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Research Article

Determination of radio sensitivity of jasmine (*Jasminum* spp.) to gamma rays

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Abstract
Present study was carried out to find out mutagenic sensitivity of jasmine species to gamma rays. In this study, terminal and semi hardwood cuttings of three different jasmine species (*Jasminum grandiflorum*, cv. White, *Jasminum multiflorum* cv. Arka, Arpan and *Jaminum nitidum* pre-release culture Acc.Jn-1) were subjected to eight different dosages of gamma radiation ranging between 5 Gy and 40 Gy. The results revealed a gradual and significant reduction in survival of cuttings, shoot length, number of leaves, leaf length and leaf width with increase in dosage of gamma rays. The probit curve analysis based on the survival percentage and growth rate of treated cuttings revealed that the LD_{50} dosages of gamma rays for cv. White, Arka Arpan and ACC Jn-1 were 17.8 Gy, 28 Gy and 25.1 Gy respectively.

Key words
Mutagenic sensitivity, Gamma rays, Jasmine, LD_{50}

Introduction

Jasmine, belonging to family Oleaceae is one of the most important traditional flower crops in India, distributed widely in the tropical and warm temperate regions of Europe, Asia and Africa. The genus comprises of around 200 species out of which only few species have gained commercial importance namely *J. sambac*, *J. grandiflorum*, *J. auriculatum and Jasminum multiflorum.* Recent research taken up at Tamil Nadu Agricultural University has indicated that besides the above commercial species, a few lesser known species namely, *J. nitidum*, *J. calophyllum*, *J. flexile* and *J. rigidum* possess economic importance, since they provide the advantages of producing flowers which are suitable for use as loose flowers, flower round throughout the year and also the plants of many of these species are suitable for use as fragrant flowering garden plants since they have attractive plant architecture (Ganga *et al*., 2015). As these species are normally propagated by asexual means, limited variability exists in each of these plant species. Mutation breeding, therefore, can play an important role to create variability in these economically important species.

The most important goal of a breeder is to create variation so that the material can commercially be used as new variety or it can be used as a source for further plant breeding programmes. Mutation breeding has been successfully used for generating genetic variation and breeding new varieties in many crop plants during the past decades (Van Harten, 1998; Tambe and Apparao, 2009) and has become the ultimate source of genetic variation to provide unique germplasm and valuable raw material for plant breeders (Van Harten, 1998). Generally, both physical and chemical mutagens are employed in mutation experiments. The effectiveness of a mutagenic treatment in inducing genetic variations in crop plants largely depends on the genetic constitution of test varieties and treatment dosage (Van Harten, 1998; Mba *et al.*, 2010).

Exposure to mutagenic treatments at high doses may destroy growth promoters and induce the growth inhibitors along with various chromosomal aberrations, whereas very low doses may not generate potential useful mutants due to low mutation frequency and effectiveness. Hence, the primary step in inducing mutagenesis is the optimization of radiation dose, where its predictable value guides the researcher in the choice of the ideal dose, depending on the plant materials and desired outcome, as the response to mutagens in plants is species specific and differs even among genotypes of the same species (Kwon and Im, 1973). The term ‘radio-sensitivity’ is a relative measure of the quantum of recognizable effects on the irradiated material (Owoseni *et al.*, 2007) and it is essential to observe the growth responses after irradiation to determine optimal mutagen dosages.

The present study was taken up as the first step in the mutation breeding of jasmine cvs. White, Arka

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Arpan and ACC Jn-1. White Pitchi is a type of *J. grandiflorum* commercially cultivated in the southern parts of Tamil Nadu. Arka Arpan is a variety of *J. multiflorum* developed by IIHR, Bengaluru. 'Acc.Jn-1' is a clonal selection of *J. nitidum* which has been selected for commercial cultivation for loose flower as well as for gardening by TNAU. The culture is under multi-locational trials (MLT) at various sub-centres of Tamil Nadu Agricultural University and under adaptive research trials (ART) in farmers' fields in various regions of Tamil Nadu. The present study was attempted to induce useful variants with respect to flower yield, better floral traits, plant architecture, concrete content, etc. through mutation breeding.

