTILIZATION

The four indica restorers, commonly used in China, in the WA (wild abortion) hybrid rice system, namely Minghui 63, TG4-7, IR26 and 910, were treated with physical and chemical mutagens. The mutation frequency in M_2 generation, the correlation between heading date of the mutants and other characters were investigated. A number of early-heading mutants detected in M_2 were analyzed for their restoring ability to cytoplasmic male sterility (cms), heterosis in combination with cms line and their combining ability.

Mutation affecting heading date occurred in both directions, early and late. The varieties with a short growth period produced a lower percentage of early heading mutants, with a small range of days than those with a long growth period. The heritability of early or late heading was relatively high. Early heading had a significantly positive correlation with other agronomic characters concerned, except for seed setting rate.

A significantly positive correlation existed in heading date between the early mutants and the F_1 of its cross combinations with cms lines. Usually, the cross combinations with an early heading mutant showed a shorter growth period than the ones with the parent restorers. However, a few exceptions were found in the F_1 cross combinations with early mutants as the pollen donor.

Most of the early heading mutants (87.8%) still kept their restoring ability at the same level as their parents. Generally, the yield heterosis of the most early mutant combinations decreased as the heading date became earlier. However, some of those F_1 exhibited not only early maturity but also high heterosis. The results of combining ability analysis for the early mutants revealed that the general and special combining ability (GCA and SCA) of most agronomic characters were changed in the early mutants compared to their parents. There were 3 cross-combinations with early mutants derived from Minghui 63, showing early-maturity and high yield heterosis, based on the field test in three different areas. One of the mutants is being used as a new restorer to produce hybrid seeds, on a relatively large-scale, for further field evaluation in Zhejiang, China.

(Contributed by XIANG, Y. and M. GAO, Biotechnology Research Centre, Zhejiang Academy of Agricultural Sciences, Hangzhou, China and Institute of Nuclear Agricultural Sciences, Zhejiang Agricultural University, Hangzhou, China)

INDUCTION OF MUTANTS IN *Zinnia elegans* Jacq.

Gamma rays are very often used to induce mutations in plants, including horticultural species [1]. In the presented investigations *Zinnia elegans* Jacq. has been used to induce mutations of flower colours. Seeds were treated with gamma rays from ^{60}Co. The moisture content of seeds was 9.0±1.7%. Doses of 2.5 - 12.5 kR were applied.

In the M_2 generation some new flower colour mutants were observed. These colours were entirely different from the control plant. After irradiation of the parent variety with "Crimson Red" flower colour, four different types of mutants were observed with colours: magenta, yellow, red and red with white spots. The mutants were found in combinations with 2.5, 5.0, 7.5 and 10.0 kR gamma rays respectively. New colour mutations were inherited in M_3 and M_4 generations. Dichotomous branching was identified in yellow and red colour mutants.

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THE 30TH GAMMA-FIELD SYMPOSIUM

In Japan, the Gamma-Field Symposia have been held annually since the early 1960s. This was commemorated by the 30th Gamma-Field Symposium held on 17-18 July, 1991, in Tsukuba, about 80 km south of the gamma-field in Ohmiya-machi. The Symposia have been organized in cooperation with the Institute of Radiation Breeding of the National Institute of Agrobiological Resouces (NIAR) and University Cooperative Programmes for Gamma-Field. The purpose of these symposia is to report on and to discuss research related to mutation breeding and also to promote their application in practical breeding. The number of participants has gradually increased to 180 in recent years, but at this 30th Symposium, it reached more than 380, indicating the strong interest of Japanese scientists in this field of research.

"Bio-technology and Mutation Breeding" was the theme of this years Symposium. A commemorative lecture entitled "Induced mutations for crop improvement" was given by A. MICKE. Another invited lecture, entitled "Mutation breeding using tissue culture techniques" was presented by F. NOVAK. These two lectures were given in English, but other presentations and discussions were held in Japanese.

There were a large number of very interesting papers and posters. Among them, Osamu YATOU, Institute of Radiation Breeding (IRB), Ohmiya-machi, Ibaraki-ken, presented a paper on "Mutation and structural alteration of DNA induced by radiations". Recent analytical technology for DNA molecular alterations opened the way to examine the nature of induced mutations at the molecular level. At NIAR, a large collection of induced mutants in rice are maintained, enabling the study of specific loci with many independently induced mutations. Amylose deficiency in starch is known as "waxy" or "glutinous" mutation, and is relatively easy to select visually in endosperm of de-hulled rice grain. Many waxy mutants have been induced ranging from complete deficiency of amylose to intermediately low amylose.

Southern blotting analysis using a DNA probe of the maize *wx* locus revealed that in all gamma-rays or EMS induced mutants, the portion of DNA detectable by the probe remained almost intact, or that the induced alteration was too small to be detected. Of the 14 analyzed mutants, only two showed different banding patterns, both these mutants were induced by treatment of dry seed with thermal neutrons from Kyoto University Reactor (KUR) and backcrossed to variety Norin 8. One mutant, KURwx4N1, indicated the complete lack of the band, suggesting deletion of the DNA segment which has affinity to the DNA probe used. The mutant 78KURwx2 showed a thin band at the normal position and another thin band at a larger molecular position. These results would suggest that the induction of molecular alteration of a detectable size might be expected by treatment with high LET corpuscular radiations. The second locus analyzed was the nitrate reductase locus. Using potassium chlorate screening, 4 resistant and 15 semi-resistant mutants of various treatments from the IRB collection were identified. One of them showed only 10% in the nitrate reductase activity. Loss of activity of the central enzyme subunit among the three domains that constitute the structure of the enzyme, was suggested on the basis of presented results.

Koisuke KITAMURA, National Agriculture Research Center, MAFF, Kannondai, Tsukuba, Ibaraki-ken 305, has reported on spontaneous and induced mutations in soybean proteins. Storage proteins of soybean seeds are composed of two major units, 7S and 11S. The 7S unit contains a lower content of sulphur-amino acids. The relative amount of both these units decides the different processing characteristics of soybean seed products. Therefore, studies to widen the genetic variation of seed storage proteins can result in quality improvement of soybean. The 7S unit is built from three sub-units, alpha, alpha' and beta, which could be separated by SDS-gel electrophoresis. A spontaneous mutant with deletion of alpha' sub-unit and another with low content of alpha and beta sub-units were found [1]. By crossing these two mutants and using the half-seed analysis method for screening, KITAMURA could develop a mutant soybean line with significantly low 7S proteins.

Similarly, from the progenies of gamma-irradiated soybean cultivar "Wase-suzunari", it was also possible to identify mutants with drastically modified 11S unit [2]. These mutant lines were normal in their growth. Recently, after gamma-irradiation with 40 kR, a mutant with deletion of almost all alpha, and beta sub-units was found [3]. Another mutant was also induced which deletes or has a very low level of all three 7S sub-units [4]. However, these last two mutants could be only maintained as heterozygotes.

Lipoxygenase oxidizes the unsaturated fatty acid and produces the unfavorable smell of soybean products. Three isozymes, L-1, L-2, and L-3, have been identified in this group of enzymes. Two lines, Kanto 102 and Kanto 101, were already developed with deletion of L-1 and L-3, or L-2 and L-3 respectively. However, lines with the deletion of L-1 and L-2, or all of the three isozymes, could not be developed by cross breeding, probably due to very tight linkage between loci. KITAMURA reported that recently, after gamma-irradiation of both Kanto lines, two complete deletion type mutants were found independently in Kyushu Agriculture Experimental Station and National Agriculture Research Center. Preliminary trials indicated expected performance of parent and mutant lines and a check cultivar, Suzu-yutaka (Table 1).

Chronic gamma-irradiation and *in vitro* culture were demonstrated by Shigeki NAGATOMI, IRB, Ohmiya-machi, Ibaraki-ken, as a very useful method for sugarcane improvement. It is difficult to improve this important crop by conventional breeding methods. To overcome this difficulty, Ni-5 and 5 other cultivars were

Table 1: Lipoxygenase activity of soybean seed

Cultivar/line	Enzyme activity* pH 6.5	pH 9.5
Suzu-yutaka	4.76 ± 0.13	7.76 ± 0.27
Kanto 101	0.70 ± 0.05	7.57 ± 0.91
Kanto 102	3.35 ± 0.05	0.15 ± 0.01
Deletion(ARC)	0.04 ± 0.01	0.14 ± 0.03
Deletion(KAES)	0.04 ± 0.02	0.13 ± 0.04

*/ A-235nm/min./mg seed flour.

Table 2: Comparison of variation range (mean and c.v.) of selected agronomic characters in populations of plants regenerated from callus derived from sugarcane plants growing on gamma-field or under normal conditions

Character	Dose (kR)	Mean	C.v. (%)
Stalk length(cm)	0	117.4	10.96
	30	114.9	17.16
No. of stalks	0	6.08	25.45
	30	5.84	46.96
Stalk diameter(cm)	0	1.96	6.79
	30	1.84	13.11
No. of nodes	0	8.20	12.60
	30	8.69	18.22
Stalk weight (g)	0	453	19.52
	30	399	33.59
Cane weight (g)	0	2770	34.09
	30	2396	64.88

planted in the gamma-field for irradiation with gamma-rays from ^{60}Co source for 90 days, while growing. The accumulated dose varied from 5 kR to 50 kR. Young leaf pieces near the apical meristem, were collected and used as explants for *in vitro* cultures. 1895 regenerants from calli were planted in the field. There was no inhibitory effect of the irradiation on *in vitro* cultures up to 30 kR.

Variation range (evaluated on the basis of mean value and c.v.) in populations of plants regenerated from irradiated material increased with the dose of gamma-rays. In the non-irradiated but *in vitro* regenerated plants much less variation was noted (Table 2). Acute irradiation of callus cultures (10 kR as optimal dose) produced more negative mutations in comparison to chronic irradiation.

Promising results were also obtained using the gamma-field for breeding of chrysanthemum. The cultivar Ohira, which adapts well in Okinawa, was the material to investigate the mutagenic effect of gamma-rays and follow up *in vitro* culture. Chrysanthemum plants were grown at 25 - 150 R/day (20hr) zone of gamma-field and the accumulated dose amounted to 15 kR for 100 days of irradiation. Petals or flower buds from irradiated plants were cultured *in vitro*.

The highest frequency and range of variation in populations of regenerated plants was observed when chronic irradiation was combined with *in vitro* culture. In this experiment the following mutation frequencies were observed:

Table 3: Ploidy of cms plants after unequal cell fusion

Combination (cytoplasm + nucleous)	No. of regenerated plants	Sterile plants Diploid	Tetraploid	Aneuploid (chrom. No.)
N. debneyi + Consolation	318	30	6	0
(suv) Burley21 + Tsukuba 1	207	84	23	0
(suv) Burley21 + F114	117	16	0	0
N. repanda + Consolation	150	8	0	7 (46,47)
N. africana + Burley21	300	1	0	0
N. megalosiphon + Consolation	230	0	0	5 (60-71)

- chronic irradiation, then petal culture - 39%
- chronic irradiation, then bud culture - 37.5%
- chronic irradiation (*in vivo*) - 4.5%
- without irradiation, then petal culture - 1.4%
- acute irradiation of callus from petal - 0%

The use of chronic irradiation in combination with *in vitro* culture, besides the high frequency of mutations, has broadened the range of colors and flower morphology.

Takashi KUMASHIRO, Institute of Breeding and Genetics, Japan Tobacco Co. Ltd., reviewed the method of irradiation of protoplast, preceding the fusion with other protoplast, focusing on the development of cytoplasmic male sterile (cms) tobacco lines. In the presented case, only protoplasts of cytoplasm donor plant were treated with X-rays. Among the regenerated plants, cms plants were found at frequencies of 0.3 to 51 %. Some cms plants had the tetraploid set of chromosomes but in most cases were diploid with the same morphological characteristics of the non-irradiated parent. As the result of "unequal cell fusion" of *Nicotiana repanda* + *N. tabacum*, some aneuploids were found and segregated fertile plants after back-crossing. After fusion *N. megalosiphon* + *N. tabacum*, cms could be inherited well but part of *N. megalosiphon* chromosomes were found in the progeny (Table 3). Measurements of quantitative characters of the back-crossed progeny of cms lines revealed some variation in sizes of leaves and other components. This variation decreased in advanced back-cross generations.

Chloroplasts of cms lines were molecularly analyzed. Generally, they seem stabilized into type of parent. Analyses of mitochondrial DNA suggested the presence of frequent and complicated recombination of the molecules. Such research may be helpful to identify the gene(s) related to cms.

Although some variations may also be induced by irradiation or *in vitro* culture, this type of unequal cell fusion seems to be a promising method to create cms in many crop species.

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[3] Kaizuma, N., H. Odanaka, H. Sato and H. Kowata, 1990. Mutants on soybean storage proteins induced by gamma-ray irradiation. Jpn.J.Breed. 40 (Suppl. 1): 504-505 (in Japanese).
[4] Hajika, M., K. Igita and K. Kitamura, 1991. A line lacking all the seed lipoxygenase isozymes in soybean *Glycine max* (L) Merr. induced by gamma-ray irradiation. Jpn.J.Breed. 124: 607-613. (In Press)

(Contributed by AMANO, E., Plant Breeding and Genetics Section, Joint FAO/IAEA Division, A-1400 Vienna, Austria)

MEETING OF ESNA - WORKING GROUP 6 ON "PLANT BIOTECHNOLOGY AND APPLIED MUTAGENESIS", ANTALYA, TURKEY, 15 AND 16 SEPTEMBER, 1991.

The Working Group 6 organized three sessions during the 22nd ESNA annual meeting. Attention was focused, to a great extent, on cereals. One session was completely devoted to barley, durum and bread wheat. In other sessions several papers dealt with grain legumes such as pea, faba bean, soybean and lentil or with various crops such as cotton, tobacco, the medicinal plant *Atropa belladonna*, the *Azolla/Anabaena*, or forest tree species such as Norway spruce and oak. A special review paper was presented on mutation induction and other biotechnological methods for fruit tree breeding with special emphasis on breeding Mediterranean species.

