

FNCA MUTATION BREEDING MANUAL

FOREWORD	1
PART I: ESSENTIAL BASIC INFORMATION	
1. AN OVERVIEW OF THE METHODS OF CROP IMPROVEMENT	3
2. MOLECULAR BASIS OF MUTATION : THE NUCLEUS, CHROMOSOMES AND DNA	6
2.1 THE NUCLEUS	6
2.2 THE CHROMOSOMES	6
2.3 THE GENES	8
2.4 THE DNA	8
3. MUTAGENESIS	12
3-1 RADIATION MUTAGENESIS	12
3.1.1 GAMMA RAYS	12
3.1.2 UV RAYS	13
3.1.3 BETA PARTICLES	13
3.1.4 NEUTRONS	13
3.1.5 ION BEAMS	13
3-2 CHEMICAL MUTAGENS	13
3.2.1 BASE ANALOGUES AND RELATED COMPOUNDS	13
3.2.2 ANTIBIOTICS	13
3.2.3 ALKYLATING AGENTS	14
3.2.4 AZIDE	14
4. OTHER MECHANISMS OF MUTAGENESIS	15
4.1 GENETIC CONSTITUTION	15
4.2 PHYSIOLOGICAL CONDITIONS	15
5. CELL CYCLE	16
5.1 MITOSIS	17
PROPHASE	18
PROMETAPHASE	18
METAPHASE	18
ANAPHASE	18
TELOPHASE	18
5.2 MEIOSIS I	18
PROPHASE I	20
LEPTOTENE	20
ZYGOTENE	20
PACHYTENE	20
DIPLTENE	20
DIKINESIS	20
PROMETAPHASE	20
METAPHASE I	20
ANAPHASE I	20
TELOPHASE	20
INTERKINESIS	20
5.3 MEIOSIS II	20
PROPHASE II	20
METAPHASE II	20
ANAPHASE II	21
TELOPHASE II	21
6. SPOROGENESIS AND FERTILIZATION	22

7. EFFECTS OF IONIZING RADIATION	24
7.1 RADIATION EFFECTS ON DNA	24
7.2 RADIATION EFFECTS ON CHROMOSOME STRUCTURE	24
7.3 EFFECTS OF RADIATION ON MITOTIC APPARATUS	25
8. PLANT BIOTECHNOLOGY (<i>IN VITRO</i> CULTURE)	26
9. DOSE DETERMINATION OF RADIATIONS	28
10. TREATMENT METHODS OF RADIATIONS	29
10.1 RADIATION TREATMENT	29
WHOLE PLANT	29
POLLEN GRAINS	30
CULTURED CELLS AND TISSUES	30
DEVELOPMENT OF CHIMERA	30
MERISTEM	30
10.2 CHEMICAL TREATMENT	35
ETHYL METHANE SULPHONATE (EMS) TREATMENT FOR SEEDS	35
SODIUM AZIDE (NAM ₃) TREATMENT FOR SEEDS	35
11. HANDLING OF THE TREATED MATERIALS AND THEIR SUCCEEDING GENERATIONS	37
11.1 CHLOROPHYLL AND MORPHOLOGICAL MUTATION IN THE M ₂ GENERATION	40
11.2 BULK METHOD	42
11.3 PEDIGREE METHODS	42
11.4 HOW THE MUTANTS ARE SELECTED	42
11.5 HOW TO DETERMINE WHETHER A VARIANT IS A MUTANT OR CONTAMINANT	42
11.6 ASEXUALLY PROPAGATED CROPS	43
11.7 YIELD TESTING OF MUTANTS	43
PART II: APPLIED MUTATION BREEDING	
1. COMMODITY I : CEREALS	46
1.1 RICE MUTATION BREEDING	46
INTRODUCTION	46
MATERIALS	53
METHODOLOGY	53
HANDLING OF M ₁ GENERATION	54
a. TREATMENT CLASS	54
b. HARVESTING SCHEME	54
c. SCREENING/SELECTION METHODS	56
CONCEPT OF RESISTANT/TOLERANT SCREENING (SURVIVAL SCREENING)	56
SCREENING BY MEASUREMENT	56
FURTHER EXAMPLES OF MUTANT EVALUATION	57
GRAIN QUALITY EVALUATION	57
METHODOLOGY	57
a. MILLING POTENTIALS	59
b. PHYSICAL ATTRIBUTES	59
c. PHYSICO-CHEMICAL CHARACTERISTICS	60
d. COOKING PARAMETERS AND SENSORY EVALUATION OF MILLED RICE	61
1.2 MUTATION BREEDING IN WHEAT	61
INTRODUCTION	61
OBJECTIVES FOR MUTATION BREEDING	62
MATERIALS AND METHODOLOGY	62
MATERIALS	62
METHODOLOGIES	62
2. COMMODITY II: LEGUMES	63