Materials and Methods

Terminal cuttings of *J. grandiflorum* cv. White and semi hard wood cuttings of *J. multiflorum* cv. Arka Arpan and *J. nitidum* culture Acc.Jn-1 were treated with eight different doses of gamma radiation, namely, 5, 10, 15, 20, 25, 30, 35, and 40, Gyand control. Gamma irradiation was given using ^{60}Co gamma source (Gamma Chamber 1200, Board of Radiation and Isotope Technology (BRIT), Mumbai, India) at the Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Uniform size cuttings were collected and 30 cuttings per treatment were irradiated with gamma rays according to the assigned treatments. The treated cuttings were planted in nursery polythene bags filled with red soil: FYM: sand: (1:1:1), along with untreated cuttings as control. The planted cuttings were maintained under low polytunnels with a temperature of 28–30 °C and relative humidity of 80-85% for 25-30 days until rooting. The rooted plants were then shifted to 50% shade house for hardening. The percentage survival, shoot length, number of leaves, leaf length and leaf width were measured eight weeks after shifting to shade net house. The experiment was laid out in Completely Randomized Design with three replications.

The LD_{50} values for gamma irradiation were determined based on Probit analysis (Finney, 1978), considering the survival of treated cuttings in comparison with the untreated control. The probit function is the inverse cumulative distribution function (CDF) or quantile function associated with the standard normal distribution.

Data obtained for vegetative growth related traits were subjected to the standard analysis of variance procedure using AGRES statistical package. The LD_{50} for each variety was estimated through the simple linear regression model by fitting the straight line equation $y= a + bx$; where y is the response variable (per cent survival), x is the independent variable (irradiation dose) and while a and b represent the slope and constant, respectively.

Results and Discussion

In the present study, all the three jasmine genotypes displayed a dose dependent negative linear relationship between gamma ray dose and survival percentage (Table 1). LD_{50} values for gamma irradiation for the three genotypes were fixed based on survival percentage and growth rate of cuttings. Probit analysis was carried out based on survival rate of the stem cuttings after treatment with different doses of gamma rays compared with that in untreated control (Table 2). The LD_{50} values as assessed from the probit curve analysis (Figs. 1, 2 and 3) were 17.8 Gy, 28 Gy and 25.1 Gy for cvs White, Arka Arpan and Acc.Jn-1 respectively.

Similar to survival rate, a declining trend with increase in gamma ray dose was observed for the vegetative growth traits also, in comparison with control. The actual shoot length without gamma treatment was 27.5 cm which is higher compared to 40 Gy (4.78 cm) in cv. White. Similarly lower values for number of leaves, leaf length and leaf width were observed in all three cultivars (Tables 3 to 5).

In a gamma irradiation experiment, a survival rate of 40-60 % in control plants (Van Harten, 1998) or a growth reduction of 30%–50% for M_1 seedlings has often been used as the criterion for a promising treatment. The decreasing trend of survival percentage with increase in doses of gamma rays is similar to earlier mutation experiments reported by many workers (Sutarto *et al.,* 2009; Selvi, 2005; Coban, 1998). The lower percentage of survival after the treatment with the gamma rays may be attributed to drop in auxin level resulting in poor establishment and chromosomal aberrations caused by the mutagenic treatments (Sparrow, 1961, Vishwanathan *et al*., 1992; Mahure *et al*., 2010). The decreasing trend of the vegetative growth traits namely, shoot length, number of leaves and leaf length with an increasing dose of gamma irradiation can be ascribed to the inhibitory influence of the mutagenic agents. The inhibitory influence of ionizing radiation has been well established in many woody perennials including rose (Kaicker and Swarup, 1972), *Jasminum sambac* (Kannan, 1994), hibiscus (Datta and Chakrabarthy, 2005) and aonla (Selvi, 2005) etc.

The gamma rays being more potent and highly penetrating in nature, might have impacted the cells undergoing meiotic division in the bud region

(Deshpande *et al.*, 2010). For this reason, in addition to survival percentage, growth rate was also considered for fixing LD_{50}. Sensitivity of each cultivar to mutagen always differs due to its genetic makeup. Since 40-50 % reduction in growth rate was observed in 20 Gy for White (Table3, Fig, 4), 30 Gy for Arka Arpan (Table 4, Fig 5), 25 Gy for Acc.Jn-1 (Table 5, Fig 6), based on both survival and growth rates, LD_{50} values for gamma irradiation were fixed as 17.8 Gy, 28 Gy, and 25.1 Gy for these genotypes respectively. Sparrow (1961), while working on cytological effect of radiation, concluded that the decrease in vegetative growth is a result of radiation induced cytological changes such as chromosomal damages, inhibited mitotic division, degeneration of nuclei, cell enlargement, *etc*. Similar trend of linear reduction in leaf length with dosage of mutagens was reported by Kainthura and Srivastava (2015) in tuberose (*Polianthes tuberosa* L), Dwivedi and Banerji (2008) in *Dahlia variabilis* and Dilta *et al.* (2003) in chrysanthemum.