Almost all conventional approaches of mutation induction and several *in vitro* systems were demonstrated. The following traits were most often presented as the objective of mutation breeding:

- earliness (durum wheat)
- oil content (soybean)
- determinate flowering (lentil)
- climatic adaptation (cotton)
- disease resistance (barley, fruit trees, tobacco)
- yield and quality improvement (barley, bread wheat, fruit trees)

A series of biotechnology approaches, which have recently been incorporated into the scope of this working group, were presented in a wide variety of plant improvement programmes:

- anther culture in early screening for tolerance to several environmental stress factors in *Brassica*
- organogenesis and somatic embryogenesis systems in grain legumes as basic tools in breeding for resistance
- organogenesis in *Atropa belladonna* as a suitable system to induce mutations for increased atropine productivity
- micropropagation of chestnut to facilitate *in vitro* screening against blight
- molecular characterization of genotype as a base for gene conservation, genotype selection and advanced breeding in forest trees.

In conclusion one can say that the close linkage between plant biotechnology and applied mutagenesis was well demonstrated by presented papers. Discussions during the meeting were intense and fruitful with active participation of experts from the Plant Breeding and Genetics Section of the Joint FAO/IAEA Division and Seibersdorf Laboratory. Valuable results from a series of breeding experiments were presented by a number of former attendants of the FAO/IAEA Interregional Training Courses on Mutation Breeding For Crop Improvement, including a strong representation of the host country.

The following papers were presented under ESNA Working Group 6 sessions:

Bammoun, A. Use of mutation breeding to improve some characters in durum wheat and barley. ITGC Res. St., PO Box 2, Dahmounz Ticaret, Algeria.

Behl, R.K. and K.P. Singh. Gene deployment in wheat cultivars for subtropics. Haryana Agric. Univ., Hisar-125 004, India.

Brunner, H. Estimates of optimal mutation rates for different breeding objectives. Plant Breeding Unit, IAEA Lab. Seibersdorf, A-2444.

Brunner, H. Mutation breeding to improve herbicide resistance/tolerance to *Azolla*. Plant Breeding Unit, IAEA Lab. Seibersdorf, A-2444.

Burg, K. *et al.* Oak chloroplast DNA - variations detected by RFLP. Agric. Res. & Biotechnology, Austrian Res. Ctr. Seibersdorf, A-2444.

Buttgereit, J. and J. Schmidt. Optimization of *in vitro* germination of somatic embryos of Norway spruce. Dept. Agric. Res. & Biotechnology, Austrian Res. Ctr. Seibersdorf, A-2444.

Cagirgan, M.I. and S.E. Ullrich. Male sterile facilitated recurrent selection - a review. Dept. Field Crops, Mediterranean Univ. Antalya, Turkey.

Donini, B. Improvement of mediterranean fruit trees through mutation breeding. Agriculture Lab., ENEA, CRE Casaccia, I-00100.

Griga, M. *et al.* Regeneration via organogenesis and somatic embryogenesis in grain legumes (*Glycine max, Pisum sativum and Vicia faba)*. Plant Biotechnol. Dept., Oseva Res. Inst. Techn. Crops & Legumes, Sumperk, CSFR.

Jandurova, O. *et al.* Pollen culture and *in vitro* selection of genotypes tolerant to different agrochemicals. Univ. of Agric., Dept. of Plant Genetics & Breeding, CSFR-165 21 Prague 6.

Narula, N. and K. Lakshminarayana. Nature and role of plasmids in *Azotobacter chroococcum*. Dept. of Microbiology, Haryana Agric. Univ., Hisar-125 005, India.

Ozbek, N. *et al.* Induced mutation for yield and oil content in soybean. Ankara Nuclear Agriculture Research Inst., Sarayköy, Ankara, Turkey.

Peskircioglu, H. *et al.* Adaptation of mutant lines of Cukurova 1518 cotton variety to GAP region. Ankara Nuclear Research Inst., Sarayköy, Ankara, Turkey.

Rashidov, N.M. *et al.* Study of the first and second generation of barley after treatment of seeds with ^{10}B, Sm and thermal neutrons and/or gamma-rays.

Sagel, Z., *et al.* The effect of gamma radiation doses on some characters in M_1 generation of green lentil (PUL-11) variety. Ankara Nuclear Agriculture Research Inst., Sarayköy, Ankara, Turkey.

Savaskan, C. *et al.* Chromosomal aberration induced by gamma irradiation in soybean. Ankara Nuclear Agriculture Research Inst., Sarayköy, Ankara, Turkey.

Sonnino, A. *et al.* *In vitro* mutation breeding of root and tuber plants. Dept. of Agroindustrial R&D, ENEA, CRE Casaccia, I-00100.

Toth, E.T. and T. Onisei. Effect of gamma irradiation on *Atropa belladonna* callus. Doina Amariei "Stejarul" Res. ST., R-5600.

Tökei, K.M. and J. Füredi. Yield component analysis of four pea varieties influenced by acute and recurrent neutron irradiation. Dept. Gen. & Plant Breed., Univ. of Agric. Science, Gödöllö, H-2103, Hungary.

Tutluer, H. *et al.* Mutation breeding for blue mold resistance in tobacco. Ankara Nuclear Research Inst., Saraykö, Ankara, Turkey.

Ullrich, S.E. and M.I. Cagirgan. Experiences and opinions on proanthocyanidin-free malting barley breeding. Dept. Crop & Soil Sc., Wash. State Univ. Pullman, WA 99164-6420, USA.

Yildirim, B.M. and Z. Yildirim. Anther culture of potato and breeding strategies. Dept. of Field Crops, Aegeon Univ. Bornova, izmir, Turkey.

Zipko, H. and E. Wilhelm. Biocontrol of chestnut blight. Agric. Res. & Biotechnology, Austrian Res. Ctr. Seibersdorf, A-2444.

(Contributed by SCHMIDT, J., Austrian Research Centre, A-2444 Seibersdorf, Austria)

MUTANT VARIETIES - DATA BANK
FAO/IAEA DATABASE

The idea to collect and transfer to plant breeders information on any crop variety developed with the use of mutation techniques was born almost parallel to the establishment of the Plant Breeding and Genetics Section (PBG), Joint FAO/IAEA Division. Dr. B. Sigurbjörnsson, the first Head of the PBG Section began collecting data on mutant varieties in 1963. The first classified list of induced mutant varieties was presented by Sigurbjörnsson at the Pullmann symposium and published in 1969 [1]. This work was continued for 22 years by Dr. A. Micke. The original information from the author or other plant breeder on a new, officially released or approved mutant variety was transferred to an information sheet and kept on file. A comprehensive, official list of mutant varieties was published by Sigurbjörnsson and Micke in 1974 [2] and this was updated in 1985 [3]. Since the first issue of the Mutation Breeding Newsletter (MBNL)(May, 1972) information on newly released mutant varieties was published at the end of each issue under the title "List of Mutant Varieties". Filing and retyping the incoming information sheets for the MBNL was done by Ms. M. Weiner and continued to date by Ms. L. Halgand. In 1980, Sigurbjörnsson and then Dr. C. Konzak and Dr. B. Donini undertook the work leading to establishment of a database for mutant varieties with the use of mainframe facilities of the IAEA. Fast development of personal computer technology, together with the large number of suitable software, gave Dr. M. Maluszynski the idea to organize a database on IBM PC using "dBaseIII+" software. The work was initiated by him in 1987 and has continued, with the help of Ms. K. Weindl. Only data on mutant varieties previously published in the MBNL are inserted in the "Mutant Varieties Database". The last record has already number 1548 and includes mutant varieties published in MBNL No. 37, 1991. For each record/variety the information is collected on 19 fields, including references in MBNL.

We are publishing the first part of the "Mutant Varieties Database" in the current issue of MBNL, No. 38. We hope that all the information contained in the database will help the readers of the Mutation Breeding Newsletter to choose the proper method in their plant breeding and other research programmes. We hope as well that such condensed but full information on mutant varieties will allow the readers to build their own opinion on the achievements and impact of mutation breeding in crop improvement.

By publishing the full list of mutant varieties we also hope to receive not only some corrections, if necessary, related to presented information on mutant varieties but also more detailed or additional information on the use of different mutant varieties in cross breeding programmes. We are also very much interested, as it was already mentioned in MBNL No. 2 (1973) "in knowing the acreage under mutant varieties in your countries and, if possible, the estimated annual value of the mutant crops".

As we are going, in the near future, to organize a database on available crop plant mutant varieties germplasm collections this list of mutant varieties can help you in sending us the proper information. If you have in your germplasm collection any of the listed mutant varieties and if you are interested in putting your name and address on the information list, please send us your exact address (including Fax number if possible) together with the name of crop(s) and mutant variety(s) kept in your collection. This information will help other plant breeders to contact you and, if applicable, to exchange seeds.

Please send relevant information to the following address:
Dr. M. Maluszynski
Plant Breeding and Genetics Section
Joint FAO/IAEA Division
P.O. Box 100
1400 Vienna, Austria
FAX: 43-1-234564

In this issue of the Mutation Breeding Newsletter only that part of Mutant Varieties Database dealing with "seed propagated crops" is being published. Under this category, in addition to crops propagated exclusively by seed, are also plant species usually propagated vegetatively but producing seeds. This character is or can be used in plant breeding programmes of these crops. In this classification, which is a somewhat facultative we have usually followed suggestions of the breeders of varieties. The problem is more complicated if one considers the changes in the biology of reproduction of different plant species depending on environmental conditions. The second part of "Mutant Varieties Database" related to "vegetatively propagated plants" will be published in issue 39 of the MBNL.

We are presenting below two tables with the number of mutant varieties in each crop (Table 1) and the number of officially released mutant varieties of "seed-propagated crops" in various countries (Table 2). Both tables were prepared on the basis of data taken from the database.

Table 1: Number of officially released mutant varieties of different species of seed propagated crops and published in Mutation Breeding Newsletters up to Number 37, 1991

Latin name	Common name	No. of mutant cv.	
		Total	Obtained by cross with mutant
Abelmoschus esculentus Moench	okra	1	-
Agrostis sp.	creeping bent grass	1	-
Alium cepa L.	onion	2	-
Alopecurus pratensis L.	meadow foxtail	2	-
Arachis hypogaea L.	groundnut	33	14
Arctium lappa L.	burdock	4	-
Astragalus huangheensis	shadawang	1	-
Avena sativa L.	cat	15	10
Beta vulgaris L.	fodder beet	1	-
Brassica campestris L.	turnip/japanese rape	1	-

Table 1: (cont.)

Latin name	Common name	No. of mutant cv.	
		Total	Obtained by cross with mutant
Brassica juncea L.	oriental/chinese mustard	3	1
Brassica napus L.	rapeseed	7	1
Brassica pekinensis Rupr.	chinese cabbage	2	-
Cajanus cajan Millsp.	pigeon pea	5	1
Capsicum annuum L.	green pepper	5	1
Capsicum annuum L.	pepper	1	-
Carica papaya L.	papaya	1	-
Cicer arietinum L.	chickpea	7	-
Citrullus lanatus Mansf.	watermelon	2	-
Corchorus capsularis L.	white jute	2	1
Corchorus olitorius L.	tossa jute	7	1
Cucumis sativus L.	cucumber	2	1
Curcuma domestica Val.	turmeric	2	-
Dolichos lablab L.	hyacinth bean	1	-
Eriobotrya japonica Lindl	loquat	1	-
Fagopyrum esculentum Gili	buckwheat	1	-
Fagopyrum sagittatum Gili	buckwheat	4	-
Festuca pratensis Huds.	meadow fescue	3	-
Glycine max L.	soybean	41	3
Gossypium sp.	cotton	16	3
Helianthus annuus L.	sunflower	1	-
Hibiscus sp.	roselle	4	-
Hippophaea rhamnoides L.	buckthorn	1	-
Hordeum vulgare L.	barley	229	192
Juncus effusus L.	mat rush	2	-
Lactuca sativa L.	lettuce	2	-
Lens culinaris Medik.	lentil	1	-
Lepidium sativum L.	cress	1	-
Lespedeza cuneata Dum.	lespedeza	2	1
Linum usitatissimum L.	flax/linseed	6	3
Lolium sp.	ryegrass	1	-
Luffa acutangula Roxb.	ridged gourd	1	-
Lupinus albus L.	white lupin	6	2
Lupinus angustifolius L.	blue lupin	1	-
Lupinus consentini Guss.	lupin	1	1
Lupinus luteus L.	yellow lupin	4	3
Lycopersicon esculentum M.	tomato	10	3
Momordica charantia L.	bitter gourd	1	-
Nicotiana tabacum L.	tobacco	7	5
Onobrychis viciifolia Sco.	sainfoin	1	-
Ornithopus compressus L.	serradella	1	-
Oryza sativa L.	rice	278	80
Panicum miliaceum L.	proso millet	1	-
Pennisetum sp.	pearl millet	5	2
Phaseolus vulgaris L.	bean	17	4
Pisum sativum L.	pea	24	13
Prunus dulcis Webb	almond	1	-
Ricinus communis L.	castor bean	3	1
Secale cereale L.	rye	4	-

Table 1: (cont.)

Latin name	Common name	No. of mutant cv. Total	No. of mutant cv. Obtained by cross with mutant
Sesamum orientale DC.	sesame	2	-
Setaria Italica Beauv.	foxtail millet	1	-
Setaria sp.	millet	6	-
Sinapis alba L.	mustard	4	1
Solanum khasianum Clarke	khasianum	1	-
Solanum melongena L.	eggplant	4	-
Sorghum bicolor L.	sorghum	5	1
Spinacia oleracea L.	spinach	1	-
Trifolium alexandrinum L.	egyptian clover	1	-
Trifolium incarnatum L.	crimson clover	1	-
Trifolium pratense L.	red clover	1	-
Trifolium subterraneum L.	subterranean	1	-
Triticum aestivum L.	wheat	113	16
Triticum turgidum ssp. durum Desf.	durum	25	17
Vicia faba L.	faba bean	7	1
Vigna angularis Willd.	azuki bean	1	-
Vigna mungo L.	black gram	2	1
Vigna radiata (L.) Wil.	mungbean	9	-
Vigna unguiculata Walp.	cowpea	9	-
Zea mays L.	maize	33	26
Ziziphus mauritiana Lam.	indian jujube	2	-
	Total	1019	410

Table 2: Number of officially released mutant varieties of seed propagated crops listed by country of release as published in Mutation Breeding Newsletters up to Number 37. Some mutant varieties were released in more than one country.