BREEDING MUNGBEAN	63
3. COMMODITY III : ASEXUALLY PROPAGATED ORNAMENTALS	65
INTRODUCTION	65
OBJECTIVES	65
3.1 CUTFLOWER ORNAMENTALS	68
<i>MURRAYA EXOTICA</i>	68
<i>DRACAENA SANDERIANA</i>	68
3.2 ORNAMENTAL PINEAPPLE	73
INTRODUCTION	73
MATERIALS AND METHOD	73
a. MATERIALS	73
b. <i>IN VITRO</i> CULTURE APPROACH	73
c. IRRADIATION TREATMENT	76
d. GROWING OF MV ₁ GENERATION	76
e. GROWING OF MV ₂ GENERATION	76
3.3 CHRYSANTHEMUM	76
3.4 CANNA	80
PART III: CELL AND MOLECULAR BIOTECHNOLOGY TECHNIQUES IN MUTATION	
BREEDING	
DNA ANALYSIS ON ORCHID MUTANTS	83
METHOD	83
DNA ISOLATION	83
MATERIALS AND REAGENTS	83
RAPD ANALYSIS	83
OLIGONUCLEOTIDE 10BP PRIMERS	83
REACTION(PCR KIT)	84
PCR PROGRAMME	84
GEL ELECTROPHORESIS	84
METHODOLOGY FOR IN VITRO MUTAGENESIS OF ORCHIDS	84
BREEDING TECHNIQUES OF MUTATION INDUCTION COMBINED WITH TISSUE CULTURE	87
FOR CHRYSANTHEMUM	
PROCEDURE OF RAPID PROPAGATION WITH TISSUE CULTURE FOR OVARY OF	88
GLADIOLUS GANDA VENSIS	
MICROPROJECTILE BOMBARDMENT FOR MAIZE TRANSFORMATION	89
ANTHER CULTURE OF RICE	90
REFERENCES	93
LIST OF CONTRIBUTORS	95
LIST OF REGIONAL NUCLEAR COOPERATION FOR ASIA (AGRICULTURE) CONTACT PERSONS/ FORUM FOR NUCLEAR COOPERATION IN ASIA PROJECT LEADERS (1993-2004)	97
THE LIST OF PARTICIPANTS FOR RNCA SEMINAR AND FNCA WORKSHOP, 1993-2004	99

PRACTICAL SUGGESTIONS for MUTATION BREEDING

Notes for a Laboratory Manual	111
Introduction	112
Methods of crop improvement	112
Gene structure	113
Mutagens	114
Dominant / recessive	116
Extra-information	116
Extra Suggestions	119
Selection method(Visualization of mutant segregation)	119
Additional Information	120
1. Rice	124
Some mutants for hybrid rice system	127
The use of mutation breeding in Japanese rice	129
Mutants screened in M ₁ panicle	130
Mutant character selectable in M ₂ generation	130
Use of viable and fertile mutant as marker gene	131
Some examples of rice mutation experiments	132
Starch mutant in rice	133
2. Barley and wheat	134
Mutant segregation and screening work	138
3. Maize	139
Mutagenesis in maize (Chimerism)	141
Mutagenesis in maize (mutagen)	143
4. Tomato (also <i>Capsicum</i> peppers etc)	144
Mutagenesis in tomato and <i>Capsicum</i>	146
5. Cucumber and melons	148
Mutagenesis in cucumber	149
6. <i>Chrysanthemum</i>	151
Chrysanthemum is preferred flower all over the world.	153
7. Difficult Crops	155
Orchid and other examples	156
8. Self incompatible crops	158
9. Beans	163
Some examples of soy-bean and sesame mutants	165
10. Callus culture	166
Callus activation of retro-transposon	167
11. Fruit Trees	170
Induced mutation in fruit tree	172
12. World facilities	173
13. Plant for fundamental research	175
14. Use of chemical mutagen, EMS	176
15. References	177