Determination of LD_{50} value for any mutagen is necessary to generate maximum viable mutants with minimum unintended damage to the plant. In the present study, based on the survival and growth rates, LD_{50} doses for gamma irradiation have been fixed as 17.8 Gy, 28 Gy, and 25.1 Gy for cv. White, Arka Arpan and Acc.Jn-1 respectively. These optimum mutagen doses determined for the above jasmine genotypes can be highly useful while formulating jasmine mutation breeding programmes for improvement of specific traits in jasmine.

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References

Coban, H., 1998. Investigations on the variations caused by gamma rays, originating from ^{60}co, treated to round seedless grape variety in different doses. Ege Uni. Fen Bilimleri Ens. (Ph.D. Thesis). Bornova-Izmir.

Datta, S.K and Debasis Chakrabarthy. 2005. Classical mutation breeding and molecular methods for genetic improvement of ornamentals. Classical mutation breeding and molecular methods. Daya publishing House, Delhi, pp:267

Deshpande, K.N., Mehetre, S.S., Pingle, S.D., 2010. Effect of different mutagens for induction of mutations in mulberry. Asian J. Exp. Biol. Sci. Spl. 104–108.

Dilta, B. S., Sharma, Y. D., Gupta, Y. C., Bhalla, R. and Sharma, B.P. 2003. Effect of gamma rays on vegetative and flowering parameters of chrysanthemum. *J. Ornam. Hort.*, **6**: 328-334.

Dwivedi, A.K. and Banerji, B.K.2008. Effect of gamma irradiation on dahlia cv. 'Pinki' with particular reference to induction of somatic mutation. *Journal of Ornamental Horticulture*, **11**(2): 148 – 151.

Finney, D.J., 1978. Statistical Method in Biological Assay. Charles Griffin Co.

Ganga, M., Ranchana, P. Ganesh, S. and Kannan M. 2015. *Jasminum nitidum* – a potential unexploited jasmine species. In: Third International Symposium on Underutilized Plant Species-Exploration and conservation for future generation, Madurai, Tamil Nadu, India

Kaicker, U.S and Vishnu Swarup. 1972. Induced mutations in rose. Indian Journal of Genetics and Plant breeding., **32**(2):257-265.

Kainthura, P. and Srivastava, R. 2015. Induction of genetic variability and isolation of mutants in tuberose (*Polianthes tuberosa* L.). *Tropical Agricultural Research*, **26** (4): 721 – 732

Kannan, M.1994. Studies on induced mutation in *Jasminum sambac* cv. Gundumalli through mutation breeding. Ph.D thesis submitted at TamilNadu Agricultural University, Coimbatore, Tamil Nadu, India.

Kwon, S.H., Im, K.H., 1973. Studies on radiosensitivity of soyabean varieties. Korean J. Breed. **5** (1): 5–10.

Mahure, H.R., Choudhary, M.L., Prasad, K.V., Singh, S.K., 2010. Mutation in chrysanthemum through gamma irradiation. *Indian J. Hort*. **67**: 356–358.

Mba, C., Afza, R., Bado, S., Jain, S.M., 2010. Induced mutagenesis in plants using physical and chemical agents. In: Davey, M.R., Anthony, P. (Eds.), Plant Cell Culture: Essential Methods. John Wiley & Sons, Ltd., Chichester, UK, pp. 111–130.

Owoseni, O., Okwaro, H., Afza, R., Bado, S., Dixon, A., Mba, C., 2007. Radiosensetivity and *in vitro* mutagenesis in African accessions of cassava, *Manihot esculenta* Crantz. Plant Mutat. Rep. 1, 32–36.

Senthamizh Selvi, B. 2005. Studies on induced mutagenis in amla (*Emblica officinalis* Gaertn.) through gamma rays. Ph.D thesis submitted at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Sparrow, A.H.1961. Types of ionizing radiations and their cytogenetic effects. Mutation Plant Breeding *NAS-NRC*, **891**: 55 – 119

Sutarto, I., Agisimanto, D., Supriyanto, A., 2009. Development of promising seedless citrus mutants through gamma irradiation. In: Shu, Q.Y. (Ed.), Induced Plant Mutations in the Genomics Era. Food and Agriculture Organization of the United Nations, Rome, pp. 306–308.