Country	No. of mutant cv.	Crop
Algeria	1	soybean
Argentina	3	groundnut (2), wheat* (1)
Australia	6	blue lupin (1), lupin (1), oat (2), serradella (1), subterranean clover (1)
Austria	18	barley (11), durum** (6), faba bean (1)
Bangladesh	7	chickpea (1), oriental mustard (1), rice (2), tossa jute (3)
Belgium	3	barley (1), red clover (1), ryegrass (1)
Brazil	30	bean (1), rice (27), wheat (2)
Bulgaria	24	barley (4), durum (4), green pepper (3), maize (7), soybean (3), tobacco (1), wheat (2)
Burkina Faso	3	rice

Table 2: (cont.)

Country	No. of mutant cv.	Crop
Canada	7	barley (2), bean (1), flax/linseed (2), rapeseed (1), tobacco (1)
Cameroon	4	rice
Chile	2	barley (1), wheat (1)
China	281	barley (1), chinese cabbage (2), cotton (5), cucumber (1), flax/linseed (3), foxtail millet (1), groundnut (20), maize (21), millet (6), pea (1), rapeseed (4), rice (114), shadawang (1), sorghum (3), soybean (19), watermelon (1), wheat (78)
Costa Rica	1	cowpea
Côte d'Ivoire	26	rice
CSFR	33	barley (27), bean (1), crimson clover (1), maize (3), soybean (1)
Denmark	22	barley
Egypt	1	bean
Germany (DR)	28	barley (24), faba bean (1), rye (2), soybean (1)
Germany (FR)	30	barley (20), bean (2), meadow fescue (3), meadow foxtail (2), spinach (1), wheat (2)
Finland	11	barley (4), oat (4), rye (2), wheat (1)
France	21	barley (15), durum (1), rice (5)
Greece	2	barley (1), durum (1)
Guinea Bissau	1	rice
Guyana	26	rice
Hungary	5	maize (1), rice (3), wheat (1)
India	116	barley (14), bean (1), bitter gourd (1), black gram (2), castor bean (3), chickpea (4), chinese mustard (1), cotton (8), cowpea (6), eggplant (1), egyptian clover (1), green pepper (1), groundnut (8), hyacinth bean (1), khasianum (1), lentil (1), mungbean (4), mustard (1), okra (1), oriental mustard (1), papaya (1), pea (1), pearl millet (5), pigeon pea (5), rice (24), ridge gourd (1), sesame (1), sorghum (1), tobacco (1), tomato (4), tossa jute (3), turmeric (2), wheat (4), white jute (2)
Indonesia	6	rice (3), soybean (2), tobacco (1)
Italy	29	almond (1), bean (2), durum (13), eggplant (3), green pepper (1), pea (6), rice (1), wheat (2)
Japan	65	azuki bean (1), barley (7), burdock (4), creeping bent grass (1),lettuce (2), loquat (1), mat rush (2), rice (31), roselle (4), soybean (5), tomato (4), turnip/jpn rape (1), wheat (2)
Kenya	2	cowpea
Korea (Rep. of)	5	barley (1), rice (1), sesame (1), soybean (2)
Madagascar	1	rice
Myanmar	5	groundnut (1), rice (3), tossa jute (1)
Netherlands	3	barley (1), onion (2)

Table 2: (cont.)

Country	No. of mutant cv.	Crop
Norway	2	barley
Pakistan	12	chickpea (2), cotton (1), mungbean (5), rice (3), wheat (1)
Philippines	3	rice
Poland	15	faba bean (3), pea (11), yellow lupin (1)
Portugal	1	rice
Senegal	2	rice
Spain	1	barley
Sri Lanka	1	rice
Sweden	26	barley (20), mustard (3), pea (1), rapeseed (2)
Switzerland	1	wheat
Thailand	4	rice (3), soybean (1)
Togo	1	rice
UK	32	barley
USA	44	barley (9), bean (6), groundnut (1), lespedeza (2), oat (6), rice (17), wheat (3)
USSR	82	barley (19), bean (2), buckthorn (1), buckwheat (5), cotton (2), cress (1), cucumber (1), faba bean (2), flax/linseed (1), fodder beet (1), maize (1), oat (3), pea (4), proso millet (1), rice (2), sainfoin (1), sorghum (1), soybean (6), sunflower (1), tobacco (1), tomato (2), watermelon (1), wheat (12), white lupin (6), yellow lupin (3)
Vietnam	9	groundnut (1), indian jujube (2), rice (6)
Yugoslavia	1	pepper

* wheat = bread wheat; ** durum = durum wheat

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(Contributed by Maluszynski, M., B. Sigurbjörnsson, E. Amano, L. Sitch and O. Kamra, Plant Breeding and Genetics Section, Joint FAO/IAEA Division, A-1400 Vienna, Austria)

Mutant varieties of seed-propagated crops* officially released in various countries and published in Mutation Breeding Newsletter (MBNL) till Number 37 or in publication Sigurbjörnsson and Micke, 1974**

(cited in the table as MBNL "0 - 74")

Crop plant/ species	Mutant cultivar	Country	and Year of release	Mutagen(s)	MBNL Issue.	Page	Main character improved
almond	Supernova	Italy	1987	gamma rays	32	29	lateness
azuki bean	Beni-nambu	Japan	1978	gamma rays	21	17	earliness
barley	Acclaim	GDR	1984	cross	37	26	yield
barley	Accord	USSR	1987	cross	31	21	earliness
barley	Advance	USA	1979	cross	28	20	yield
barley	Aizao No.3	China	1977	gamma rays	25	11	earliness
barley	Alexis	FRG	1986	cross	36	16	powdery mildew res.
barley	Alf	Denmark	1978	thN	13	18	shortness
barley	Alis	Denmark	1985	cross	36	16	nematode resistance
barley	Allasch	FRG	1963	cross	5	13	stiffness
barley	Amagi Nijo 1	Japan	1971	x-rays	2	8	earliness
barley	Amalia	Austria	1988	cross	33	24	yield
barley	Amazone	FRG	1986	cross	36	16	-
barley	Amei	FRG	1966	cross	5	13	stiffness
barley	Amethyst	CSFR	1972	cross	10	17	yield
barley	Anker	Denmark	1986	cross	37	26	-
barley	Anna Abed	Denmark	1979	cross	34	29	stiffer straw
barley	Araraty	USSR	1983	EI	31	21	stiffness
barley	Arena	FRG	1983	cross	36	16	shortness
barley	Ariel	Sweden	1988	cross	37	26	stiffness
barley	Atlanta	Canada	1977	cross	11	17	stiffness
barley	Atlas	CSFR	1976	cross	10	14	yield
barley	Ayr	UK	1986	cross	34	30	short culm
barley	BH-75	India	1983	cross	36	17	dwarfness
barley	Bacchus	UK	1981	cross	37	26	-

barley	Balder J.	Finland	1960	x-rays	5	14	yield
barley	Baraka	France	1986	cross	37	26	winter type
barley	Beate	FRG	1984	cross	36	16	brewing quality
barley	Beauly	UK	1983	cross	34	30	short culm
barley	Berolina	Austria	1982	cross	37	26	yield
barley	Berta	Austria	1982	cross	20	17	yield
barley	Betina	France	1970	EMS	0	74	shortness
barley	Blazer	USA	1974	cross	10	18	alpha amylase
barley	Blenheim	UK	1987	cross	36	17	yield
barley	Bonneville 70	USA	1969	thN	0	74	threshability
barley	Bonus	CSFR	1984	cross	31	21	yield
barley	Boyer	USA	1974	cross	10	18	earliness
barley	Camargue	UK	1986	cross	32	23	yield
barley	Camen	Denmark	1989	cross	37	26	yield
barley	Camir	Denmark	1985	cross	36	17	malting quality
barley	Canor	Denmark	1985	cross	37	27	malting quality
barley	Canut	Denmark	1988	cross	37	27	yield
barley	Cargine	France	1986	cross	37	27	-
barley	Carmen	Austria	1986	cross	29	23	yield
barley	Carnival	UK	1981	cross	37	27	-
barley	Carula	Denmark	1989	cross	37	27	malting quality
barley	Catrin	Denmark	1985	cross	37	27	yield
barley	Cheri	FRG	1987	cross	36	17	earliness
barley	Comtesse	FRG	1987	cross	33	24	yield
barley	Consista	GDR	1979	cross	32	23	yield
barley	Corgi	UK	1985	cross	37	27	-
barley	Corniche	UK	1985	cross	32	23	yield
barley	Cromarty	UK	1983	cross	34	30	short culm
barley	DL-253	India	1981	gamma rays + EMS	19	15	yield
barley	Deawn	USA	1975	cross	11	17	shortness
barley	Debut	USSR	-	NEM	20	17	yield
barley	Defia	GDR	1984	cross	37	27	yield

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* including species where seed-propagation is used only for breeding than vegetatively propagated

** Sigurbjörnsson, B. and A. Micke, 1974. Philosophy and accomplishments of mutation breeding. In: Polyploidy and Induced Mutations in Plant Breeding. IAEA, Vienna, pp. 303-343.

Crop plant/	Mutant cultivar	Country	and Year	Mutagen(s)	MBNL		Main character
species			of release		Issue,	Page	improved
barley	Defra	GDR	1984	cross	32	23	yield
barley	Delita	GDR	1987	cross	32	23	yield
barley	Denar	CSFR	1969	x-rays	6	13	-
barley	Dera	GDR	1982	cross	32	24	yield
barley	Derkado	GDR	1987	cross	32	24	yield
barley	Diabas	CSFR	1977	cross	13	19	-
barley	Diamant	CSFR	1965	x-rays	0	74	yield
barley	Diana	Bulgaria	1983	gamma rays	36	17	yield
barley	Dinky	Belgium	1987	cross	37	27	-
barley	Donan	UK	1983	cross	34	30	short culm
barley	Dorett	FRG	1985	cross	36	17	yield
barley	Dorina	GDR	1984	cross	32	24	yield
barley	Doublet	UK	1983	cross	30	22	yield
barley	Empress	Canada	1983	cross	28	20	yield
barley	Esk	UK	1985	cross	34	30	short culm
barley	Eva	Sweden	1972	cross	7	12	stiffness
barley	Everest	UK	1985	cross	37	28	-
barley	Fakel	USSR	1975	EI	12	14	shortness
barley	Fatran	CSFR	1980	cross	31	21	yield
barley	Favorit	CSFR	1973	cross	10	18	yield
barley	Femina	GDR	1984	cross	32	24	grain quality
barley	Fergie	UK	1990	cross	37	28	-
barley	Fleet	UK	1985	cross	37	28	yield
barley	Formula (=W 7200)	Sweden	1987	cross	37	28	shortness
barley	Frankengold	FRG	1975	cross	37	28	-
barley	Fuji 2-jyo II	Japan	1974	BUdR + gamma rays	11	17	stiffness
barley	Galant	Denmark	1984	NaN_3	37	29	proanthocyani. free
barley	Gamma No. 4	Japan	1965	gamma rays	0	74	shortness
barley	Gavotte	France	1986	cross	37	29	-
barley	Gerlinde	GDR	1979	cross	32	25	yield
barley	Goldfield	UK	1969	cross	36	17	-
barley	Goldmarker	UK	1976	cross	10	15	erectoide
barley	Goldspear	UK	1975	cross	10	15	erectoide

barley	Gorm	Denmark	1981	cross	37	29	-
barley	Grammos	Greece	1969	gamma rays	37	29	cold tolerance
barley	Grisante	UK	1984	cross	37	29	-
barley	Grit	GDR	1979	cross	32	24	yield
barley	Gunilla	Sweden	1970	cross	0	74	yield
barley	Gunnar	Denmark	1982	cross	*33*	*24*	*early maturing*
barley	Hana	CSFR	1973	cross	10	17	yield
barley	Hankkija's Aapo	Finland	1975	x-rays	7	13	stiffness
barley	Hankkija's Eero	Finland	1975	cross	7	13	stiffness
barley	*Harkovskii 84*	*USSR*	*1988*	*ethyleneoxide*	31	21	earliness
barley	Haya-Shinriki	Japan	1962	gamma rays	2	8	earliness
barley	Helena	FRG	1983	cross	37	29	-
barley	Hellas	Sweden	1967	cross	0	74	stiffness
barley	Heriot	UK	1983	cross	30	22	semi-prostrate
barley	Herzo	FRG	1976	cross	37	29	-
barley	Hesk	USA	1979	cross	36	18	shortness
barley	Horal	CSFR	1982	cross	31	21	yield
barley	Ilka	GDR	1984	cross	32	25	yield
barley	Inga	Denmark	1982	cross	36	18	-
barley	Ingot	UK	1980	cross	36	18	-
barley	Jamina	UK	1979	cross	36	18	-
barley	Jarek	CSFR	1987	cross	31	22	yield
barley	Jaspis	CSFR	1986	cross	31	22	yield
barley	Jenny	Sweden	1980	cross	19	15	yield
barley	Jupiter	UK	1976	cross	13	18	yield
barley	Jutta	Austria	1983	cross	29	23	yield
barley	Jutta	GDR	1955	x-rays	0	74	yield
barley	K-2578	India	1980	cross	36	18	tallness
barley	Karan-15	India	1982	cross	36	19	dwarfness
barley	Karan-201	India	1984	cross	36	19	dwarfness
barley	Karan-265	India	1989	cross	36	19	dwarfness
barley	Karan-3	India	1982	cross	36	18	dwarfness
barley	Karan-4	India	1983	cross	36	19	dwarfness
barley	Karat	CSFR	1981	cross	31	22	yield
barley	Kaskad	USSR	1984	cross	31	22	stiffness
barley	Kawamizuki	Japan	1979	cross	21	13	shortness
barley	Kazbek 1	USSR	1983	gamma rays	31	22	yield

