Journal Crop and Weed, 11(1):62-65(2015)

Effect of different doses of gamma rays on survivability and rooting ability in chrysanthemum (*Chrysanthemum morifolium* Ramat.)

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Received:31-01-2015, Revised:10-04-2015, Accepted:15-04-2015

ABSTRACT

Mutation breeding plays a major role to create genetic variation in crop plants. Chrysanthemum is one among them where it has been exploited many a times to generate variation. Generally rooted cuttings are used for irradiation treatment. The present study was aimed to know the response of unrooted cuttings to gamma radiation. Stock plants of three varieties BC-8-05, Winter Queen and Bidhan Shova of Chrysanthemum were subjected to different levels of gamma irradiation 0, 10, 15, 20, 25 and 30 Grays to study the rooting potential. Number of roots, as well as root length increased significantly in several cases at 10 Grays in comparison to control. But further increase in dose reduced the length and also resulted in poor morphological appearance. Increase in radiation doses also resulted in delayed root initiation period and survival percentage. Pronounced intervarietal difference in respect of LD_{50} values was found and it was higher in case of unrooted cuttings as compared to the rooted cuttings. Unrooted cuttings of Winter Queen recorded highest LD_{50} (20.1 Grays), whereas it was found to be lowest in case of rooted cuttings of Bidhan Shova (10.2 Grays).

Keywords : Chrysanthemum, gamma radiation, terminal cuttings

Chrysanthemum is an herbaceous perennial flowering plant extensively grown all over the world for its beautiful charming flowers with an excellent vase life. It is highly attractive short day plant, which behaves both as annual as well as perennial flowering herb and better flowering is observed generally in the early winter. The wide variation exhibited by its large number of cultivars with respect to their growth habit, size, colour and shape of blooms makes the chrysanthemum highly suitable for pot culture and other purposes such as cut flowers, making bouquets and vase decoration. It is believed to be native of northern hemisphere, mainly Europe and Asia (Honfi, 2004).

Mutation breeding plays a important role in plant breeding and helps in the creation of genetic variation. Spontaneously occurring mutations which are helpful but it occurs at a very low rate (Sharma and Singh, 2013). Among the induced mutagens gamma rays, the physical mutagen are non particulate ionizing radiations having high energy penetrable capacity in biological tissues, interact with atoms or molecules to produce free radicals in cells and make changes in base and disruptions of hydrogen bonds between complementary strands of DNA (Ahloowalia *et al*., 2004) and affect different characters related to morphology, anatomy, biochemistry and physiological mainly depending on the level of irradiation.

Chrysanthemum is propagated both sexually and through vegetative means. Since chrysanthemum is highly cross-pollinated and due to its polyploidal and heterozygous nature, a wide range of variations are observed when grown from seeds. The plants also possess sporophytic self-incompatibility (Zalewska *et al*., 2001). A commercial method of propagation is through terminal stem cuttings taken from healthy mother plants. Chrysanthemums are also propagated through suckers but they produce tall plants, which are not suitable for decorative purpose. Enhanced rooting was reported with low irradiation in some crops like bougainvillea, hibiscus, gladiolus, rose and *Lantana depressa* (Datta, 2009) but in some instances, high irradiation dose also found to increase the number of roots to certain extent (Borzouei *et al*., 2010). Generally rooted cuttings of chrysanthemum are used for mutagen treatment (Datta and Chakrabarty, 2009; Kiran Kumar *et al*., 2013). But the present study was conducted to observe the response of unrooted cuttings through irradiation treatment.

MATERIAL AND METHODS

Terminal cuttings of 6-8 cm were taken from healthy mother stock of three varieties *viz*.., BC-8-05, Winter Queen and Bidhan Shova due to the large scale cultivation of these varieties by the growers of the plains of West Bengal. These cuttings along with the rooted cuttings were irradiated with gamma rays of 0, 10, 15, 20, 25 and 30 Grays. After irradiation, base of the cuttings were dipped in IBA and NAA (200 ppm) and were placed in sterilized sand medium. There were 20 cuttings per treatment. Observations such as days to root initiation, survival percentage, number of roots per cutting, average root length were recorded on 15, 25 and

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35 DAP and the data was statistically analyzed by using the procedure of (Gomez and Gomez, 1984) to evaluate the rooting potential of different varieties with various doses of gamma rays.