Tambe, A.B., Apparao, B.J., 2009. Gamma ray induced mutations in soybean [Glycine max (L.) Merill] for yield contributing traits. In: Shu, Q.Y. (Ed.), Induced Plant Mutations in the Genomics Era. Joint FAO/IAEA Programme, Vienna, Austria, pp. 95–96

Van Harten, A.M., 1998. Mutation Breeding: Theory and Practical Applications. Cambridge University Press, UK.

Vishwanathan, T.V., Mahato, K.P., Jaya, M., 1992. Effect of gamma irradiation on the M1 generation of Kaempferia (*Kaempferia galangal* L.). South Indian Hortic. **40**: 146–150.

Table 1. Effect of mutagen on survival of cuttings in *J. grandiflorum* cv. White, *J. multiflorum* cv. Arka Arpan and *J. nitidum* culture Acc.Jn-1

Dose(Gy)	*J. grandiflorum* cv. White			*J. multiflorum* cv. Arka Arpan			*J. nitidum* culture Acc.Jn-1		
	Survival percentage	Per cent survival over control	Per cent reduction over control	Survival percentage	Per cent survival over control	Per cent reduction over control	Survival percentage	Per cent survival over control	Per cent reduction over control
0	76.67	100	-	73.33	100	-	76.67	100	-
5	73.33	95.64	4.36	66.67	90.91	9.09	70..00	91.30	8.7
10	66.67	86.95	13.05	63.33	86.36	13.64	66.67	86.95	13.05
15	60.00	78.25	21.75	60	81.82	18.18	63.33	69.55	30.45
20	43.33	56.51	43.49	50	68.18	31.82	56.67	73.94	26.06
25	36.67	47.82	52.18	33.33	45.45	54.55	23.33	30.42	69.58
30	30.00	39.12	60.88	23.33	31.82	68.18	16.67	21.74	78.26
35	26.67	34.78	65.22	16.66	22.71	77.29	10.00	13.04	86.96
40	16.67	21.74	78.26	10	13.63	86.37	6.67	8.699	91.301
SE(d)	0.50			0.58			0.64		
CD(5%)	1.06			1.22			1.36		

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Table 2. Probit analysis for calculating LD_{50} in *J. grandiflorum* cv. White, *J. multiflorum* cv. Arka Arpan and *J. nitidum* culture Acc.Jn-1

Dose (Gy)	Log_{10} of doses	*J. grandiflorum* cv. White				*J. multiflorum* cv. Arka Arpan				*J. nitidum* culture Acc.Jn-1			
		Observed mortality percentage	Corrected mortality percentage	Emprical probit unit	LD_{50} value	Observed mortality percentage	Corrected mortality percentage	Emprical probit unit	LD_{50} value	Observed mortality percentage	Corrected mortality percentage	Emprical probit unit	LD_{50} value
0	-	23.00	-	-		27.00	-	-		23.00	-	-	
5	0.69	27.00	5.0	**3.35**		33.00	8.0	**3.59**		30.00	9.0	**3.66**	
10	1.00	33.00	13.0	**3.87**		37.00	14.0	**3.19**		33.00	13.0	**3.87**	
15	1.17	40.00	22.0	**4.23**		40.00	18.0	**4.08**		37.00	18.0	**4.08**	
20	1.30	57.00	44.0	**4.85**	**17.8 Gy**	50.00	32.0	**4.53**	**28.0 Gy**	43.00	26.0	**4.36**	
25	1.39	63.00	52.0	**5.05**		67.00	55.0	**5.13**		77.00	70.0	**5.52**	**25.1 Gy**
30	1.47	70.00	61.0	**5.28**		77.00	68.0	**5.47**		83.00	78.0	**5.77**	
35	1.54	73.00	65.0	**5.38**		83.00	77.0	**5.74**		90.00	87.0	**6.13**	
40	1.60	83.00	78.0	**5.77**		90.00	86.0	**6.08**		93.00	90.0	**6.28**	

Table 3. Effect of gamma rays on vegetative growth parameters of *J. grandiflorum* cv. White