Crop plant/ species	Mutant cultivar	Country	and Year of release	Mutagen(s)	MBNL Issue.	Page	Main character improved
barley	Keti	Denmark	1982	cross	20	17	yield
barley	Kingspin	UK	1985	cross	36	19	-
barley	Koral	CSFR	1978	cross	31	22	yield
barley	Korinna	GDR	1988	cross	36	19	yield
barley	Krassi 2	Bulgaria	1983	cross	36	19	shortness
barley	Kredit	CSFR	1984	cross	31	23	yield
barley	Kristina	Sweden	1969	cross	0	74	stiffness
barley	Krystal	CSFR	1981	cross	31	23	yield
barley	Kustaa	Finland	1980	cross	19	15	earliness
barley	Lada	GDR	1979	cross	32	25	yield
barley	Larissa	GDR	1989	cross	36	20	yield
barley	Laura	France	1971	cross	37	29	-
barley	Leila	France	1984	cross	37	29	-
barley	Lenka	GDR	1985	cross	32	25	yield
barley	Leo-INIA/CCU	Chile	1990	cross	37	30	earliness
barley	Lina	Sweden	1982	cross	25	11	yield
barley	Lussi (=Vicky)	Sweden	-	cross	37	30	malting quality
barley	Luther	USA	1967	dES	0	74	shortness
barley	Madelon	France	1985	cross	37	30	-
barley	Maksim	USSR	-	cross	37	30	lodging resistance
barley	Mal	USA	1979	cross	36	20	lodging resistance
barley	Maresi	GDR	1986	cross	32	25	yield
barley	Mari	Sweden	1962	x-rays	0	74	earliness
barley	Markeli 5	Bulgaria	1976	gamma rays	14	10	earliness
barley	Mars	CSFR	1983	cross	31	23	yield
barley	Masakadomugi	Japan	1989	cross	35	35	BYMV resistance
barley	Matura	FRG	1967	cross	37	30	-
barley	Midas	UK	1970	cross	0	74	shortness
barley	Mikkel	Denmark	1983	cross	37	30	-
barley	Milns Golden Promise	UK	1966	gamma rays	0	74	shortness
barley	Minak	UK	1976	cross	13	18	stiffness
barley	Minsk	USSR	1974	gamma rays	6	13	stiffness
barley	Mona	Sweden	1970	cross	0	74	yield

barley	Moskovskii 2	USSR	1984	cross	30	22	yield
barley	Nadja	GDR	1975	cross	9	15	shortness
barley	Nairn	UK	1983	cross	34	31	short culm
barley	Natasha	France	1986	cross	36	20	yield
barley	Nebi	GDR	1983	cross	32	25	yield
barley	Nirasaki Nijo 8	Japan	1967	cross	2	8	earliness
barley	Nomad	FRG	1990	cross	36	20	-
barley	Novator	USSR	-	cross	20	17	yield
barley	Novum	CSFR	1988	cross	34	31	yield
barley	Octave	Austria	1986	cross	36	20	-
barley	Opal	CSFR	1980	cross	31	23	disease resistance
barley	Orbit	CSFR	1986	cross	31	23	yield
barley	Othello	UK	1988	cross	37	31	-
barley	PL 56	India	1975	EMS	32	25	tillering
barley	Pacha	France	1986	cross	37	31	-
barley	Pallas	Sweden	1960	x-rays	0	74	stiffness
barley	Patricia	France	1988	cross	37	31	-
barley	Peak	UK	1988	cross	37	31	-
barley	Pennrad	USA	1963	thN	0	74	winter hardiness
barley	Pernilla	Sweden	1979	cross	19	15	earliness
barley	Perun	CSFR	1987	cross	31	23	yield
barley	Pression	France	1986	cross	37	31	-
barley	Prisiv	USSR	-	cross	20	17	yield
barley	Prisma	Netherlands	1985	cross	36	20	yield
barley	Profit	CSFR	1988	cross	34	31	yield
barley	RD-103	India	1978	cross	26	13	shortness
barley	RD-137	India	1981	cross	36	21	shortness
barley	RD-2035	India	1988	cross	36	21	shortness
barley	RDB-1	India	1972	pile neutrons	0	74	shortness
barley	Radiation	Korea	1974	thN	5	13	earliness
barley	Radikal	USSR	1988	cross	31	23	winter hardiness
barley	Rapid	CSFR	1976	cross	9	14	yield
barley	Rejkiran	India	1982	cross	26	13	shortness
barley	Robin	Austria	1986	cross	29	23	yield
barley	Romi	Denmark	1983	cross	36	21	-
barley	Rosie	Denmark	1980	cross	36	21	-
barley	Rubin	CSFR	1982	cross	31	24	yield

Crop plant/ species	Mutant cultivar	Country and Year of release		Mutagen(s)	MBNL		Main character improved
					Issue.	Page	
barley	Rumba	FRG	1988	cross	36	21	-
barley	Rupal	Sweden	1972	cross	7	12	shortness
barley	Safir	CSFR	1978	cross	14	11	shortness
barley	Salome	GDR	1981	cross	32	25	yield
barley	Salve	Sweden	1974	cross	7	12	grain size
barley	Semal	Denmark	1990	cross	37	31	yield
barley	Senat	Sweden	1974	cross	7	12	stiffness
barley	Seru	Sweden	1973	cross	36	21	-
barley	Shirokolistnii	USSR	1987	ENH	31	24	tallness
barley	Sila	Denmark	1986	cross	36	21	stiffness
barley	Sissy	FRG	1990	cross	37	31	quality
barley	Spartan	CSFR	1977	cross	14	11	shortness
barley	Spirit	GDR	1986	cross	32	25	earliness
barley	Stange	Norway	1978	cross	12	14	shortness
barley	Stella	FRG	1989	cross	36	21	brewing quality
barley	Taarn	Sweden	1982	cross	36	22	-
barley	Tamina	GDR	1982	cross	32	26	yield
barley	Teele	USSR	1988	DMSO	35	36	earliness
barley	Temp	USSR	1976	ENH	13	18	yield
barley	Toga	FRG	1986	cross	36	22	shortness
barley	Troja	Sweden	1981	cross	25	11	yield
barley	Trumpf	GDR	1973	cross	9	14	shortness
barley	Tyne	UK	1987	cross	34	31	short culm
barley	Tyra	Norway	1988	cross	33	25	yield
barley	Ursel	FRG	1985	cross	36	22	-
barley	Valerie	France	-	cross	37	31	-
barley	Vavilon	USSR	1990	cross	36	22	eco. stability
barley	Vega Abed	Denmark	1977	cross	34	31	stiffer straw
barley	Vienna	Austria	1959	x-rays	0	74	yield
barley	Visir	Sweden	1970	cross	0	74	mildew resistance
barley	Yubilei 100	Bulgaria	1982	cross	36	22	yield
barley	Zazerskij 85	USSR	-	cross	37	31	-
barley	Zenit	CSFR	1985	cross	31	24	yield

barley	Zgoda	USSR	-	cross	37	31	-
bean	Alfa	CSFR	1972	EMS	10	16	seed colour
bean	Carioca Arbustivo	Brazil	1986	gamma rays	34	33	bushy type
bean	Giza 80	Egypt	1980	gamma rays	17	14	rust resistance
bean	Gratiot	USA	1962	x-rays	0	74	stiffness
bean	Harkovskaya 8	USSR	1985	gamma rays	31	31	seed colour
bean	Mitchell	Canada	1986	cross	34	33	-
bean	Mogano	Italy	1985	EMS	31	31	seed colour
bean	Montalbano	Italy	1985	EMS	31	31	seed colour
bean	Neptune	USA	1986	cross	30	25	plant architecture
bean	Ouray	USA	1982	cross	28	22	bushy type
bean	Pusa Parvati	India	1970	x-rays	0	74	earliness
bean	Sanilac	USA	1956	x-rays	0	74	bushy type
bean	Saparke 75	USSR	1967	gamma rays	0	74	yield
bean	Seafarer	USA	1967	x-rays	0	74	earliness
bean	Seaway	USA	1960	x-rays	0	74	earliness
bean	Unima	FRG	1957	cross	0	74	disease resistance
bean	Universal	FRG	1950	x-rays	0	74	earliness
bitter gourd	MDU 1	India	1984	gamma rays	32	27	insect resistance
black gram	Co 4	India	1978	MMS	29	28	earliness
black gram	TAU 1	India	1985	cross	28	23	yield
blue lupin	Chittick	Australia	1982	EI	20	17	earliness
buckthorn	Zyrianka	USSR	1985	gamma rays, MNH	28	21	yield
buckwheat	Aelita	USSR	1978	gamma rays	30	21	yield
buckwheat	Aromat	USSR	1985	EI	31	19	stiffness
buckwheat	Galleya	USSR	1979	gamma rays	30	21	yield
buckwheat	Lada	USSR	1979	gamma rays	30	21	yield
buckwheat	Podolyanka	USSR	1984	radiation , chemical	30	21	compact type
burdock	Kobaruto-gokuwase	Japan	1981	gamma rays	21	12	earliness
burdock	Kobaruto-okute	Japan	1981	gamma rays	21	12	lateness
burdock	Kobaruto-wase	Japan	1981	gamma rays	21	12	earliness
burdock	Tsuneyutaka	Japan	1986	gamma rays	33	21	thick root
castor bean	Aruna	India	1969	thN	0	74	earliness
castor bean	RC8	India	1978	gamma rays	11	17	growth period
castor bean	Sowbhagya (157-B)	India	1976	cross	11	17	growth period
chickpea	CM72	Pakistan	1983	gamma rays	23	17	blight resistance
chickpea	Hyprosola	Bangladesh	1981	gamma rays	19	14	earliness

Crop plant/ species	Mutant cultivar	Country and Year of release		Mutagen(s)	MBNL		Main character improved
					Issue.	Page	
chickpea	Kiran	India	1984	Neutrons	26	12	erectoid type
chickpea	NIFA-88 (CM-1918)	Pakistan	1990	gamma rays	37	24	Ascochyta resist.
chickpea	Pusa 408	India	1985	gamma rays	29	21	yield
chickpea	Pusa 413	India	1985	gamma rays	29	21	yield
chickpea	Pusa 417	India	1985	gamma rays	29	21	yield
chinese cabbage	Baicai No.9	China	1978	gamma rays	25	10	earliness
chinese cabbage	Longbai No.1	China	1984	gamma rays	30	20	earliness
chinese mustard	RL 1359	India	1987	cross	31	11	earliness
cotton	113	China	1985	gamma rays	35	35	earliness
cotton	Agdash 3	USSR	1983	gamma rays	31	20	yield
cotton	Badnawar-1	India	1961	cross	30	21	-
cotton	Chuanpei 1	China	1982	gamma rays	34	29	earliness
cotton	Indore-2	India	1950	x-rays	30	21	-
cotton	Khandwa-2	India	1971	cross	30	21	-
cotton	Lumian No.1	China	1976	gamma rays	19	15	plant architecture
cotton	M.A.9	India	1948	x-rays	30	21	drought resistance
cotton	MCU 10	India	1982	gamma rays	29	22	drought tolerance
cotton	MCU 7	India	1971	x-rays	2	9	earliness
cotton	NIAB-78	Pakistan	1983	gamma rays	23	18	yield
cotton	Oktyabr	USSR	1984	cross	31	20	compact type
cotton	Pusa Ageti	India	1978	gamma rays	16	19	ginning capacity
cotton	Rasmi	India	1976	gamma rays	16	18	daylength tolerance
cotton	Xinhai No.2	China	1979	x-rays	27	20	plant architecture
cotton	Yunfu 885	China	1977	gamma rays	27	20	earliness
cowpea	Co 5	India	1986	gamma rays	29	27	nutritional value
cowpea	Cowpea-88	India	1990	radiation	37	44	yield
cowpea	ICV 11	Kenya	1985	gamma rays	28	23	semi-erect type
cowpea	ICV 12	Kenya	1985	gamma rays	28	23	yield
cowpea	Uneca-Gama	Costa Rica	1986	gamma rays	34	33	yield
cowpea	V16 (Amba)	India	1981	dMS	25	21	yield
cowpea	V240	India	1984	dMS	25	21	yield
cowpea	V37 (Shreshtha)	India	1981	dMS	25	21	yield
cowpea	V38 (Swarna)	India	1984	dMS	25	21	yield

creep. bent grass	Springs	Japan	1973	gamma rays	32	19	heat tolerance
cress	Vest	USSR	1988	electrons	31	26	plasticity
crimson clover	Cardinal	CSFR	-	-	6	13	-
cucumber	Altay	USSR	1981	cross	31	18	earliness
cucumber	Ludi 1	China	1981	laser	35	33	vigorous growth
durum	Arpad	Austria	1987	cross	30	27	shortness
durum	Attila	Austria	1980	cross	16	18	shortness
durum	Augusto	Italy	1976	cross	10	14	yield
durum	Cargidurox	France	1981	EMS	21	17	shortness
durum	Castel del Monte	Italy	1969	fN	0	74	stiffness
durum	Castelfusano	Italy	1968	thN	0	74	stiffness
durum	Castelnuovo	Italy	1971	x-rays	0	74	stiffness
durum	Castelporziano	Italy	1968	thN	0	74	stiffness
durum	Creso	Italy	1974	cross	6	14	stiffness
durum	Febo	Italy	1982	cross	37	43	yield
durum	G-0367	Greece	1970	thN	16	18	shortness
durum	Gergana	Bulgaria	1984	gamma rays	37	43	lodging resistance
durum	Giano	Italy	1982	cross	37	43	yield
durum	Grandur	Austria	1980	cross	16	18	shortness
durum	Icaro	Italy	1987	fN	35	41	short culm
durum	Lozen 76	Bulgaria	1982	cross	20	18	yield
durum	Mida	Italy	1974	cross	6	14	stiffness
durum	Peleo	Italy	1988	cross	37	43	shortness
durum	Probstdorfer Miradur	Austria	1978	cross	13	20	yield
durum	Signadur	Austria	1984	cross	26	15	shortness
durum	Sredetz	Bulgaria	1988	cross	33	32	yield
durum	Tito	Italy	1975	cross	6	14	stiffness
durum	Ulisse	Italy	1988	cross	37	43	shortness
durum	Unidur	Austria	1984	cross	29	27	stiffness
durum	Zeveryana	Bulgaria	1986	cross	33	33	shortness
eggplant	Floralba	Italy	1985	EMS	32	29	shortness
eggplant	Macla	Italy	1983	EMS	32	29	shortness
eggplant	PKM 1	India	1985	gamma rays	32	29	yield
eggplant	Picentia	Italy	1983	EMS	32	29	shortness
egyptian clover	BL-22	India	1984	gamma rays	26	15	lateness
faba bean	Bronto	Poland	1989	gamma rays	37	44	yield
faba bean	Chabanskii	USSR	1985	ENH	31	37	earliness