RESULTS AND DISCUSSION

Survival percentage

The cuttings above 20 Gy were died within 10 days after planting. It was observed that survival percentage was decreased with increase in radiation dose (Fig.1). Maximum survival rate was found in control of all the varieties whereas minimum survival percentage was noticed in variety Bidhan Shova (35%) at the dose of 20 Gy. For rooted cuttings optimum dose was reported in between 10-30 Gy (Dutta, 2009) however, in the present investigation no plants survived beyond 20 Gy in both the rooted and unrooted cuttings. Determination of radio sensitivity and LD_{50} dose of gamma rays are prerequisites for a mutation breeding programme. Some cultivars were found to be more sensitive and some most resistant to gamma rays. LD_{50} varied from one variety to other and the state material like rooted and unrooted cuttings (Table 2). In case of unrooted cuttings survival percentage was found to be higher as compared to the rooted cuttings. Unrooted cuttings of Winter Queen recorded highest LD_{50} (20.11 Gy), whereas it was found to be lowest in case of rooted cuttings of Bidhan Shova (10.21 Gy) it's showing that LD_{50} differs with genotypes and material used (Datta, 1997). Acording to Koing *et al*., (2008) the nature and extent of chromosomal damage are important factors for survival of plants and reduction in survival is also due to the hindrance caused by the mutagen on different metabolic pathways of the cells. Increasing frequency of chromosomal damage with increasing radiation dose may be responsible for reduction in survival percentage

Days to root initiation

Days taken to root initiation differed with both the varieties and radiation doses. Initiation of rooting took within 11 days in control plants (non-irradiated), whereas in treated plants days to root initiation ranged from 13 to 25 days. As the dose of irradiation increased, days taken to root initiation were also increased. Minimum days to root initiation (10.5 days) was observed in varieties Winter Queen and Bidhan Shova in case of control, where as in the variety Winter Queen

Table 1: LD_{50} (Gy) of different varieties calculated at 30 DAP

Varieties	Unrooted cuttings			Rooted cuttings		
	LD_{50} (Gy)	Regression equation	R^2	L.D $_{50}$ (Gy)	Regression equation	R^2
BC-8-05	18.469	Y = -24.5x+140.5	0.836	15.970	Y= -26.8x+135.6	0.914
Winter Queen	20.117	Y= -21.3x+135	0.680	14.426	Y= -24.4x+120.4	0.885
Bidhan Shova	16.731	Y= -26.0x +137	0.956	10.210	Y =-22.4x+107.2	0.992

Table 3: Effect of different doses of gamma radiation on number of roots and root length at 15, 25 and 35 DAP

Treatment	Varieties	15 DAP		25 DAP		35 DAP	
		Number of roots	Root length (cm)	Number of roots	Root length (cm)	Number of roots	Root length (cm)
Control	BC-8-05	16.83	3.28	27.00	5.50	40.17	7.77
	Winter Queen	13.50	2.90	25.00	3.13	42.00	3.60
	Bidhan Shova	18.50	1.88	15.00	2.62	19.00	3.95
10 Gy	BC-8-05	17.17	4.00	25.67	3.67	42.83	5.92
	Winter Queen	19.17	2.33	28.83	3.47	37.00	4.32
	Bidhan Shova	14.67	2.88	28.50	3.73	39.33	5.43
15 Gy	BC-8-05	0.00	0.00	9.00	2.90	18.83	3.65
	Winter Queen	17.33	1.42	17.17	2.90	25.33	3.65
	Bidhan Shova	15.33	2.25	19.33	3.33	39.50	4.22
20 Gy	BC-8-05	2.83	0.07	4.17	3.62	16.83	5.58
	Winter Queen	5.50	1.08	15.17	2.58	27.67	3.85
	Bidhan Shova	0.00	0.00	3.00	0.17	7.17	0.55

