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Chromosomal Aberrations Induced by Chemical Mutagens in *Allium*

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Abstract: The effect of chemical mutagens on the induction of mitotic chromosomal aberrations in diploid *Allium cepa* and tetraploid *Allium vineale* has been studied. In inducing chromosomal aberrations in case of both diploid and tetraploid *Allium* all the mutagens were found to be effective . Mitotic irregularities were higher in tetraploid species as compared with the diploid species. All types of chemical mutagens were found to be effective for the induction of chromosomal aberrations but chromosomal aberrations are increased due to the effect of Ethyl Methyl Sulphonate (EMS) in comparison to the other chemical mutagens. In explaining the concentration of EMS application of 0.20% of the chemical may be the highest dose whereas 0.05% may be considered as a lower dose.

Key words: Chromosomal aberrations, chemical mutagens, *Allium cepa*, *Allium vineale*

Introduction

Genetic variation among existing cultivars and in germplasm collection is the out come of selection during evolution and plant breeding. Mutagenesis offers the plant breeder a chance to tackle unconventional objectives, particularly those that were at a selection disadvantage in the past. Effective mutagens are available, but the bottleneck is the effective selection of rare desired variants from large mutagenized populations. Selection methods must be non-destructive.

Effect of chemical mutagens to study the induction of chromosomal aberrations in various crop plants such as, cereals (Smith, 1946) *Soianum* species (Yamagata *et al*., 1969) *Tradescantia* (Ma, 1979); barley (Gichner *et al*., 1971; Pearson *et al*., 1975), *Vicia faba* (Andersson and Kihlman, 1987; Darlington and McLeish, 1951; Evans and Scott, 1964; Kihlman, 1975; Kihlman and Sturelid, 1975) chickpea (Shaikh *et al*., 1982; Shamsuzzaman and Shaikh, 1991) has been documented. All the authors agreed on a point that application of chemical mutagens in crop plants presumably induced some abnormalities in chromosome structure. Khan and Siddiqui (1993) induced mutation in mungbean (*Vigna radiate* (L.) Wilczek) by the application of chemical mutagens. In the M2 generation they observed three types of chlorphyil mutants. Chlorophyll mutant frequency increased with increase in concentration of various mutagens.

Natarajan (1993) stated that genetotoxic agents induce chromosomal alterations, such as aberrations, micronuclei and sister chromatid exchange as well as mutations both *in vivo* and *in vitro*. Ionising radiation and typical radiometric agents such as bieomycin are very efficient inducers of chromosomal aberrations. Chemical mutagens played a vital role to produce chromosomal aberrations in a considerable number of crop plants as well as animals. Although not all mutagenic changes are beneficial to the human being or welfare for the society as a whole but some of them are really of tremendous use. Researchers are capable to make proper the use of the chromosomal changes arises due to the application of mutagens. Presumably the application of chemical mutagens leads to produce chromosomal aberrations on a varying degree in various species. Nevertheless a perusal of the related literature clearly indicates the urgency of radiobiological investigations in onionrye. Keeping the above view in mind the work on the effect of different mutagens such as maleic hydrazide (MH), ethyl methylsulphonate (EMS), diethyl sulphonate (DES) and ethylene imine (EI) on diploid and tetraploid onion was initiated. The present paper deals with the mitotic chromosomal aberrations induced by different mutagens in diploid and tetraploid forms of *Allium*.

Materials and Methods

The experiment was conducted at the farm of the department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh, Bangladesh. Preparation of slides and subsequent studies were conducted at the University of Wales Aberystwyth, United Kingdom.

Seeds of diploid and tetraploid *Allium* of equal size and uniform moisture content were subjected to treatment separately with three chemical mutagens EMS (0.05, 0.10, 0.15 and 0.20%), DES (0.02, 0.06, 0.10 and 0.15%) and EI (0.0025, 0.005, 0.0075 and 0.01%) for 24 hours. The seeds were arranged in petridishes for cytological studies after treatment with the mutagens. Root tips were fixed in 1:3 acetic acid alcohol and were squashed in hematoxylene using ferric alum as a mordant. The mitotic metaphase and anaphase were scored to determine the percentage of chromosomal aberrations. Different abnormalities such as, fragments, laggards, precocious movement, non orientation of chromosomes and bridges were scored in the root tip cells of the treated material.