Crop plant/	Mutant cultivar	Country	and Year	Mutagen(s)	MBNL		Main character
species			of release		Issue.	Page	improved
faba bean	Dino	Poland	1987	gamma rays	31	38	shortness
faba bean	KIU-82	USSR	1987	chemical mutagen	31	37	disease resistance
faba bean	Karna	Austria	1983	gamma rays	29	27	yield
faba bean	Stego	Poland	1987	gamma rays	31	37	shortness
faba bean	Ti-Nova	GDR	1986	cross	30	27	terminal inflores.
flax/linseed	Dufferin	Canada	1979	cross	18	17	oil content
flax/linseed	Heiya No.4	China	1978	cross	27	21	earliness
flax/linseed	Heiya No.6	China	1984	cross	32	26	yield
flax/linseed	Ningya No.10	China	1982	gamma rays	32	26	earliness
flax/linseed	Redwood 65	Canada	1965	x-rays	5	13	oil content
flax/linseed	Zarya 87	USSR	1988	EI	31	26	late flowering
fodder beet	Timiryazevskaya	USSR	1988	chemical mutagen	31	10	yield
foxtail millet	Lugu No. 7	China	1987	gamma rays	33	32	shortness
green pepper	Albena	Bulgaria	1976	gamma rays	16	19	fruit morphology
green pepper	Friari KS80	Italy	1985	EMS	37	22	shortness
green pepper	Krichimsky ran	Bulgaria	1972	x-rays	12	16	yield
green pepper	Ljulin	Bulgaria	1982	cross	20	16	hybrid variety
green pepper	MDU.1	India	1976	gamma rays	10	16	compact type
groundnut	78961	China	1988	cross	37	19	earliness
groundnut	B 5000	Vietnam	1985	gamma rays	31	9	seed size
groundnut	BP-1	India	1979	gamma rays	31	19	seed size
groundnut	BP-2	India	1979	gamma rays	32	19	seed size
groundnut	Changhua No.4	China	1972	gamma rays	27	19	earliness
groundnut	Co 2	India	1984	EMS	26	12	yield
groundnut	Colorado Irradiado	Argentina	-	x-rays	7	13	yield
groundnut	Fu 21	China	1981	gamma rays	29	20	yield
groundnut	Fu 22	China	1985	gamma rays	37	19	A. flavus resist.
groundnut	Lainong 10	China	1984	laser	37	19	earliness
groundnut	Luhua 6	China	1986	gamma rays	34	26	earliness
groundnut	Luhua No.7	China	1986	gamma rays	32	19	lodging resistance
groundnut	MH-2	India	1973	-	37	20	yield
groundnut	N.C.4-X	USA	1959	x-rays	0	74	hull toughness
groundnut	P12	China	1986	cross	37	20	yield

groundnut	Shanyou 27	China	1985	cross	37	20	uniform emergence
groundnut	Sin Pa detha 1	Myanmar	1982	gamma rays	20	16	earliness
groundnut	TG 17	India	1977	x-rays	12	14	yield
groundnut	TG 3	India	1973	x-rays	12	14	pod number
groundnut	TG 4	India	1976	x-rays	12	14	uniform maturity
groundnut	Vikram	India	1973	x-rays	11	18	seed size
groundnut	Virginia No.3	Argentina	1979	radiation	30	20	pod size
groundnut	Yangxuan 1	China	1978	cross	37	20	-
groundnut	Yeuyou 551	China	1972	cross	25	9	dwarfness
groundnut	Yeuyou No.22	China	1968	cross	25	9	dwarfness
groundnut	Yuexuan 58	China	1978	cross	37	20	yield
groundnut	Yueyou 169	China	1980	cross	37	21	luxurious growth
groundnut	Yueyou 187	China	1981	cross	37	21	tallness
groundnut	Yueyou 187-93	China	1982	cross	37	21	tallness
groundnut	Yueyou 33	China	1971	cross	37	20	yield
groundnut	Yueyou 551-116	China	1975	cross	37	21	yield
groundnut	Yueyou 551-38	China	1975	cross	37	21	yield
groundnut	Yueyou 551-6	China	1975	cross	37	21	yield
hyacinth bean	Co 10	India	1983	gamma rays	29	22	yield
indian jujube	Dao tien	Vietnam	1986	MNH	34	34	earliness
indian jujube	Ma hong	Vietnam	1986	MNH	34	34	fruit shape
khasianum	RRL-20-2	India	1975	gamma rays	13	21	solasodine content
lentil	S-256	India	1981	radiation	20	17	spreading type
lespedeza	Interstate	USA	1970	thN	0	74	compact
lespedeza	Interstate 76	USA	1979	cross	16	19	Meloidogyne toler.
lettuce	Evergreen	Japan	-	32P	2	9	heat tolerance
lettuce	Giantgreen	Japan	-	32P	2	9	heat tolerance
loquat	Shiro-mogi	Japan	1981	gamma rays	21	13	fruit size
lupin	Eregulla	Australia	1972	cross	12	14	alkaloid content
maize	CE 200	CSFR	1979	gamma rays chronic	17	14	yield
maize	CE 268	CSFR	1979	gamma rays chronic	17	14	yield
maize	CE 330	CSFR	1979	gamma rays chronic	17	14	yield
maize	De 2205 SC	Hungary	1987	cross	37	45	earliness
maize	Jidan 101	China	1974	cross	25	22	root system
maize	Jidan No.1	China	1967	cross	27	29	blight resistance
maize	KNEJA-510 (hybrid)	Bulgaria	1982	cross	32	32	yield
maize	KNEJA-641 (hybrid)	Bulgaria	1982	cross	32	33	yield

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maize	KNEJA-666 (hybrid)	Bulgaria	1987	cross	32	33	silage suitability
maize	KNEJA-HP-556(hybrid)	Bulgaria	1981	cross	32	32	protein content
maize	KNEJA-HP-633(hybrid)	Bulgaria	1980	cross	32	32	protein content
maize	KNEJA-M-712 (hybrid)	Bulgaria	1987	cross	32	32	yield
maize	Knezha MHP 556	Bulgaria	1982	cross	37	45	-
maize	Kollectivnyi 210 ATV	USSR	1984	cross	30	28	yield
maize	Lauyu No.5 (hybrid)	China	1985	cross	31	38	earliness
maize	Longfuyu No.1 (hyb.)	China	1983	cross	31	38	earliness
maize	Luyu No. 5 (hybrid)	China	1984	cross	33	33	earliness
maize	Luyu No.3	China	1980	cross	25	22	disease resistance
maize	Luyuan S.C.9(hybrid)	China	1987	cross	33	33	maturity time
maize	Luyuan SC No.4	China	1976	gamma rays	19	19	yield
maize	Luyuandan No.1	China	1976	cross	25	22	disease resistance
maize	Luyuandan No.3	China	1976	cross	27	29	disease resistance
maize	Luyuandan No.4	China	1976	cross	27	30	earliness
maize	Luyuandan No.7	China	1981	cross	25	22	cob size
maize	Luyuanshan No.2	China	1981	cross	25	22	disease resistance
maize	Xiangsan No.1	China	1980	cross	27	30	disease resistance
maize	Yuan 74-751	China	1974	gamma rays	18	18	plant type
maize	Yuan 79-171	China	1979	gamma rays	18	18	shortness
maize	Yuan 79-418	China	1979	fN	18	18	earliness
maize	Yuangi 123	China	1978	cross	33	33	earliness
maize	Yuangi 722	China	1978	cross	33	33	maturity time
maize	Yuanlian No.5	China	1980	cross	25	22	earliness
maize	Zhongyuandan No.4	China	1982	cross	25	22	earliness
mat rush	Fukunami	Japan	1984	gamma rays	31	25	yield
mat rush	Seto-nami	Japan	1982	gamma rays	21	13	yield
meadow fescue	Fesco	FRG	1982	gamma rays	34	28	seed retention
meadow fescue	Lifesta	FRG	1981	gamma rays	34	28	seed retention
meadow fescue	Liforte	FRG	1984	gamma rays	34	28	seed retention
meadow foxtail	Alko	FRG	1983	gamma rays	34	26	seed retention
meadow foxtail	Limosa	FRG	1984	gamma rays	34	26	seed retention
millet	Angu 221	China	1978	gamma rays	27	25	earliness

millet	Changwei 74	China	1975	gamma rays	29	27	glutinous seeds
millet	Changwei 75	China	1975	gamma rays	29	27	disease resistance
millet	Zhangnong No.10	China	1966	gamma rays	27	25	grain morphology
millet	Zhangnong No.11	China	1966	gamma rays	27	25	waterlogging res.
millet	Zhufu No.1	China	1974	gamma rays	27	25	adaptability
mungbean	Co 4	India	1982	gamma rays	29	28	yield
mungbean	ML 26-10-3	India	1983	gamma rays	33	33	YMV resistance
mungbean	NIAB Mung 121-25	Pakistan	1985	gamma rays	30	28	earliness
mungbean	NIAB Mung 13-1	Pakistan	1986	gamma rays	29	28	earliness
mungbean	NIAB Mung 19-19	Pakistan	1985	gamma rays	30	28	earliness
mungbean	NIAB Mung 20-21	Pakistan	1986	gamma rays	29	28	earliness
mungbean	NIAB Mung-28	Pakistan	1983	gamma rays	23	21	earliness
mungbean	Pant Moong 2	India	1982	gamma rays	23	21	virus resistance
mungbean	TAP-7	India	1982	gamma rays	23	21	earliness
mustard	RLM 198	India	1975	radiation	7	13	oil content
mustard	Seco	Sweden	1961	cross	6	14	yield
mustard	Svalof's Primex	Sweden	1950	x-rays	0	74	yield
mustard	Trico	Sweden	1967	x-rays	6	14	yield
oat	Alamo-X	USA	1961	x-rays	0	74	blight resistance
oat	Bates	USA	1977	cross	14	10	shortness
oat	Belozernji	USSR	1978	NMH	13	21	-
oat	Bob	USA	1977	cross	14	10	yield
oat	Dolphin	Australia	1984	cross	28	19	shortness
oat	Echidna	Australia	1984	cross	28	19	shortness
oat	Florad	USA	1959	thN	0	74	rust resistance
oat	Florida 500	USA	1965	cross	0	74	rust resistance
oat	Florida 501	USA	1967	cross	0	74	plant type
oat	Nasta	Finland	1970	cross	20	16	earliness
oat	Puhti	Finland	1978	cross	25	9	yield
oat	Ryhti	Finland	1970	cross	0	74	yield
oat	Sir-4	USSR	1988	diazoacetylbutan	31	9	adaptability
oat	Veli	Finland	1981	cross	32	20	yield
oat	Zelenji	USSR	1976	ENH	13	21	plant type
okra	MDU 2	India	1978	DES	33	21	yield
onion	Brunette	Netherlands	1973	x-rays	0	74	earliness
onion	Compas	Netherlands	1970	x-rays	1	7	firmness
oriental mustard	RLM 514	India	1980	gamma rays	17	13	yield

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oriental mustard	Shambal (BAU-M/248)	Bangladesh	1984	EMS	34	27	shortness
papaya	Pusa nanha	India	1986	gamma rays	30	20	shortness
pea	Bosman	Poland	1989	cross	37	37	afila type
pea	Caoyuan 10	China	1980	x-rays	37	38	seed colour
pea	Diament	Poland	1989	cross	35	40	-
pea	Esedra	Italy	1980	x-rays	19	17	lateness
pea	Hamil	Poland	1981	cross	18	17	tendrilness
pea	Hans	India	1979	EI	15	13	yield
pea	Heiga	Poland	1986	cross	30	26	afila type
pea	Jaran	Poland	1986	cross	30	26	afila type
pea	Mihan	Poland	1983	cross	26	14	lodging resistance
pea	Miko	Poland	1989	cross	35	40	afila type
pea	Milewska	Poland	1983	cross	26	14	lodging resistance
pea	Moskovsky 73	USSR	1974	DES	12	14	grain size
pea	Navona	Italy	1980	x-rays	19	17	lateness
pea	Nemchinovskii 85	USSR	1986	cross	31	31	yield
pea	Paride	Italy	1988	gamma rays	37	38	determinate type
pea	Pirro	Italy	1988	gamma rays	37	38	determinate type
pea	Priamo	Italy	1988	gamma rays	37	38	determinate type
pea	Ramir	Poland	1985	cross	26	14	lodging resistance
pea	Shikhan	USSR	1984	cross	37	38	seed shedding res.
pea	Stral-art	Sweden	1954	x-rays	0	74	plant vigor
pea	Streletskii 11	USSR	1985	EI	31	31	earliness
pea	Sum	Poland	1979	cross	15	13	shortness
pea	Trevi	Italy	1985	cross	35	40	determinate type
pea	Wasata	Poland	1979	gamma rays	15	13	tendrilness
pearl millet	ICMH 451	India	1986	gamma rays	30	25	mildew resistance
pearl millet	NHB 3 (hybrid)	India	1975	cross	37	37	Sclerospora resist.
pearl millet	NHB 4 (hybrid)	India	1975	cross	37	37	Sclerospore resist.
pearl millet	New Hybrid Bajra 5	India	1974	gamma rays	11	18	Sclerospora resist.
pearl millet	Pusa 46	India	1982	radiation	23	19	mildew resistance
pepper	Horgoska slatki-X-3	Yugoslavia	1974	gamma rays	33	22	quality
pigeon pea	Co 3	India	1977	EMS	29	20	yield
pigeon pea	Co 5	India	1984	gamma rays	29	20	earliness
pigeon pea	TAT 10	India	1985	cross	28	20	seed size
pigeon pea	TAT 5	India	1984	fN	28	19	seed size
pigeon pea	Trombay Vishakha-1	India	1976	fN	23	16	seed size
proso millet	Lipetskoe 19	USSR	1985	DMS , NEH	30	25	earliness
rapeseed	Ganyu No.5	China	1984	gamma rays	32	20	shortness

