https://doi.org/10.29321/MAJ.10.A03442

Madras agric. J. 61 (10—12) : 930-935 Oct.—Dec, 1974.

STUDIES ON RADIOBIOLOGICAL EFFECTS OF X-IRRADIATION IN CASTOR

BY

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ABSTRACT

Pollen grains and dry dormant seeds of two varieties of castor were irradiated with X-rays at different doses. Reduction in germination and number of racemes per plant were noticed in R C 1377. No marked decrease in survival of seedlings, reduction in flowering duration, height of plant and number of primary branches per plant in both the varieties of pollen and seed irradiations were noticed in the M_1 generation. A greater inhibition of germination was noted in seed irradiations in the two varieties in the M_2 generation. Increase in height was recorded in pollen and seed irradiations in the two varieties. Reduction in R C 1377 and increase in NPH 1 in respect of the number of primary branches was registered in pollen as well as seed irradiations. In respect of the length of main raceme increase in R C 1377 and decrease in NPH 1 of pollen and seed irradiations was noticed. The number of racemes per plant increased in both the varieties in pollen irradiation The doses employed in the present investigation can not be considered as high enough in the case of seed irradiation.

INTRODUCTION

Attempts on improvement through mutation breeding in castor (*Ricinus communis* L.) have been a few and were conducted by irradiation of seeds with neutrons and gamma rays (Chandramouli *et al.*, 1961; Bhatnagar *et al.* 1962 and Ankineedu *et al.*, 1968). The potentialities of irridiation of pollen grains for inducing genetic changes have not been assessed in castor so far, as made in certain other crops. In the present study X-irradiation of seeds and pollen grains was made in two dwarf varieties of castor, NPH 1 and R C 1377 to find out the radiosensitivity and induced variation. The observations from these investigations are reported herein.

MATERIALS AND METHODS

Seeds and pollen grains of two varieties of castor, *viz.*, RC 1377 and NPH1 were utilised in the present investigations. Fifty dry seeds were irradiated at 30, 40, 50, 60 and 60 kR in each variety at room temperature (28-30°C) with X-rays (50 Kv-2MA) using a Phillips Contact Cavity Therapy Apparatus. Non-irra-

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diated seeds in both the varieties served as controls. The seeds were sown in the field on the next day for observations.

Pollen collected at anthesis was successfully germinated in 17 per cent chemically pure sucrose solution with 50 ppm of boric acid *in vitro* for fixing the Median Lethal doses for X-irradiated pollen. The criterion taken for pollen germination was the length of the tube extended to twice the diameter of pollen grain. Pollen collected at anthesis and irradiated was dusted immediately on previously protected and emasculated flowers of the respective varieties. The doses given were 2.5, 5.0 and 7.5 kR for pollen. At the same time protected and emasculated flowers of RC 1377 and NPH 1 were pollinated with non-irradiated pollen grains to serve as controls. The germination and survival of seedlings of M_1 and M_2 progenies were recorded on 10th day and 45th day after sowing. Pollen sterility in the M_1 was determined by staining the pollen grains in 1 : 1 acetocarmine-glycerine mixture.

RESULTS AND DISCUSSION

In the M_1 generation raised from seeds obtained by pollen irradiation, an inhibition of germination was noticed in RC 1377, while there was no reduction in the percentage of germination in the case of NPH 1. In seed irradiation also, in the M_1 generation, an inhibition of germination was noted in RC 1377 only. However there was no reduction in survival of seedlings in pollen as well well as seed irradiations in both the varieties. The high tolerance to irradiation of NPH 1 was observed in pollen grains and dry seeds as may be seen from Table 1.

In pollen irradiation, the morphological variations induced in the M_1 resulted in a earliness in flowering (first flowering), reduction in height at maturity and number of primary branches per plant in both the varieties. A reduction in the mean number of racemes was registered in RC 1377 whereas increase in mean values and co-efficient of variation was noticed in NPH 1.