Results and Discussion

The effect of all the chemical mutagens on mitotic chromosomal aberrations of diploid *Allium cape* are presented in Table 1 and that for tetraploid *Allium vineale* are presented in Table 2. In these species all the three mutagene were found to be effective in inducing various types of chromosomal aberrations. In all the

Table 1: The effect of EMS, DES and EI on diploid *Allium cepa* along with the percentage of mitotic chromosomal aberrations

Dose/Treatment	Number of cells scored	Percentage of cells in division	Percentage of chromosomal Aberrations		Total Percentage
			Metaphase	Anaphase	
	2019	21.91	0	0	0
EMS					
0.02%	2200	1860	3.63	5.18	8.81
0.10%	2101	1639	4.61	6.31	11.34
0.15%	2016	17.01	6.05	9.41	15.46
DES					
0.02%	2093	16.33	4.39	5.61	10.00
0.06%	2113	15.17	4.74	6.31	11.05
0.10%	2087	15.09	5.18	8.77	13.95
EI					
0.0025%	2018	16.31	3.91	5.66	9.57
0.0050%	2143	16.91	4.60	6.54	11.14
0.0075%	2023	15.73	5.33	9.36	14.69

Table 2: The effect of EMS, DES and EI on tetraploid and *Allium vineale* along with the percentage of mitotic chromosomal aberrations

Dose/Treatment	Number of cells scored	Percentage of cells in division	Percentage of chromosomal Aberrations		Total Percentage
			Metaphase	Anaphase	
	2019	21.91	0	0	0
EMS					
0.02%	2011	12.01	8.41	9.46	17.87
0.10%	2123	11.33	7.93	10.23	18.16
0.15%	2099	11.07	9.63	13.61	23.24
DES					
0.02%	2098	8.36	4.31	4.91	9.22
0.06%	2119	8.01	5.64	7.82	13.46
0.10%	2079	8.17	6.77	11.39	18.16
EI					
0.0025%	2013	10.46	4.32	7.63	11.95
0.0050%	2046	10.63	5.91	9.11	15.02
0.0075%	2103	9.97	6.89	9.98	16.87

mutagen treatment, there was an increase in the percentage of abnormal mitotic cells with an increase in the concentration of the rnutagen. In all the treatments the percentage of cells showing mitotic abnormalities was found to be more in the tetraplold *Allium* as compared to the diploid. On investigation in both diploid and tetraploid (Table 1 and 2) it is clear that the effect of EMS is higher in comparison to the other chemical agents.

Application of mutagens and the relationship of chromosomal sensitivity on polyploidy in various plant species was extensively studied by various authors. In the root tip cells of diploid and autotetraploid barley, there was a proportional increase of chromosomal bridges with the increase in ploidy level (Smith, 1946). In a flower bud of *Tradescantia paludosa* containing a mixed population of haploid and diploid microspores the same relationship was obtained by Conger and Johnston (1956).

Bhaskaran and Swaminathan (1982) put forward an investigation on the effect of X-ray and fast neutrons on the mitotic aberrations of diploid, tetraploid and hexaploid wheat and diploid and tetraplold barley. They concluded that there is an increase in chromosome aberrations along with the increase in doses, the frequency of aberration was highest in the hexaploid wheat and least in the diploid wheat. From the studies, it is clear that with an increase in dosage the aberration frequency also increases.

A positive relationship in chromosomal aberrations and chromatin length was observed by Mikaelsen (1958) in onion, Smith (1946) in barley and wheat and Konzak and Singleton (1952) in maize. Similar higher frequency of chromosomal aberrations was found in polyploids while they were making a comparison between the diploid versus autotetraploids. Higher frequency of mitotic aberrations in the cells was recorded by Swaminathan *et al*. (1962) in the tetraploid wheat in comparison to the hexaploids by the application of EMS.

Yamagata *et al*. (1969) studied the effect of X-rays on the mitotic aberrations of several non tuberous *Solanum* species comprising 2x, 4x and 6x forms. In all the three forms they noticed an increase in the frequency of cells showing aberrations with the increase In dose, however, they found the hexaploid to be less sensitive than the tetraploid. From these results, they concluded that the higher polyploids are generally less sensitive to radiation. In the present work it is clearly demonstrated that the tetraploid *Allium vineale* is more sensitive than the diploid

Allium cepa as for as frequency of the mitotic chromosomal aberrations is concerned. The cause of this increase in the frequency of the aberrations is due to the fact that with the increase in ploidy level there is an increase in the target area availability for the mutagens. Induction of this type of aberrations by the application of chemical mutagens have immense importance in the improvement of crop plants. Of course, not all types of aberrations are useful but the geneticists and the plant breeders may select and exploit the beneficial effects.

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