rapeseed	Huyou No.4	China	1970	gamma rays	27	19	cold tolerance
rapeseed	Regina varraps el. A	Sweden	1953	x-rays	0	74	yield
rapeseed	Regina varraps el. F	Sweden	1962	x-rays	0	74	yield
rapeseed	Stellar	Canada	1987	cross	33	22	quality
rapeseed	Xinyou No.1	China	1979	gamma rays	27	19	seedling growth
rapeseed	Xiuyou No.1	China	1979	gamma rays	32	20	earliness
red clover	Rotra, R.v.P	Belgium	1967	colchicine	0	74	yield
rice	202	China	1973	gamma rays	27	24	leaf size
rice	240	China	1980	gamma rays	27	24	earliness
rice	6 B	Vietnam	1986	cross	31	30	yield
rice	652	China	1979	gamma rays	30	25	blast resistance
rice	69-280	China	1969	gamma rays	27	24	shortness
rice	7404	China	1977	gamma rays	31	30	shortness
rice	7738	China	1980	gamma rays	25	15	earliness
rice	Aifu No.9	China	1966	gamma rays	25	12	shortness
rice	Ailiutiaohong	China	1989	gamma rays	37	34	dwarf
rice	Akichikara	Japan	1986	cross	32	28	shortness
rice	Akihikari	Japan	1976	cross	11	17	shortness
rice	Arlatan	France	1979	gamma rays	18	15	threshability
rice	Atomita 1	Indonesia	1982	gamma rays	21	15	earliness
rice	Atomita 2	Indonesia	1983	gamma rays	23	18	salinity tolerance
rice	Au-1	India	1976	gamma rays	29	23	earliness
rice	B-fu 1	China	1982	gamma rays	29	23	shortness
rice	BPI-121-407	Philippines	1971	gamma rays	1	7	earliness
rice	Binasail	Bangladesh	1987	gamma rays	31	29	tallness
rice	Biraj	India	1982	x-rays	29	24	lateness
rice	CNM 20	India	1980	x-rays	18	17	earliness
rice	CNM 25	India	1979	x-rays	18	17	earliness
rice	CNM 31	India	1979	x-rays	17	17	earliness
rice	CNM 6	India	1980	x-rays	18	17	earliness
rice	Calendal	France	1979	gamma rays	18	16	grain size
rice	Calmochi 201	USA	1979	gamma rays	15	12	glutinous endosperm
rice	Calmochi 202	USA	1981	cross	25	15	shortness
rice	Calmochi-101	USA	1985	cross	28	22	photoperiod insens.
rice	Calpearl	USA	1981	cross	23	18	stiffness
rice	Calrose 76	USA	1976	gamma rays	9	15	shortness
rice	Chenzao No.5	China	1979	gamma rays	30	23	earliness
rice	DB 250	Vietnam	1986	gamma rays	30	23	adaptability
rice	Daisenminori	Japan	1988	cross	35	36	lodging resistance
rice	Dalris 11	USSR	1988	MNH	31	29	earliness
rice	Danau atas	Indonesia	1988	gamma rays	35	36	blast resistance
rice	Delta	France	1970	gamma rays	0	74	grain quality
rice	Dongting No.3	China	1982	gamma rays	21	14	shortness

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rice	Erfuzao	China	1968	gamma rays	25	12	earliness
rice	Erjiufeng	China	1982	cross	30	23	blight resistance
rice	Fu 709	China	1974	gamma rays	25	13	yield
rice	Fu 756	China	1975	gamma rays	27	22	disease resistance
rice	Fu 769	China	1976	gamma rays	27	22	disease resistance
rice	Fubao 201	China	1978	gamma rays	26	21	earliness
rice	Fuchuerai	China	1978	cross	37	34	shortness
rice	Fugui No.1	China	1980	gamma rays	27	21	earliness
rice	Fuhui 06	China	1983	gamma rays	35	37	earliness
rice	Fujihikari	Japan	1977	cross	11	16	season-neutral
rice	Fulgente	Italy	1973	x-rays	10	15	blast resistance
rice	Fulianai	China	1966	gamma rays	25	12	shortness
rice	Fulianzao No.3	China	1968	gamma rays	27	21	earliness
rice	Fuluzao No. 1	China	1976	gamma rays	27	21	leaf size
rice	Funo 101	China	1987	gamma rays	33	26	earliness
rice	Funo 402	China	1989	gamma rays	35	37	glutinous
rice	Fushe 31	China	1965	gamma rays	25	12	earliness
rice	Fushe 410	China	1974	gamma rays	27	21	blast resistance
rice	Fushe 94	China	1971	Neutrons	25	13	earliness
rice	Fushenongken 58	China	1973	gamma rays	29	24	-
rice	Fuwan 23	China	1978	gamma rays	25	14	disease resistance
rice	Fuxian 6	China	1989	cross	37	34	earliness
rice	Fuxiang No.1	China	1978	gamma rays	27	22	earliness
rice	Fuxuan 124	China	1972	gamma rays	25	13	blast resistance
rice	Fuxuan No. 1	China	1968	gamma rays	27	22	earliness
rice	Fuxuan No.3	China	1970	gamma rays	25	13	tillering
rice	Fuyu No.1	China	1968	gamma rays	25	12	earliness
rice	Fuzao No.2	China	1970	gamma rays	25	13	earliness
rice	Fuzhu	China	1979	gamma rays	25	15	earliness
rice	Gangai A/Fuhai 06 H.	China	1985	cross	35	37	good fertility
rice	Gongshe No.13	China	1969	gamma rays	27	22	disease resistance
rice	Guangdabai	China	1979	-	25	15	maturity time
rice	Guangfen No. 1	China	1977	laser	27	22	earliness
rice	Guangfu No.1	China	1981	gamma rays	25	16	earliness
rice	Guifu No.3	China	1977	gamma rays	25	14	earliness
rice	HPU 8020	India	1984	gamma rays	29	24	lateness
rice	Hanahikari	Japan	1975	cross	21	14	shortness
rice	Hangfeng	China	1983	cross	30	23	shortness
rice	Hari	India	1987	cross	34	31	short culm

rice	Hatsukogane	Japan	1984	cross	32	28	shortness
rice	Hayahikari	Japan	1976	cross	11	16	stiffness
rice	Hongfuzao No.7	China	1980	gamma rays	27	23	shortness
rice	Hongnan	China	1981	gamma rays	25	16	maturity time
rice	Hongtu 31	China	1980	electron beam	31	29	grain quality
rice	Houhai	Japan	1976	cross	21	16	shortness
rice	Huangpiai	China	1969	gamma rays	25	12	shortness
rice	Hybrid Mutant 95	India	1973	gamma rays	4	14	shortness
rice	Hyokeisake 18	Japan	1972	cross	21	14	shortness
rice	IIT 48	India	1972	ethylenoxide	0	74	earliness
rice	IIT 60	India	1972	EMS	0	74	earliness
rice	IRAT 13	Cote d'Ivoire	1978	gamma rays chronic	11	16	stiffness
rice	IRAT 101	Cote d'Ivoire	1976	gamma rays chronic	33	27	adaptability
rice	IRAT 104	Cote d'Ivoire	1983	cross	34	32	tallness
rice	IRAT 109	Cote d'Ivoire	1978	cross	37	34	productivity
rice	IRAT 110	Cote d'Ivoire	1978	cross	37	34	grain quality
rice	IRAT 112	Cote d'Ivoire	1983	cross	34	32	tillering
rice	IRAT 113	Cote d'Ivoire	1979	gamma rays chronic	33	27	shortness
rice	IRAT 114	Cote d'Ivoire	1979	gamma rays chronic	33	27	shortness
rice	IRAT 115	Cote d'Ivoire	1979	gamma rays chronic	33	27	shortness
rice	IRAT 116	Cote d'Ivoire	1979	gamma rays chronic	33	27	shortness
rice	IRAT 117	Cote d'Ivoire	1979	gamma rays chronic	33	27	shortness
rice	IRAT 133	Cote d'Ivoire	1978	cross	35	37	shortness
rice	IRAT 134	Cote d'Ivoire	1978	cross	35	37	shortness
rice	IRAT 136	Cote d'Ivoire	1978	cross	37	34	grain quality
rice	IRAT 144	Burkina Faso	1978	cross	34	32	yield
rice	IRAT 146	Burkina Faso	1979	cross	35	38	shortness
rice	IRAT 147	Cote d'Ivoire	1979	cross	37	35	grain shape
rice	IRAT 161	Cote d'Ivoire	1980	cross	37	35	productivity
rice	IRAT 170	Cote d'Ivoire	1984	cross	34	32	tillering
rice	IRAT 177	Brazil	1988	spont. from IRAT 79	34	32	taller
rice	IRAT 191 (IREM 191)	Guyana	1980	gamma rays chronic	33	28	tallness
rice	IRAT 192 (IREM 192)	Guyana	1980	gamma rays chronic	33	28	tallness
rice	IRAT 193 (IREM 193)	Guyana	1980	gamma rays chronic	33	28	tallness
rice	IRAT 194 (IREM 194)	Guyana	1980	gamma rays chronic	33	28	shortness
rice	IRAT 195 (IREM 195)	Guyana	1980	gamma rays chronic	33	28	tallness
rice	IRAT 196 (IREM 196)	Guyana	1980	gamma rays chronic	33	29	tallness
rice	IRAT 213 = ISA 3	Cote d'Ivoire	1982	cross	37	35	grain shape
rice	IRAT 214 = ISA 4	Cote d'Ivoire	1982	cross	37	35	yield
rice	IRAT 216	Cote d'Ivoire	1985	cross	34	32	adaptability
rice	IRAT 239 (IREM 779)	Guyana	1980	gamma rays chronic	33	29	tallness
rice	IRAT 240 (IREM 950)	Guyana	1980	gamma rays chronic	33	29	tallness

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rice	IRAT 241 (IREM 73-2)	Guyana	1983	gamma rays chronic	33	29	tallness
rice	IRAT 242 (IREM575-1)	Guyana	1983	gamma rays chronic	33	29	shortness
rice	IRAT 243 (IREM 15-2)	Guyana	1983	gamma rays chronic	33	29	tallness
rice	IRAT 244 (IREM 12-5)	Guyana	1983	gamma rays chronic	33	29	tallness
rice	IRAT 245 (IREM43111)	Guyana	1983	gamma rays chronic	33	30	tallness
rice	IRAT 246 (IREM 3463)	Guyana	1983	gamma rays chronic	33	30	tallness
rice	IRAT 247 (IREM 75-1)	Guyana	1983	gamma rays chronic	33	30	tallness
rice	IRAT 248 (IREM 2-1)	Guyana	1983	gamma rays chronic	33	30	shortness
rice	IRAT 249 (IREM12322)	Guyana	1983	gamma rays chronic	33	30	tallness
rice	IRAT 250 (IREM 52-1)	Guyana	1983	gamma rays chronic	33	30	tallness
rice	IRAT 251 (IREM297-3)	Guyana	1983	gamma rays chronic	33	31	tallness
rice	IRAT 252 (IREM 46-4)	Guyana	1983	gamma rays chronic	33	31	tallness
rice	IRAT 253 (IREM 50-2)	Guyana	1983	gamma rays chronic	33	31	tallness
rice	IRAT 254 (IREM 53-2)	Guyana	1983	gamma rays chronic	33	31	tallness
rice	IRAT 255 (IREM 35-2)	Guyana	1983	gamma rays chronic	33	31	shortness
rice	IRAT 256 (IREM 46-2)	Guyana	1983	gamma rays chronic	33	31	shortness
rice	IRAT 257 (IREM 4113)	Guyana	1983	gamma rays chronic	33	31	shortness
rice	IRAT 258 (IREM 4114)	Guyana	1983	gamma rays chronic	33	32	shortness
rice	IRAT 268 = IDSA 16	Cote d'Ivoire	1983	cross	37	35	grain quality
rice	IRAT 269 = IDSA 16	Cote d'Ivoire	1983	cross	37	35	grain quality
rice	IRAT 320 = IDSA 48	Cote d'Ivoire	1987	cross	37	35	grain shape
rice	IRAT 4 (IRAT 51)	Senegal	1968	gamma rays chronic	33	26	-
rice	IRAT 5 (IRAT 52)	Senegal	1968	gamma rays chronic	33	26	-
rice	IRAT 78 (M18)	Cote d'Ivoire	1976	gamma rays chronic	33	26	pubes. leaf blade
rice	IRAT 79 (M45)	Cote d'Ivoire	1976	gamma rays chronic	33	26	tillering
rice	Ibukiwase	Japan	1986	cross	32	28	cold resistance
rice	Ikungbau 4-2	China	1973	x-rays	37	34	-
rice	Indira	India	1980	EMS	29	24	earliness
rice	Intan Mutant	India	1988	EI	35	37	photoperiod insens.
rice	Iratom 24	Bangladesh	1970	gamma rays	29	24	earliness
rice	Iratom 38	Pakistan	1970	gamma rays	0	74	earliness
rice	Iwate 21	Japan	1988	gamma rays	35	38	semi-dwarf culm
rice	Jagannath	India	1969	x-rays	0	74	grain size
rice	Jiasifu	China	1973	gamma rays	25	13	earliness
rice	Jiguang No. 2	China	1977	laser	27	23	shortness
rice	Jinfu No.1	China	1969	gamma rays	25	12	earliness
rice	Jinfu No.8	China	1969	gamma rays	25	12	earliness
rice	Jingnou No.6	China	1986	gamma rays	31	29	blast resistance
rice	Juangyebai	China	1978	Neutrons	25	14	roll leaf