	SEm (±)	LSD (0.05)	SEm (±)	LSD (0.05)	SEm (±)	LSD (0.05)	SEm (±)	LSD (0.05)	SEm (±)	LSD (0.05)	SEm (±)	LSD (0.05)
V	**0.698**	**3.017**	**0.106**	**0.457**	**1.040**	**4.493**	**0.140**	**0.603**	**1.028**	**4.441**	**0.233**	**1.008**
T	**0.807**	**3.484**	**0.122**	**0.528**	**1.201**	**5.188**	**0.161**	**0.696**	**1.187**	**5.128**	**0.270**	**1.164**
VxT	**1.397**	**6.034**	**0.212**	**0.914**	**2.080**	**8.985**	**0.279**	**1.206**	**2.056**	**8.881**	**0.467**	**2.017**

with 20 Gy dose it took maximum days (20.5 days) to root initiation (Table1). Higher doses of gamma rays may cause damage in the structure of DNA (Mehetre *et al*., 1994) and usually have inhibitory effects (Thapa, 1999).

Number of roots

Significant difference was found among the varieties in respect of different doses of radiation and their interactions with root development. There was an increase in the number roots per cutting at 10 Gy in some cases. But in case of BC-8-05 at 25 DAP, in Winter Queen at 35 DAP and in Bidhan Shova at 15 DAP less number of roots was found in irradiated cuttings as compared to control. Among the treatments, increased number of roots was noticed at 10 Gy and 15 Gy, but further increase in radiation resulted in declined number of roots (Table 3).Similar results were also reported by Boranayaka *et al*. (2010) in sesame.

Table 2: Days to root initiation as affected by gamma radiation dose in chrysanthemum

Treatment (T)	Varieties (V)		Days to root initiation
Control	BC-8-05		11.0
	Winter Queen		10.5
	Bidhan Shova		10.5
10 Gy	BC-8-05		13.5
	Winter Queen		13.0
	Bidhan Shova		13.0
15 Gy	BC-8-05		15.0
	Winter Queen		15.5
	Bidhan Shova		17.0
20 Gy	BC-8-05		18.0
	Winter Queen		20.5
	Bidhan Shova		20.0
	T	**V**	**V X T**
SEm(±)	**0.417**	**0.361**	**0.722**
LSD (0.05)	**1.800**	**1.559**	**3.118**

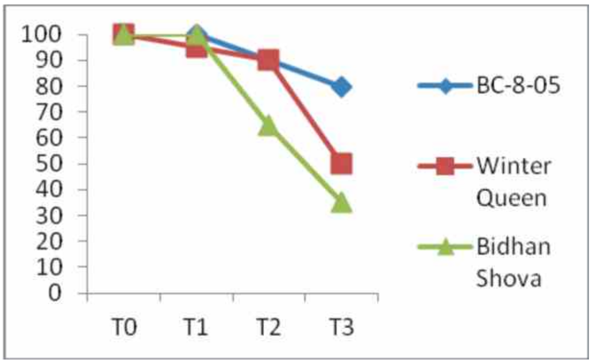

Fig 1: Survival percentage of unrooted cuttings

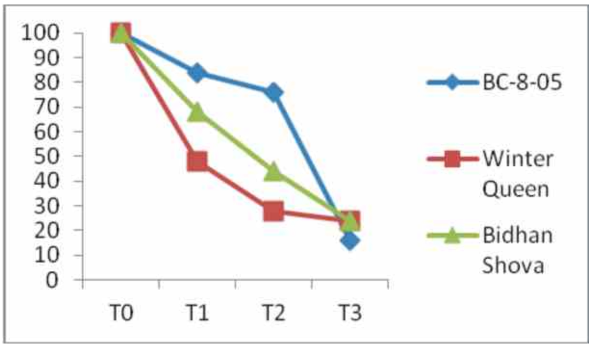

Fig 2: Survival percentage of rooted cuttings (T0-0 Gy, T1- 10Gy, T2- 15Gy, T3-20 Gy)

A

B

Fig. 3: Variation in number of roots as influenced by irradiation A) 15 DAP B) 25 DAP and C) 35 DAP

The effect of gamma radiation on rooting ability of different varieties revealed that increase in radiation dose increased the number of roots per cuttings to certain extent but resulted in delayed rooting process. Enhanced survival percentage and higher LD $_{50}$ value was found with unrooted cuttings. This study indicated that for induction of mutation through irradiation use of fresh cuttings were equally effective as that of rooted cuttings.

Acknowledgement: Authors are thankful to Department of Science and Technology, New Delhi for providing the financial assistance and also UGC-CSIR, Jadavpur University, for providing the radiation source.

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