In M_1 progenies following seed irradiation, a reduction in mean values for height of maturity, number of primary branches and number of racemes per plant (except 30 kR) was noted in the two varieties. In respect of duration to flowering (first flowering) a delay in flowering in NPH 1 and earliness in RC 1377 (except 60 kR) were noticed. Pollen sterility was considerably less in the progenies derived from pollen irradiation than those from seed irradiation (Table 1). Bhatnagar *et al.* (1962) noticed detrimental effect in germination only in higher doses, reduction in seedling survival and height of plant at harvest in the treated seeds with gamma rays. Shivaraj and Ramana Rao (1963) noted a linear stimulating effect with increase in dose in the case of fast neutrons, whereas gamma irradiation showed non-linear relationship with slight stimulating effect on germination in higher doses. They also observed reduction in seedling survival and height

TABLE 1. Germination, survival and expression of attributes in M_1 of castor

Material/ X-Irradiation	Dose (kR)	Seed germination (Mean %)	Seedling survival (Mean %)	First flowering		Height		No. of Primary branches		No. of racemes		Pollen sterility
				Mean (Days)	C. V. %	Mean (cm)	C. V. %	Mean	C. V. (%)	Mean	C. V. (%)	(%)
RC 1377/Poller	0	94.1	97.4	58.6	13.0	23.0	10.1	3.5	21.6	4.6	17.6	0.6
	2.5	91.6	96.9	43.1	21.5	16.2	35.8	2.9	56.2	4.4	78.0	1.1
	5.0	90.7	96.0	49.8	22.1	16.5	38.7	2.9	52.4	2.7	84.4	3.8
	7.5	80.4	89.3	53.0	18.9	15.8	35.3	3.3	46.7	3.9	61.3	4.9
NPH 1/Pollen	0	94.4	99.1	63.6	0.7	24.8	10.4	4.2	16.3	4.5	20.3	2.9
	2.5	95.1	98.9	49.8	22.2	16.5	38.8	2.9	52.4	14.2	51.3	3.8
	5.0	96.3	96.9	43.1	21.5	16.2	41.1	4.1	46.1	10.4	53.4	4.4
	7.5	97.0	94.9	49.8	22.0	16.5	38.7	2.9	56.2	10.9	62.5	6.3
RC 1377/Seeds	0	94.1	97.4	58.6	13.0	23.0	10.1	3.5	21.6	4.6	17.6	0.6
	30	86.0	95.3	48.6	18.2	18.0	26.3	3.2	44.1	4.5	69.7	1.2
	40	94.0	91.4	54.3	15.8	15.5	26.2	2.8	43.1	3.7	59.7	2.1
	50	92.0	89.1	53.9	15.7	16.2	45.9	2.6	47.3	3.4	69.7	3.7
	60	92.0	86.9	59.1	18.4	18.6	48.5	2.6	55.6	3.1	65.3	5.2
	70	92.0	95.6	56.1	15.8	15.5	40.9	2.5	52.0	2.6	68.9	7.8
NPH 1/Seeds	0	94.4	99.1	63.6	0.7	24.8	10.4	4.2	16.3	4.5	20.3	2.9
	30	100.0	96.0	65.8	10.4	22.3	26.7	4.1	42.6	5.9	63.1	8.0
	40	98.0	95.9	68.8	17.3	20.1	28.0	2.7	44.4	3.6	52.4	12.8
	50	94.0	95.7	68.5	12.9	20.7	30.8	3.2	58.9	3.3	53.3	16.0
	60	94.0	95.7	70.1	13.3	23.4	23.3	3.9	46.3	4.2	71.2	17.1
	70	98.0	93.8	68.9	17.9	21.9	21.6	3.7	45.1	3.9	53.9	24.3

of plant following gamma irradiation. Ankineedu *et al* (1963) noted that germination was not much affected in any of the treatments with fast neutrons and gamma rays. Marked reduction in survival and height of plant were observed when the seeds were irradiated with fast neutrons and gamma rays. Increase in the number of racemes per plant was noticed by them in treated material with fast neutrons.

In M_2 generation, there was reduction in germination and survival of seedlings in the treatments except 2.5 kR in both the varieties following pollen irradiation. In seed irradiation, a greater reduction in germination and a decrease in the percentage of seedlings survival were noticed in both the varieties. This may be due to lethal gene segregating as brought out by Atsman (1959), due to a mutated locus. There was an increase in the mean values for height at maturity and number of racemes per plant (except 2.5 kR in RC 1377) in pollen irradiation of the two varieties. In respect of the number of primary branches per plant, there was reduction in RC 1377 and increase in NPH 1 was noticed. The length of main racemes found to be high in RC 1377, while there was decrease in NPH1. In seed irradiation, increase in mean values for height at maturity and length of main racemes (except 40 kR) and a decrease in mean values for number of primary branches (except 30 and 50 kR) and number of racemes per plant were noticed in RC 1377. There was a significant increase in co-efficient of variation for height, number of primary branches and number of racemes per plant at all doses studied in NPH 1 (Table 2). In respect of length of main raceme, a reduction was found (except 70 kR) in that variety.