rice	K84	India	1967	gamma rays	29	24	earliness
rice	KT 20-74	China	1957	x-rays	0	74	yield
rice	Kagahikari	Japan	1973	cross	11	16	earlines
rice	Kashmir Basmati	Pakistan	1977	gamma rays	10	15	earliness
rice	Katsurawase	Japan	1978	cross	21	15	earliness
rice	Kefuhong No.2	China	1981	cross	25	16	earliness
rice	Keshari	India	1980	cross	29	24	shortness
rice	Kunihikari	Japan	1987	cross	33	32	lodging resistance
rice	Liaofeng No.5	China	1969	gamma rays	27	23	earliness
rice	M 112	China	1981	gamma rays	27	23	cold tolerance
rice	M-101	USA	1979	cross	15	13	shortness
rice	M-102	USA	1987	cross	32	28	lateness
rice	M-202	USA	1985	cross	28	21	photoperiod insens.
rice	M-203 (86-Y-35)	USA	1989	gamma rays	37	35	photoperiod insens.
rice	M-301	USA	1980	cross	18	16	grain size
rice	M-302	USA	1981	cross	25	15	shortness
rice	M-401	USA	1981	gamma rays	19	16	shortness
rice	M114	China	1981	gamma rays	25	16	cold tolerance
rice	M7	USA	1977	cross	13	19	shortness
rice	MI-273(m)	Sri Lanka	1971	gamma rays	29	25	shortness
rice	Marathon	France	1985	gamma rays	30	23	blast resistance
rice	Marjan	USSR	1987	gamma rays	31	29	stiffness
rice	Megumimochi	Japan	1983	cross	32	27	shortness
rice	Mercury	USA	1988	cross	35	38	earliness
rice	Milyang 10	Korea	1970	x-rays	0	74	shortness
rice	Mineasahi	Japan	1980	cross	21	15	earliness
rice	Minnuo 706	China	1988	cross	35	38	tillering
rice	Minyuan 1	China	1977	gamma rays	35	39	photonasty
rice	Miyama Nishiki	Japan	1978	gamma rays	15	12	grain size
rice	Miyanishiki	Japan	1978	cross	17	13	earliness
rice	Miyukimochi	Japan	1979	gamma rays	15	12	glutinous endosperm
rice	Mohan = CSR4	India	1983	gamma rays	37	35	salt tolerance
rice	Musashikogane	Japan	1981	cross	21	16	shortness
rice	Mutashali	Hungary	1980	fN	30	23	blast resistance
rice	Mutsuhomare	Japan	1986	cross	32	28	shortness
rice	Mutsuhonami	Japan	1973	cross	0	74	grain quality
rice	Mutsukaori	Japan	1981	cross	21	16	shortness
rice	Mutsukomachi	Japan	1981	cross	21	16	shortness
rice	NN 22-98	Vietnam	1983	ENH	30	23	stiffness
rice	Nadahikari	Japan	1977	cross	21	15	shortness
rice	Nangeng 23	China	1967	gamma rays	27	23	shortness

Crop plant/ species	Mutant cultivar	Country and Year of release		Mutagen(s)	MBNL		Main character improved
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rice	Nanjing No.34	China	1976	gamma rays	19	16	shortness
rice	Nanzao No. 1	China	1980	gamma rays	27	23	earliness
rice	Niigatawase	Japan	1979	cross	21	15	shortness
rice	Nongshi No.4	China	1975	fN	27	23	earliness
rice	Nucleoryza	Hungary	1972	fN	2	8	earliness
rice	Oryzella	Hungary	1983	EMS	30	24	earliness
rice	PARC 1	Philippines	1970	gamma rays	4	14	grain size
rice	PARC 2	Philippines	1970	gamma rays	4	14	earliness
rice	PL-56	India	1975	EMS	29	25	tillering
rice	Padmini	India	1988	gamma rays	37	35	earliness
rice	Prabhavati	India	1984	EMS	29	25	shortness
rice	Pygmalion	France	1987	chemical mutagen	35	39	yield
rice	Qikesui	China	1986	gamma rays	30	24	cold tolerance
rice	Qinghuaai 6	China	1980	cross	37	35	yield
rice	Qingwei No.1	China	1985	gamma rays	37	36	yield
rice	Qiufu No.1	China	1977	gamma rays	31	29	shortness
rice	R 462	China	1985	gamma rays	30	24	shortness
rice	R 817	China	1981	gamma rays	31	30	glutinous endosperm
rice	RD 10	Thailand	1981	fN	18	16	glutinous endosperm
rice	RD 15	Thailand	1978	gamma rays	13	19	earliness
rice	RD 6	Thailand	1977	gamma rays	10	15	glutinous endosperm
rice	Radiation 85-63	China	1989	cross	37	36	tillering
rice	Radiation 9-1	China	1988	gamma rays	37	36	tillering
rice	Rasmi	India	1985	gamma rays	30	24	awnless
rice	Reimei	Japan	1966	gamma rays	0	74	shortness
rice	Rokkonishiki	Japan	1982	cross	21	16	grain size
rice	S 201	USA	1980	cross	18	16	shortness
rice	S2-Calpearl	USA	1987	irradiation	37	36	shortness
rice	SH 30-21	China	1957	x-rays	0	74	yield
rice	Sachiminori	Japan	1978	cross	21	15	stiffness
rice	Salir	Portugal	1983	gamma rays	30	24	yield
rice	Sattari	India	1983	gamma rays	29	25	earliness
rice	Savitri	India	1983	cross	29	25	daylength sensitiv.
rice	Shadab	Pakistan	1987	EMS	30	24	yield
rice	Shanghai Fragrant832	China	1989	x-rays	35	39	short straw
rice	Shanghai Fragrant861	China	1989	x-rays	35	39	short straw
rice	Shinanosakigake	Japan	1982	gamma rays	21	17	grain size

rice	Shirakabanishiki	Japan	1982	gamma rays	21	17	grain size
rice	Shuangchengnuo	China	1980	gamma rays	25	15	compact
rice	Shuangchiang 30-21	China	1957	x-rays	30	24	yield
rice	Shuangke No.1	China	1981	cross	25	16	maturity time
rice	Shwethwetun	Myanmar	1981	gamma rays	20	18	tallness
rice	Shwewartun	Myanmar	1975	gamma rays	12	17	grain quality
rice	Sifu 851	China	1985	cross	30	25	earliness
rice	Suifu 17	China	1979	gamma rays	25	15	shortness
rice	Suiwan No.3	China	1974	gamma rays	27	23	tillering
rice	Taifu No.4	China	1979	gamma rays	30	25	disease resistance
rice	Tangernian	China	1985	gamma rays	37	36	yield
rice	VN 10	Vietnam	1975	cross	29	26	-
rice	VN 20	Vietnam	1975	cross	29	26	-
rice	VN 4	Vietnam	1975	cross	29	25	earliness
rice	Valencia 87	USA	1987	irradiation	37	37	lodging resistance
rice	Vellayani	India	1968	Neutrons	29	25	-
rice	Wanfu 33	China	1978	gamma rays	25	14	earliness
rice	Wangeng 257	China	1975	gamma rays	25	14	fertilizer toleran.
rice	Wanhongfu	China	1980	gamma rays	27	23	cold tolerance
rice	Wanhua	China	1983	cross	37	37	dwarfness
rice	Wei A/Jiguang 4	China	1982	cross	32	28	combining ability
rice	Weiyouji	China	1983	cross	31	30	earliness
rice	Xiangfu 81-10	China	1984	gamma rays	30	25	glutinous endosperm
rice	Xiangfudao	China	1976	gamma rays	25	14	cold tolerance
rice	Xianghu 24	China	1983	cross	35	39	blast resistance
rice	Xiaofuzao	China	1974	gamma rays	25	13	earliness
rice	Xindao No.1	China	1986	gamma rays	31	30	disease resistance
rice	Xiongyue 613	China	1965	gamma rays	25	11	blast resistance
rice	Xiushui 48	China	1981	cross	35	39	blast resistance
rice	YH 1	China	1963	cross	0	74	yield
rice	Yanzhengfu	China	1980	gamma rays	37	37	-
rice	Yenhsing-1	China	1963	cross	29	25	yield
rice	Yenhsing-2	China	1967	cross	29	25	erectoid
rice	Yifunuo No.1	China	1973	gamma rays	25	13	blast resistance
rice	Youfu No.5	China	1980	gamma rays	27	24	earliness
rice	Yuanfengzao	China	1975	gamma rays	19	16	earliness
rice	Zaoyeqing	China	1980	gamma rays	27	24	panicle size
rice	Zhefu 802	China	1980	gamma rays	25	15	earliness
rice	Zhenfu No.1	China	1971	gamma rays	25	13	earliness
rice	Zhengguang No.1	China	1978	gamma rays	25	14	disease resistance
rice	Zhongbao No.2	China	1976	fN	25	14	earliness
rice	Zhongmounuodao	China	1982	gamma rays	27	24	glutinous endosperm
rice	Zhongtie	China	1985	fN	30	25	yield

Crop plant/ species	Mutant cultivar	Country and Year of release		Mutagen(s)	MBNL		Main character improved
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rice	Zhuqin 40	China	1978	gamma rays	27	24	blast resistance
ridged gourd	PKM-1	India	1984	gamma rays	32	26	yield
roselle	Hiroshima local No.1	Japan	1967	gamma rays	12	17	tallness
roselle	Hiroshima local No.3	Japan	1967	gamma rays	12	17	tallness
roselle	Hiroshima local No.5	Japan	1967	gamma rays	12	17	tallness
roselle	Hiroshima local No.7	Japan	1967	gamma rays	12	17	tallness
rye	Donar	GDR	1981	PMS	23	20	shortness
rye	HJA 6902	Finland	1981	gamma rays	35	41	lodging resistance
rye	Hankkija's Jussi	Finland	1975	gamma rays	7	12	winter hardiness
rye	Pollux	GDR	1981	PMS	23	20	shortness
ryegrass	Meritra, R.v.P.	Belgium	1971	colchicine	0	74	yield
sainfoin	Kirovogradskij 13	USSR	1986	MNH	31	28	plant architecture
serradella	Uniserra	Australia	1971	EMS	0	74	earliness
sesame	Ahnsanggae	Korea	1984	x-rays	29	26	disease resistance
sesame	Kalika (BM 3-7)	India	1980	EMS	17	14	dwarfness
shadawang	Zaoshadawang	China	1983	gamma rays	31	9	earliness
sorghum	Co 21	India	1977	x-rays	29	27	yield
sorghum	Donetskaya 5	USSR	1984	DMS	31	34	shortness
sorghum	Jinfu No.1	China	1970	gamma rays	27	25	grain quality
sorghum	Jinza No. 1	China	1970	cross	25	17	grain quality
sorghum	Longfuliang No.1	China	1979	gamma rays	25	17	earliness
soybean	Aida	CSFR	1984	EMS	26	13	earliness
soybean	Arkadiya Odesskaya	USSR	1986	dMS	31	20	earliness
soybean	Bangsa-Kong	Korea	1985	x-rays	26	13	pod number
soybean	Bisser	Bulgaria	1984	gamma rays	31	20	yield
soybean	Boriana	Bulgaria	1981	gamma rays	23	18	earliness
soybean	Cerag No.1	Algeria	1979	gamma rays	14	11	earliness
soybean	Chudo Gruzii 74	USSR	1974	gamma rays	37	25	-
soybean	Dioskuriye	USSR	1980	gamma rays	37	25	-
soybean	Doi kham	Thailand	1986	gamma rays	33	24	rust resistance
soybean	Dorado	GDR	1988	NMH	34	29	grain yield
soybean	Fengdou 1	China	1988	gamma rays	34	29	earliness
soybean	Fengshou No.11	China	1970	gamma rays	27	20	earliness
soybean	Heilong 31	China	1987	thN	32	22	yield
soybean	Heilong 32	China	1987	thN	32	22	yield
soybean	Heinong 28	China	1986	thN	30	21	earliness
soybean	Heinong No.6	China	1967	x-rays	27	20	tallness
soybean	Heinoun No.16	China	1970	gamma rays	25	11	branch number
soybean	Heinoun No.26	China	1976	cross	25	11	plant architecture

soybean	Heinoun No.4	China	1967	gamma rays	25	10	compact type
soybean	Heinoun No.5	China	1967	gamma rays	25	10	root system
soybean	Heinoun No.7	China	1967	gamma rays	25	10	branch number
soybean	Heinoun No.8	China	1967	gamma rays	25	10	earliness
soybean	KEX-2	Korea	1973	x-rays	4	14	earliness
soybean	Kartuli 7	USSR	1980	gamma rays	37	25	-
soybean	Kosuzu	Japan	1986	gamma rays	32	22	earliness
soybean	Liaodou No.3	China	1983	cross	27	20	earliness
soybean	Liaonong 1	China	1988	gamma rays	34	29	earliness
soybean	Muria	Indonesia	1987	gamma rays	35	35	yield
soybean	Mushi No.6	China	1980	gamma rays	25	11	-
soybean	Mutant 2	USSR	1980	gamma rays	37	25	-
soybean	Nanbushirome	Japan	1977	cross	21	13	maturity time
soybean	Raiden	Japan	1966	gamma rays	0	74	earliness
soybean	Raiko	Japan	1969	gamma rays	0	74	earliness
soybean	Tainung No.1(R)	China	1962	thN	0	74	vigorousness
soybean	Tainung No.2(R)	China	1962	x-rays	0	74	vigorousness
soybean	Tidar	Indonesia	1987	gamma rays	35	35	earliness
soybean	Tiefeng 18	China	1973	gamma rays	25	11	fertility tolerance
soybean	Universal I	USSR	1965	gamma rays	19	14	yield
soybean	Wase-suzunari	Japan	1983	gamma rays	32	23	earliness
soybean	Wei 7610-13	China	1983	gamma rays	32	23	earliness
soybean	Zarya	Bulgaria	1984	gamma rays	32	23	earliness
spinach	Lavewa	FRG	1987	EMS	37	39	nitrate content
subterrane.clover	Uniwager	Australia	1967	EMS	0	74	isoflavons content
sunflower	Pervenets	USSR	1977	DMS	13	20	oil content
tobacco	American Bakhchesora	USSR	1978	cross	13	21	-
tobacco	Clorina Fl	Indonesia	1934	x-rays	0	74	leaf colour
tobacco	Delhi 76	Canada	1976	gamma rays	19	16	leaf colour
tobacco	GSH-3	India	1979	cross	30	22	leaf quality
tobacco	Krupnolystnyi	USSR	1977	cross	13	21	-
tobacco	Virginia 0454	Bulgaria	1986	cross	32	27	disease resistance
tobacco	Yubilieinyi	USSR	1978	cross	13	21	-
tomato	Co 3	India	1981	EMS	29	23	compact type
tomato	Kagyoku	Japan	1985	cross	32	27	disease resistance
tomato	Kyoryoku-reikou	Japan	1974	gamma rays	21	14	TMV resistance
tomato	Kyouryokuogatareikou	Japan	1984	cross	32	26	disease resistance
tomato	Luch 1	USSR	1965	gamma rays	19	15	earliness
tomato	PKM-1	India	1980	gamma rays	32	27	yield
tomato	Pusa Lal Meeruti	India	1972	gamma rays	0	74	fruit ripening
tomato	Rannii Nush	USSR	1983	EI	31	27	earliness
tomato	Ryuugyoku	Japan	1985	cross	32	27	disease resistance
tomato	S.12	India	1969	gamma rays	0	74	dwarfness