Dose (Gy)	Shoot length (cm)			No. of leaves			Leaf length (cm)			Leaf width (cm)		
	Actual	Per cent over control	Per cent reduction over control	Actual	Per cent over control	Per cent reduction over control	Actual	Per cent over control	Per cent reduction over control	Actual	Per cent over control	Per cent reduction over control
0	27.5	100	-	10.12	100		7.45	100		4	100	
5	22.77	82.8	17.2	9.34	92.29	7.71	6.5	87.24	12.76	3.4	85	15
10	20.45	74.36	25.64	9.1	89.92	10.08	5.41	72.61	27.39	3.1	77.5	22.5
15	18.26	66.4	33.6	8.45	83.49	16.51	5.09	68.32	32.68	2.43	60.75	39.25
20	14.23	51.74	48.26	7.66	75.69	24.31	4.39	58.92	41.08	2	50	50
25	12.56	45.67	54.33	5.26	51.97	48.03	4.12	55.3	44.7	1.9	47.5	52.5
30	11.22	40.8	59.2	4.15	41	59	3.11	41.74	58.26	1.7	42.5	57.5
35	8.52	30.98	69.02	3.17	31.32	68.68	2.85	38.25	61.75	1.23	30.75	69.25
40	4.78	17.38	82.62	2.1	20.75	79.25	2.37	31.81	68.19	0.9	22.5	77.5
SE(d)	0.29			0.11			0.12			0.03		
CD(5%)	0.61			0.23			0.25			0.08		

Table 4. Effect of gamma rays on vegetative parameters of *J. multiflorum* cv. Arka Arpan

Dose (Gy)	Shoot length (cm)			No. of leaves			Leaf length (cm)			Leaf width (cm)		
	Actual	% over control	% reduction over control	Actual	% over control	% reduction over control	Actual	% over control	% reduction over control	Actual	% over control	% reduction over control
0	16.52	100		13.75	100		5.32	100		2.44	100	
5	14.76	89.34	10.66	12.35	89.81	10.19	4.21	79.13	20.87	2.23	91.39	8.61
10	12.67	76.69	23.31	11.77	85.6	14.4	4.11	77.25	22.75	2.11	86.47	13.53
15	11.78	71.3	28.7	10.89	79.2	20.8	3.89	73.12	26.88	1.96	80.32	19.68
20	10.67	64.58	35.42	9.15	66.54	33.46	3.72	69.92	30.08	1.53	62.7	37.3
25	9.1	55.08	44.92	7.58	55.12	44.88	2.96	55.63	44.37	1.32	54.09	45.91
30	8.1	49.09	50.91	6.23	45.3	54.7	2.57	48.3	51.7	1.2	49.18	50.82
35	4.12	24.93	75.07	3.12	22.59	77.41	1.43	26.87	73.13	1.12	45.9	54.1
40	2.14	12.95	87.05	2.1	15.27	84.73	1.22	22.93	77.07	0.85	34.83	65.17
SE(d)	0.22			0.15			0.07			0.04		
CD(5%)	0.47			0.32			0.15			0.08		

Table 5. Effect of gamma rays on vegetative growth parameters of *J. nitidum* culture Acc.Jn-1

Dose (Gy)	Shoot length (cm)			No. of leaves			Leaf length (cm)			Leaf width (cm)		
	Actual	Per cent over control	Per cent reduction over control	Actual	Per cent over control	Per cent reduction over control	Actual	Per cent over control	Per cent reduction over control	Actual	Per cent over control	Per cent reduction over control
0	17.48	100		12.59	100		6.25	100		2.63	100	
5	14.35	82.09	17.91	11.48	91.18	8.82	5.36	85.76	14.24	2.52	95.81	4.19
10	13.35	76.37	23.63	10.23	81.25	18.75	4.96	79.36	20.64	2.21	84.03	15.97
15	12.24	70.02	29.98	9.63	76.48	23.52	4.25	68	32	1.96	74.52	25.48
20	10.21	58.4	41.60	8.25	65.52	34.48	3.89	62.24	37.76	1.45	55.13	44.87
25	9.36	53.54	46.46	6.55	52.02	47.98	2.78	44.48	55.52	1.32	50.19	49.81
30	7.54	43.13	56.87	5.23	41.54	58.46	2.13	34.08	65.92	0.97	36.88	63.12
35	6.23	35.64	64.36	3.63	28.83	71.17	1.53	24.48	75.52	0.85	32.31	67.69
40	5.23	29.91	70.09	2.42	19.22	80.78	1.11	17.76	82.24	0.69	26.23	73.77
SE(d)	0.16			0.14			0.08			0.02		
CD(5%)	0.33			0.30			0.17			0.05		

