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Gamma-ray induced mutants in castor (*Ricinus communis* L.)

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Abstract

We report isolation of three recessive mutants in castor using dry seed irradiation with gamma rays. The crinkled leaf mutant (*cri*) was identified in K-55-112 M_2 family and leafy mutant (*lea*) in H-55-577 M_2 family; both are recessive lethal and thus maintained as heterozygotes. The *cri* mutant has highly wrinkled leaves resembling finger millet head and failed to enter reproductive phase, consequently did not produce seeds. The number of leaf lobes is reduced in *lea* mutant and though it produced spikes, the male and female flowers are converted to leafy appendages. The third mutant, fused (*fus*) stem identified in H-55-617 M_2 family is a recessive mutant. The branches of which are fused at the base and though each branch terminates in to monoceous spike like normal plant, the spike is highly condensed. The three mutants under report are valuable genetic stocks for development of linkage maps in castor, which is at infancy.

Key words: Induced mutants, gamma rays, *Ricinus communis*, recessive lethal, and developmental mutants

Introduction

In spite of its economic importance, the genetics of the castor is poorly understood. Though studies were conducted by the researchers of erstwhile USSR [1], and India [2-6], they are very limited and obsolete. Discrete mutant phenotypes like the purple morphotype reported by Anjani [7] would definitely help to construct linkage maps, which are not attempted in castor so far. Basically, mutations provide the alleles required for various types of genetic analysis, from Mendel's two-factor analysis to chromosome mapping studies. In castor, gamma-rays induced pollen sterility and female mutations were reported earlier [8, 9]. As induced mutation possesses enormous potential to create genetic variability, induced mutagenesis was initiated in castor. The recessive mutants under report are derived from the said programme, which constitute valuable genetic stocks for developing linkage maps in castor.

Materials and methods

Dry seed treatment with Gamma-rays was attempted to induce mutations in Kranthi and Haritha varieties of castor released from Regional Agricultural Research Station, ANGRAU, Palem, Mahaboobnagar District. At RARS, Palem M_1 and subsequent generations were grown. M_1 plants were selfed by simple bagging of unopened spike to derive M_2 progenies followed by removal of bags after seed setting to enable development of capsules. M_2 progeny rows were raised with 20 plants per progeny for isolation of mutants.

Ten treatments ranging from 10 to 100 kR (kiloRads) were used to determine the dose resulting in 50 % mutagen-caused mortality. The seeds of Kranthi and Haritha were subjected to irradiation along with control and sown; the number of surviving seedlings in each treatment was recorded 30 days after sowing (Table 1). The germination percent in control was considered as 100%, and mortality percent was computed accordingly (Table 1). The treatment 60 kR, showed 50 % mortality in both the varieties and hence this dose along with two additional doses, 55 and 65 kR are used in the study.

Results and discussion

In a total of 2000 M_1 plants, no surviving dominant mutants were observed. The M_2 generation constitutes first segregating mutant population; hence recessive mutants can be identified in this generation. During

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Table 1. Mortality of seedling subjected to gamma irradiation

Variety	Gamma irradiation dosage (kR)	control	10	20	30	40	50	60	70	80	90	100
Kranthi	No.of surviving seedlings	42	40	41	40	39	30	20	14	3	0	0
	Mortality (%)	0	5	2.5	5	7	29	52	67	93	100	100
Haritha	No.of surviving seedlings	96	90	86	78	75	72	50	31	12	3	0
	Mortality (%)	0	6	10	19	22	25	48	68	88	97	100

Table 2. Segregation of heterozygote of *cri, lea* and *fus* mutants

Mutant under study	Generation	Progeny number	Number of plants			Segregation ratio
			Normal phenotype	Mutant phenotype	Total	
cri mutant	M_2	112	16	3	19	5:1
	M_3	5	13	2	15	6:1
		11	12	4	16	3:1
	M_4	20	14	2	16	7:1
		18	17	3	20	6:1
	M_5	24	15	2	17	7:1
		31	16	4	20	4:1
		26	17	3	20	6:1
		35	18	2	20	9:1
	M_6	31	13	2	15	6:1
		32	12	3	15	4:1
		33	14	1	15	14:1
		34	16	4	20	4:1
		35	17	3	20	6:1
		36	18	2	20	9:1
		37	18	2	20	9:1
	Total		**246**	**42**	**288**	**6:1**
lea mutant	M_2	577	5	3	8	2:1
	M_3	2	4	1	5	4:1
		4	20	2	22	10:1
		10	10	2	12	5:1
	Total		**39**	**8**	**47**	**5:1**
fus mutant	M_2	617	14	2	16	7:1
	M_3	8	17	1	18	17:1
		9	14	1	15	14:1
		10	13	2	15	6:1
		12	12	3	15	4:1
		13	14	1	15	14:1
		14	15	2	17	7:1
		15	12	3	15	6:1
		16	12	3	15	4:1
	Total		**123**	**18**	**141**	**7:1**

Kharif 2004, 3 plants possessing highly wrinkled leaves were observed in the progeny row 112 derived from Kranthi irradiated with 55 kR, hence designated as K-55-112. The mutant has leaves resembling finger millet head was named as *crinkled* leaf mutant and gene symbol *cri* is proposed. The mutant failed to reproduce, as it did not produce spikes. Therefore, the remaining normal plants of the progeny were selfed, some of which will be carrying *cri* allele in heterozygous condition. Two M_3 progenies showed segregation for *cri* mutant; thus confirming the inheritance of the mutant phenotype.

In *Kharif* 2006, 300 M_2 progeny rows were raised from which two distinct mutants were identified in two progenies of Haritha irradiated with 65 kR. In progeny 577, two out of a total 16 plants showed leaf mutant phenotype. The mutant has leaves with reduced number of lobes and thus look like the leaves of *Hibiscus cannabinus*. As per the morphological indicators for DUS testing, the Haritha variety is categorized to possess few lobes *i.e.*, 7-10 per leaf. However, in *lea* mutant, the lobes are reduced to $\leq$ 5 and moreover the lower two lobes are non-distinct. The spikes are produced but they reverted back to leafy appendages and consequently did not set seed. Occasionally red feathery stigma was observed which did not set seed due to absence of ovaries. Therefore, the normal plants of the progeny were selfed and when M_1 generation was raised the observed *lea* mutant was recorded in 3 of the progenies indicating inheritance of the mutant. It's an interesting mutant as the developmental pathway of the flower is altered and is reverted back to leafy appendages; this phenotype is similar to *polycotyledon* mutant in tomato [10].

In the progeny 617, two plants with fused branches were observed hence termed as *fused* mutant and the gene symbol *fus* is given. The fused branches gave a distinct shape to the plant and all the branches terminated in to spike like normal plant, however, the monoecious spike is highly condensed and possessed fertile pollen and ovaries and did set seed. The studies on inheritance of *fus* mutant were initiated by attempting crosses with normal parent. In M_3 generation 8 progenies produced *fus* mutant phenotype indicating inheritance of the trait.

The *cri* and *lea* mutants are recessive lethal as they fail to reproduce and hence are maintained as heterozygotes. The segregation of heterozygotes of all the three mutants in each generation are presented in Table 2; the ratio of segregation does not fit to normal monogenic ratio of 3:1 or digenic ratio of 15:1. Thus a detailed cytogenetic analysis will help to study the involvement of chromosomal changes like deficiencies, inversions or translocations, if any. The mutants reported constitute valuable genetic stocks for development of linkage maps in castor.

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