SUMMARY

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Amaranthus is an important genus of the family Amaranthaceae, most of the species of which have been long domesticated and have evolved with human civilization. These are important either as grain crops or as vegetable greens. In the present work , cytogenetic investigations were carried out in various aspects of this group of plants which are outlined as follows:

1. Survey of chromosome numbers of as many species as possible.
2. Induction of polyploidy for improving the grain and vegetable characteristics.
3. Interspecific hybridization by conventional breeding for raising hybrids for selection.
4. Induction of mutation by chemical and physical mutagens for mutant selection.
5. Isolation of protoplasts for carrying out somatic hybridization in otherwise sexually incompatible species.

During the present study, seeds of different species were collected from various sources in India and abroad. Cytological analysis of 26 taxa belonging to 15 species of the genus Amaranthus L. alongwith previous reports on chromosome numbers revealed that the genus Amaranthus L. is dibasic with X=16 and X=17 chromosomes and there are more or less equal number of species with these two basic numbers. Both mitotic and meiotic studies of different species of the genus revealed very small chromosomes which were difficult for karyotypic analysis.

From the findings of chromosome numbers it is evident that the division of two sections, section Amaranthus and section Blitopsis of the genus Amaranthus L. is based on morphological data since both the sections contain species with these two basic numbers.

Induction of polyploidy by colchicine in various species of Amaranthus at seedling stage was successful. Various types of growth deformities encountered in the early phase of vegetative growth gradually found to be gained over in advanced vegetative phase. The polyploids produced at C_0 generation were in the form of mixoploids. The tetraploids produced in the grain species such as A. caudatus, A. hybridus and A. hypochondriacus were found to be inferior to their corresponding diploids in most of the characters where as the tetraploids of a vegetable species A. tricolor were found to be much superior in their vegetative characters to their diploid counterpart. The tetraploids of A. tricolor which have been studied for 10 generations can now be recommended agro-economically as an improved vegetable green.

Quadrivalents were observed in variable numbers at C_o, C_1, C_2, C_8 and C_{10} generations with a gradual reduction in their number with the advancement of generations. The low frequency of quadrivalents are related to the small chromosome size with low chiasma frequency at diploid level. It is therefore suggested that four homologous chromosomes are not enough for quadrivalent formation.

The increase in percentage of pollen fertility and seed fertility at C_{10} generation in A. tricolor suggests that they are related to decreased multivalent formation. However the prolonged vegetative growth and smaller sexual cycle associated with genetic and chromosome imbalance are presumed to be the causes of sterility.

Interspecific hybridization between A. spinosus and A. dubius revealed the genomic relationship between these diploid and tetraploid species. The F_1 triploid hybrids while resembling in some characters with the parents, exhibited some characters of intermediate nature. Cytological analysis of triploids at metaphase I suggested both autosyndetic and allosyndetic pairing of chromosomes. These studies strongly supported the view that A. spinosus acted as one of the parents in the origin of tetraploid A. dubius in it's past evolutionary history.

Hexaploids raised through colchicine treatment and studied at F_2, F_3 and F_4 generations exhibited pronounced vegetative characters associated with reduction of spines.

Chromosome analysis of hexaploids revealed variable number of quadrivalents with a gradual reduction in number in later generations. Reduction of quadrivalents were not found to be associated with the reduction of spines. This suggests that spine character is gene controlled.

Induction of mutation by physical and chemical mutagens was carried out in A. hypochondriacus. There was a gradual reduction in the percentage of seed germination and survival of plants with the increase in doses of mutagens. The depressing effect in the vegetative growth in 15 days old seedlings was found to be recouped in later stages.

There was a wide range of morphological variations like dichotomous branching invariably associated with a forked leaf at the point of dichotomy, curling of leaves, chlorophyll deficiency, dwarfism and varied types of fasciation of the inflorescence axis in M_1 generation. But most of the M_1 variations were not found to be transmissible. Pollen and seed sterility were found to increase gradually with the increase in concentrations of all the mutagens.

Among M_2 and M_3 mutants, chlorophyll deficiency, dwarfism, curling of leaves and fasciated floral axis were prominent. The chromosome analysis of these mutants at meiosis revealed no chromosomal change or abnormality. The different types of mutants observed in M_3 generation were therefore presumed to be due to mutation at genic level.

Attempt was made to isolate, culture and fuse the protoplasts of A. hybridus and A. hypochondriacus. Different explants of A. hybridus were inoculated in MSP_1 and UM media. The calli were formed from hypocotyl and root explants in both the media. Some calli were transferred to MSD_3 and MSD_4 media for regeneration. Though shoot bud formation was indicated in some calli, attention was more to use these calli for cell suspension. These calli were transferred to liquid UM medium for suspension culture. Protoplasts were isolated from cells in suspension which were colourless though granulated. These were cultured in B_5 medium. Some protoplasts after regenerating cell wall started budding like yeast cells. Leaf mesophyll protoplasts isolated from A. hypochondriacus were bright lusturous green with larger plastids which were also maintained in B_5 medium.

Fusion was carried out between the protoplasts of cell suspension line of A. hybridus and leaf mesophyll protoplasts of A. hypochondriacus in B_5 medium. Heterokaryons were identified by larger size and mixed characteristics of green plastids and granulated appearance and their frequency was found to be 3-5 % . After 2 weeks, some of the heterokaryons started dividing and repeated division yielded multicellular globular mass which resuslted in the formatin of microcolonies. There was brown pigment developing from very beginning and the microcolonies were

appearing as brownish mass. Though further development beyond these microcolonies could not be followed up, it was visualised that this first attempt in the protoplast fusion in Amaranthus species and it's initial success shall have great bearing on the prospect of producing somatic hybrids for the genetic improvement of this important group of crop plants.