Swaminathan (1965) found decrease in the mean expression of quantitative traits in M_2, M_3 and M_4 in comparison with control, if no selection for fertility was made. If selection was applied the mean approached the normal. Gaul (1965) also showed variability in many polygenic traits in M_2. Decrease in the mean values in the irradiated population of the M_2 and M_3 was shown by different investgators (Gregory, 1956) in peanuts, (Swaminathan, 1963) in wheat and (Gaul, 1965) in barley. Borojeric (1965) showed that the decrease in means in irradiated material was followed by an increase in variability in M_2 and in subsequent generations. The variability was shown to be due to the increase in variation in the genetic components.

The polygenic variation induced in the present study is of considerable interest because the dwarf varieties utilised in irradiation was a spontaneous mutant (RC 1377) of mutant origin (NPH 1) by thermal neutron treatment. Even though only minor deviation in height could be observed in the mean values for the M_2 population under different doses, the range of variation shows that there are plants as tall as the progenitors (TMV 1 and HC 6) and as short as the parents (RC 1377 and NPH 1). Plants shorter than the two could also be noticed pointing clearly to the genetic changes in the polygenic

TABLE 2. Germination, survival and expression of attributes in M_2 of castor.

Material/ X-irradiation	Dose (kR)	Seed Germination (%)	Seedling survival (%)	Height		No. of primary branches		Length of main raceme		No. of racemes per plant	
				Mean (cm)	C.V. (%)	Mean	C V. (%)	Mean (cm)	C.V. (%)	Mean	C.V. (%)
R.C. 1377/Pollen	0	97.9	99.2	26.2	15.0	4.1	23.7	23.3	10.8	4.1	25.2
	2.5	94.0	99.3	25.8	33.5	3.9	45.0	26.8	31.0	4.2	51.6
	5.0	93.5	98.3	37.9	47.7	3.5	43.7	27.8	26.2	3.9	45.6
	7.5	92.5	98.9	31.0	39.7	3.9	42.7	24.0	30.5	4.2	44.5
NPH 1/Pollen	0	97.6	98.1	46.8	7.7	4.1	21.8	36.1	7.8	4.1	23.3
	2.5	92.1	98.2	48.6	29.0	5.4	43.4	32.9	26.4	5.3	54.6
	5.0	89.3	96.7	49.3	21.4	4.9	41.6	32.1	23.3	4.7	56.9
	7.5	86 8	94.2	41.1	27.2	5.0	40 4	28 8	25.6	4.5	44.1
RC 1377/Seeds	0	97.8	99.2	26.2	15.0	4.1	23.7	23.3	10.8	4.1	25.2
	30	88.8	98.2	35.2	28.9	4.3	48.9	27.9	28.8	4.1	54.8
	40	90.6	98.3	30.7	37.2	3.3	50.4	21 4	28.5	3.8	47.8
	50	87.5	99.0	49.3	49.0	4.2	64.4	28.7	36.6	2.7	69.4
	60	88.4	98.4	48.9	43.9	4.0	52.6	29.1	30.2	3.2	45.4
	70	86.7	98.4	41.5	25.3	3.9	48 8	24.8	32.4	4.0	52.2
NPH 1/Seeds	0	97.6	98.1	46.8	7.7	4.1	21.8	36.1	7.8	4.1	23.3
	30	82.2	97.4	52.9	25.8	5.8	44.4	33.3	21.9	4.5	49.3
	40	80.5	90.0	52.0	27.4	5.3	46.1	33.0	16.6	4.4	49.7
	50	72.5	96.6	57.2	20.7	7.0	39.0	33.9	22.1	5.0	60.2
	60	80.9	98 8	47.2	20.4	5.3	43.5	31.2	17.8	4.8	47.9
	70	86.0	98.1	54.4	27.3	5.8	46.4	36.5	20.6	6.3	60.0

system controlling the height. The situation was also similar in respect of the three important traits related to yield in castor namely number of racemes, length of main raceme and number of primary branches. The induced variation which is positive and transgresses higher limit of the range of the parental values, can be satisfactorily further canalized by selection towards the development of plants with shorter stature and better expression of attributes related to yield than found in the varieties, RC 1377 and NPH 1.

The doses employed in the present investigation cannot be considered as high enough as judged by the parameters employed in M_1 to estimate the sensitivity in the case of seed irradiation. It would be desirable, therefore, to study the effects at high doses with reference to mutation frequency that can be realised.

ACKNOWLEDGEMENT

The authors are thankful to the University of Madras for permitting to publish the M. Sc. (Ag) dissertation.

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