Crop plant/ species	Mutant cultivar	Country and	Year of release	Mutagen(s)	MBNL Issue.	Page	Main character improved
tossa jute	Atompat-28	Bangladesh	1974	gamma rays	12	16	yield
tossa jute	Atompat-36	Bangladesh	1974	gamma rays	12	16	yield
tossa jute	Atompat-38	Bangladesh	1974	gamma rays	12	16	plant vigor
tossa jute	IR-1	India	1978	gamma rays chronic	37	25	plant vigour
tossa jute	JRO 3690	India	1985	cross	33	22	yield
tossa jute	Mahadev TJ-40	India	1983	thN	23	17	yield
tossa jute	Shwegontun	Myanmar	1975	gamma rays	12	16	earliness
turmeric	BSR 1	India	1986	x-rays	29	22	rihzome colour
turmeric	Co 1	India	1983	x-rays	29	22	rhizome colour
turnip/jpn rape	Haya-natane	Japan	1961	colchicine	21	12	yield
watermelon	Gibrid 218	USSR	1984	gamma rays	31	18	-
watermelon	Lu No.1	China	1980	gamma rays	32	21	earliness
wheat	092	China	1966	gamma rays	25	17	earliness
wheat	1161	China	1966	gamma rays	25	18	cold tolerance
wheat	352	China	1983	laser	27	29	earliness
wheat	503	China	1975	gamma rays	27	29	tillering
wheat	62-10	China	1985	fN	30	27	rust resistance
wheat	62-8	China	1985	fN	30	27	rust resistance
wheat	77 L15	China	1983	laser	27	29	stiffness
wheat	79p-17	China	1980	beta rays	25	20	earliness
wheat	Albidum 12	USSR	1984	gamma rays	31	36	frost resistance
wheat	Altimir 67	Bulgaria	1979	gamma rays	16	17	stem rust resist.
wheat	BR4	Brazil	1979	cross	26	15	yield
wheat	Carolina	Chile	1981	gamma rays	19	18	yield
wheat	Changwei 19	China	1978	gamma rays	25	19	disease resistance
wheat	Changwei 20	China	1979	gamma rays	25	19	disease resistance
wheat	Changwei 51503	China	1983	gamma rays	27	26	tillering
wheat	Chuanfu 2	China	1989	gamma rays	37	41	stripe rust resist.
wheat	Chuanfu 3	China	1989	gamma rays	37	41	stripe rust resist.
wheat	Chuanfu No.1	China	1982	beta rays	27	26	earliness
wheat	Claudia	Italy	1979	-	16	17	-
wheat	Deda	USSR	1983	MNH	31	36	earliness
wheat	Els	FRG	1960	x-rays	9	14	shortness
wheat	Emai No.6	China	1966	gamma rays	25	17	rust resistance
wheat	Emai No.9	China	1980	gamma rays	27	26	Gibberella toler.
wheat	Fuer	China	1977	gamma rays	27	26	rust resistance
wheat	Fushiabo	China	1985	gamma rays	37	41	stripe rust resist.
wheat	Hankkijas Taava	Finland	1978	gamma rays	13	19	yield
wheat	Heichun No.2	China	1979	cross	27	26	earliness

wheat	Henong 1	China	1985	gamma rays	30	27	yield
wheat	Humai No.3	China	1978	gamma rays	27	27	earliness
wheat	IAS 63	Brazil	1974	gamma rays	19	18	yield
wheat	Jauhar-78	Pakistan	1979	fN	18	14	yield
wheat	Jiaxuan No.1	China	1974	gamma rays	27	27	salt tolerance
wheat	Jienmai No.2	China	1969	gamma rays	25	18	earliness
wheat	Jingfen No.1	China	1977	gamma rays	25	19	earliness
wheat	Jinmai 22	China	1982	cross	35	41	earliness
wheat	Kexing No.15	China	1972	gamma rays	27	27	rust resistance
wheat	Kijanka	USSR	1981	dES	25	20	yield
wheat	Kormovaya 30	USSR	1983	NMH	31	36	silage suitability
wheat	Lewis	USA	1964	thN	0	74	stiffness
wheat	Ljubov	USSR	1985	laser GN	35	41	yield
wheat	Longfumai No.1	China	1984	thN	30	26	earliness
wheat	Longfumai No.2	China	1985	gamma rays	32	30	earliness
wheat	Longfumai No.3	China	1986	cross	32	30	yield
wheat	Lumai No.4	China	1983	laser	32	30	earliness
wheat	Lumai No.5	China	1984	cross	32	30	shortness
wheat	Lumai No.6	China	1984	laser	32	30	earliness
wheat	Lumai No.8	China	1985	cross	32	30	shortness
wheat	Luten No.1	China	1968	gamma rays	25	18	spike size
wheat	Motsinave 100	USSR	1980	gamma rays	37	41	-
wheat	Mv 8	Hungary	1978	gamma rays	16	17	shortness
wheat	NI-5643	India	1975	radiation	19	18	maturity time
wheat	NP 836	India	1961	x-rays	0	74	awned
wheat	Nanjing No.3	China	1976	gamma rays	19	19	shortness
wheat	Nanyang 75-6	China	1979	gamma rays , DES	25	20	uniformity
wheat	Neimai No.5	China	1979	gamma rays	27	27	earliness
wheat	Ningmai No.3	China	1973	gamma rays	25	19	spike size
wheat	Novosibirskaja 67	USSR	1969	gamma rays	0	74	stiffness
wheat	Odesskaja 75	USSR	1975	cross	14	11	shortness
wheat	Odesskaja Polukarlik	USSR	1975	cross	14	11	shortness
wheat	Payne	USA	1981	cross	19	18	disease resistance
wheat	Polukarlikovaja-49	USSR	1978	ENH	13	20	shortness
wheat	Pusa Lerma	India	1971	gamma rays	0	74	grain colour
wheat	Qicheng 115	China	1985	gamma rays	32	31	stiffness
wheat	Qichun No.1	China	1971	cross	27	27	drought tolerance
wheat	Qunzhong 42	China	1968	gamma rays	25	18	spike size
wheat	SGT 17	USSR	1980	gamma rays	37	42	-
wheat	Shannong Radio-63	China	1980	gamma rays	19	19	grain filling
wheat	Sharbati Sonora	India	1967	UV , gamma rays	6	16	amber grain colour
wheat	Shchedraya Polesya	USSR	1987	MNH	31	36	stiffness
wheat	Shirowasekomugi	Japan	1977	gamma rays	21	17	plant stature

Crop plant/ species	Mutant cultivar	Country and	Year of release	Mutagen(s)	MBNL Issue.	Page	Main character improved
wheat	Sinvalocho Gama	Argentina	1962	gamma rays	0	74	rust resistance
wheat	Sirius	FRG	1969	x-rays	9	14	stiffness
wheat	Spinnaker	Italy	1987	fN	37	42	lodging resistance
wheat	Stadler	USA	1964	thN	0	74	earliness
wheat	Taifu 23	China	1968	gamma rays	25	18	drought tolerance
wheat	Taifu No.1	China	1966	gamma rays	25	17	earliness
wheat	Taifu No.10	China	1968	gamma rays	27	27	drought tolerance
wheat	Taifu No.15	China	1968	gamma rays	27	27	earliness
wheat	Taifu No.22	China	1968	gamma rays	27	27	tillering
wheat	Tambo	Switzerland	1985	gamma rays	30	26	shortness
wheat	Wanyuan 28-88	China	1979	gamma rays	25	20	shortness
wheat	Wanyuan 75-6	China	1979	gamma rays, DES	27	28	earliness
wheat	Weifu 6757	China	1986	gamma rays	32	31	rust resistance
wheat	Wuchun No.3	China	1973	cross	27	28	drought tolerance
wheat	Xiaoyan No.6	China	1979	laser	27	28	rust resistance
wheat	Xifu 4	China	1985	cross	37	42	drought tolerance
wheat	Xifu 5	China	1985	cross	37	42	yield
wheat	Xifu No.3	China	1977	gamma rays	27	28	disease resistance
wheat	Xinchun No.2	China	1984	gamma rays	32	31	stiffness
wheat	Xinshukuang No.1	China	1971	gamma rays	25	19	disease resistance
wheat	Yannoun 685	China	1974	cross	25	19	rust resistance
wheat	Yuanchun No. 7112	China	1974	cross	18	15	yield
wheat	Yuandon No.2	China	1982	gamma rays	27	28	earliness
wheat	Yuandong 94	China	1984	gamma rays	30	27	earliness
wheat	Yuandong No.1	China	1979	gamma rays	25	20	earliness
wheat	Yuandong No.3	China	1985	gamma rays	30	26	rust resistance
wheat	Yuandong No.772	China	1977	gamma rays	18	15	yield
wheat	Yuandong No.7848	China	1978	gamma rays	18	15	yield
wheat	Yuanfeng No.1	China	1968	gamma rays	25	18	cold tolerance
wheat	Yuanfeng No.2	China	1968	gamma rays	25	18	cold tolerance
wheat	Yuanfeng No.3	China	1971	gamma rays	25	18	cold tolerance
wheat	Yuanfeng No.4	China	1978	gamma rays	25	19	shortness
wheat	Yuanfeng No.5	China	1983	gamma rays	37	42	earliness
wheat	Yuangnong No.53	China	1970	gamma rays	18	14	yield
wheat	Yuangnong No.61	China	1971	gamma rays	18	14	yield
wheat	Yunfu No.2	China	1982	cross	27	28	earliness

wheat	Yunfuzao	China	1980	gamma rays	25	20	earliness
wheat	Yuyuan No.1	China	1979	gamma rays	25	19	earliness
wheat	Zenkouzikomugi	Japan	1969	gamma rays	0	74	earliness
wheat	Zhemai No.3	China	1983	laser	32	31	earliness
wheat	Zhengliufu	China	1979	gamma rays	25	20	drought tolerance
wheat	Zhonga No.1	China	1969	gamma rays	27	29	cold resistance
wheat	Zlatostrui	Bulgaria	1985	gamma rays	32	31	yield
white jute	Hyb 'C' (Padma)	India	1983	cross	34	27	waterlodging toler.
white jute	JRC-7447	India	1980	x-rays	18	19	yield
white lupin	Dnepr	USSR	1978	cross	13	20	-
white lupin	Druzhba	USSR	1984	EMS	31	26	yield
white lupin	Gorizont	USSR	1977	cross	13	20	-
white lupin	Kievsky Mutant	USSR	1969	radiation	0	74	yield
white lupin	Pichevoy	USSR	1987	chemical mutagen	31	26	plasticity
white lupin	Start	USSR	1983	gamma rays	31	27	earliness
yellow lupin	Aga	Poland	1981	cross	19	15	earliness
yellow lupin	Kopilovskii	USSR	1985	cross	31	27	Fusarium resistance
yellow lupin	Martin 2	USSR	1984	cross	31	27	disease resistance
yellow lupin	Narochanskii	USSR	1983	gamma rays	31	27	Fusarium resistance

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FUTURE EVENTS

1992

24-28 February	**Durable Resistance** **Symposium on Durability of Disease Resistance** IAC, Wageningen, The Netherlands Contact: Prof. D. J.E. Parlevliet Department of Plant Breeding P.O. Box 386, NL-67000 Wageningen, The Netherlands
8-12 March	**International Conference on Development of New Crops** Hyatt Regency Hotel, Jerusalem Contact: Conference Secretariat Ortra Ltd. P.O. Box 50432 Tel-Aviv 61500, Israel
12-16 April	**International Food Legume Research Conference II** Cairo, Egypt Contact: Director of Administration, NVRP, ICARDA P.O. Box 2416 Cairo, Egypt
22-29 April	**FAO/IAEA Interregional Training Course on the Induction and Use of Mutations in Plant Breeding** Seibersdorf, Austria
25-29 May	**Seminar on the Use of Mutation and Related Biotechnology for Crop Improvement in the Middle East and the Mediterranean Regions** Zaragoza, Spain Contact: International Atomic Energy Agency IAEA-SR-172 P.O. Box 100 A-1400 Vienna, Austria
1992	**The Second FAO/IAEA Postgraduate Group Training on Genetic Basis of Mutation and Related Techniques for Crop Improvement** Silesian University, Katowice, Poland

LAST BUT NOT LEAST

Please submit your contribution to the Newsletter by 1 June and 1 December of each year.

Authors are kindly requested to take into account that the readers want to learn about new findings and new methods but would also like to see the most relevant data on which statements and conclusions are based. Conclusions should be precise and distinguish facts from speculations. The length of contributions should not exceed 2-3 typewritten pages including tables. We regret that photographs cannot be accepted for technical reasons. References to publications containing a more detailed description of methods for evaluation of findings are welcome but should generally be limited to one or two.

Miroslaw MALUSZYNSKI