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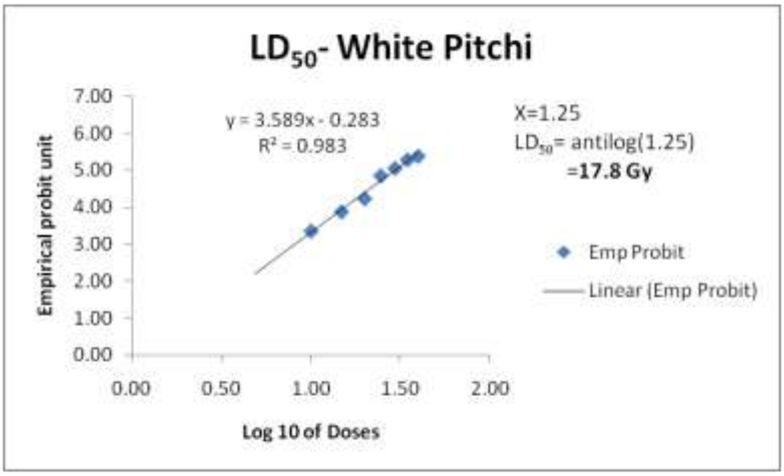

Fig. 1. Probit analysis based on corrected mortality rates for cv. White (*J. grandiflorum*)

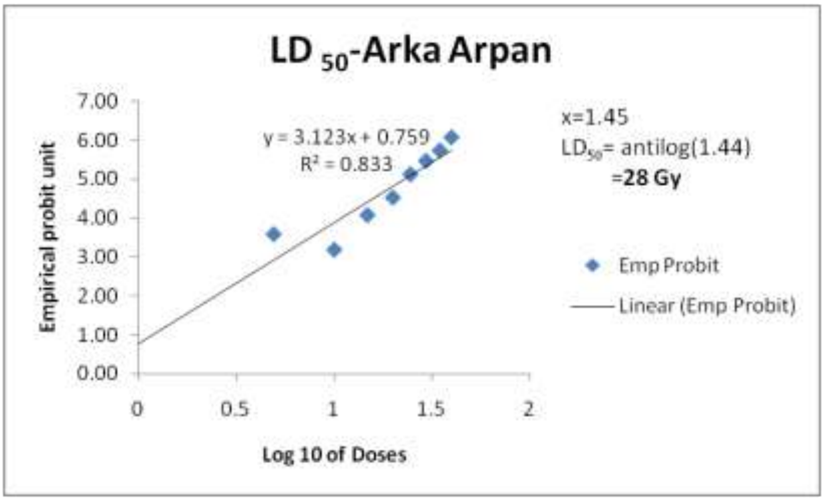

Fig. 2. Probit analysis based on corrected mortality rates for cv. Arka Arpan (*J. multiflorum*)

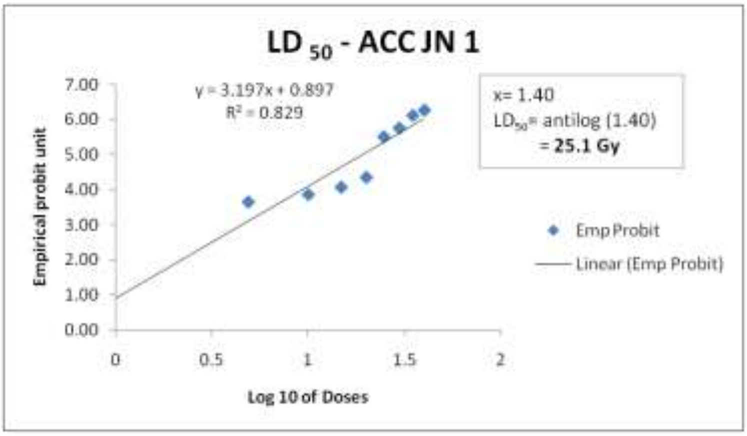

Fig.3. Probit analysis based on corrected mortality rates for culture Acc.Jn-1 (*J. nitidum*)

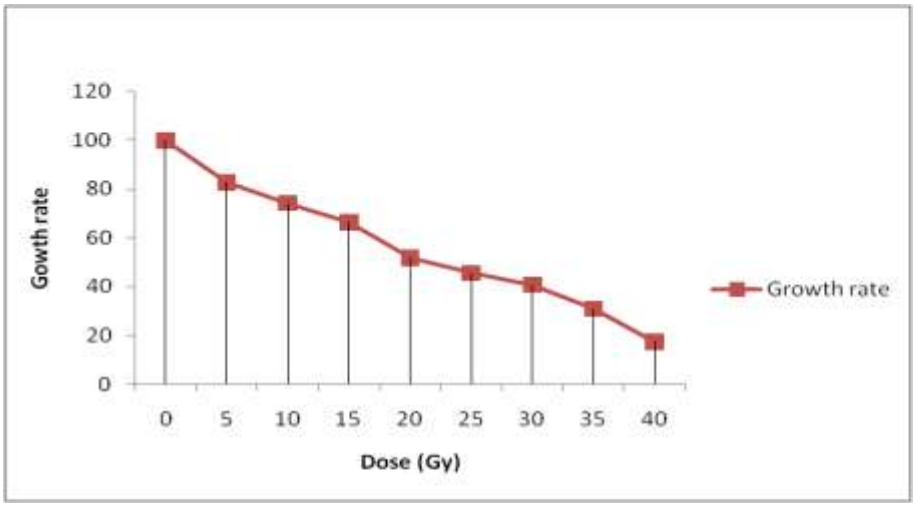

Fig. 4. Radio sensitivity v/s comparative growth rate in cv. White (*J. grandiflorum*)

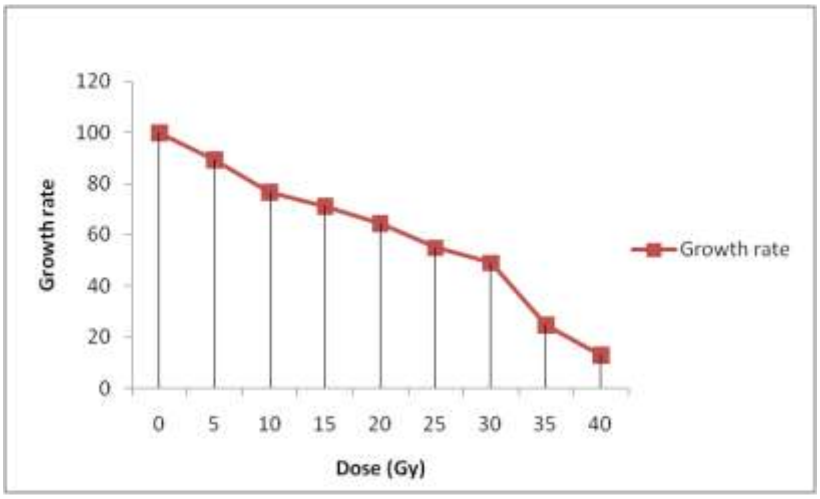

Fig. 5. Radio sensitivity v/s comparative growth rate in cv. Arka Arpan (*J. multiflorum*)

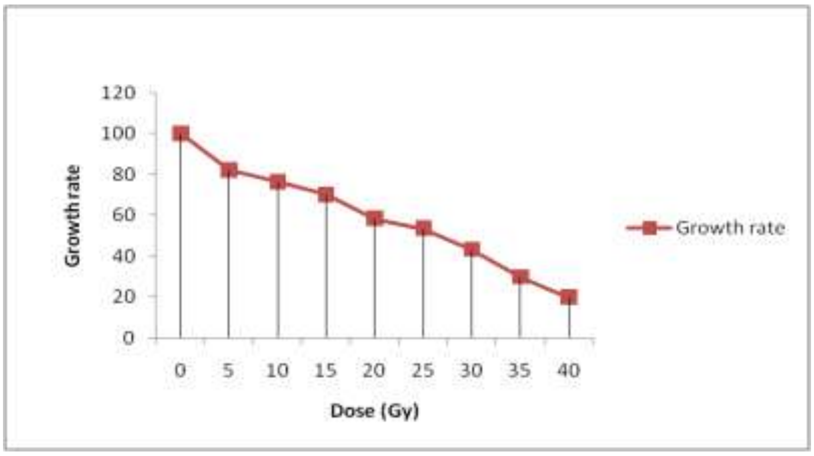

Fig. 6. Radio sensitivity v/s comparative growth rate in culture Acc.Jn-1 (*J. nitidum*)