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Comparative effects of fast neutrons and gamma rays on dry seeds of castor *

by

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Synopsis: The comparative effects of fast neutrons and gamma rays on dry seeds of Castor (HC. 1) were studied in two generations in each case. Fast neutrons showed a linear stimulating effect with increasing dosage in germination, seedling survival and yield, whereas gamma rays showed non-linear effects for these characters.

Introduction: The study reported in this paper concerns the effects of fast neutrons and gamma rays on dry seeds of castor HC. 1 *(Ricinus communis* L.*)* expressed as percentage of germination, lethality seedling injury, chlorophyll changes, chromosomal abnormalities and yield. G1 and N1 refer to the gamma rays and fast neutron-irradiated first generations, and G2, N2 to the second generations respectively.

The various morphogenetic effects of fast neutrons on HC. 1 castor observed in the N1 generation were reported by Chandramouli *et al* (1961). The gamma-irradiated castor was studied during the period 1960—'62 (G1 and G2) and various effects produced by these radiations are compared.

Material and methods: Dry seeds of HC. 1 castor were irradiated with gamma rays from Cobalt^{60} during World Agricultural Fair in the American Pavilion, New Delhi (1960). The various doses of radiation applied were 2,500r, 5,000r, 7,500r, 10,000r and 15,000r. The irradiated seeds were sown on 20–7–1960. Spacing and cultural operations were similar to those adopted for neutron-irradiated material.

For meiotic studies anthers were tested by smearing in Propiono-carmine. Flower buds showing divisions were fixed in 1:3 acetic alcohol, which were then transferred to 70% alcohol for future use.

Observations: (1) *Germination and seedling survival:* Observations on germination and seedling survival are presented in table 1. As against general observation of reduction in the percentage of germination with increasing neutron doses (Caldecott *et al* 1954, 1955; Chandramouli *et al* 1961) a linear stimulating effect was observed in castor, with the increase in dose upto a certain degree. Gamma rays showed non-linear relationship with a slight stimulating effect on germination and survival. Murty *et al* (1962) found percentage of germination to be parallel at different doses of neutrons and gamma rays in the case of tobacco.

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* Received on 19—11—1962.

TABLE 1

Effects of fast neutrons and gamma rays on germination and seedling survival

Treatment	No. seeds sown	No. germinated	No. dead seedlings	Germination %	Survival %
Fast neutron (integrated flux Cn/Cm²/Sec.					
1. Control	78	12	...	15·4	100
2. $2{\cdot}5 \times 10^{12}$	78	25	...	32·0	100
3. 5×10^{12}	78	33	2	42·3	93
4. 1×10^{13}	78	25	3	32·0	88
5. 5×10^{13}	78	21	2	26·9	90·4
Gamma rays:—					
1. Control	30	18	...	60·0	100
2. 2,500r	30	18	3	60·0	83
3. 5,000r	30	17	5	56·6	70
4. 7,500r	30	20	3	66·6	85
5. 10,000r	30	22	8	73·3	63
6. 15,000r	30	20	5	66·3	75

(2) *Growth rate of the main shoot:* The height of the plant was measured at intervals of 30 days and 60 days after germination. The data are presented in table 2. From the table it can be noted that the neutrons had a stimulating effect on growth of castor, specially so during the period from 30 to 60 days whereas the stimulating effect of gamma rays was not marked at any growth period. On the whole gamma rays showed curvilinear effect on growth rate.

TABLE 2

Effects of fast neutrons and gamma rays on periodical heights of castor

Treatment	30 days		60 days		Final	
	height in inches	% of control	height in inches	% of control	height in inches	% of control
Fast neutrons integrated flux Cn/Cm²/Sec.						
1. Control	4·6	100	12·1	100	90·0	100
2. $2{\cdot}5 \times 10^{12}$	7·2	156·5	15·9	131·4	101·0	110·2
3. 5×10^{12}	6·7	145·5	15·1	124·7	93·5	103·8
4. 1×10^{13}	7·4	160·8	16·3	134·7	96·4	107·1
5. 5×10^{13}	4·5	97·8	10·6	87·6	84·8	94·2

TABLE 2 *(Contd.)*

Treatment	30 days		60 days		Final	
	height in inches	% of control	height in inches	% of control	height in inches	% of control
Gamma rays :—						
1. Control	3·4	100	15·6	100	47	100
2. 2,500r	3·6	105·9	16·5	107·26	44·1	93·5
3. 5,000r	2·5	73·5	15·0	97·5	39·5	83·74
4. 7,500r	3·1	91·14	16·0	104·0	36·4	77·17
5. 10,000r	2·2	64·68	11·5	74·25	32·2	68·26
6. 15,000r	2·7	79·38	13·6	88·4	41·5	87·98

(3) *Flowering and fruiting abnormalities :* The flowering and fruiting abnormalities produced by fast neutrons and gamma rays were almost similar, in presenting plants with spiny fruits, pistillate racemes, variation in fruit size, fruits with larger stigmas and fused stigmatic lobes etc. However, completely female plants did not come out in G1, N1 generations, but this character appeared in G2 and N2 generations only.

(4) *Yield and 100 seed weight :* From the data presented in table 3, it is seen that there was a slight increase in the yield with doses 2500r and 5000r, though the 100 seed weight was not much affected. The yield was high in treatment 2 and 4 in case of fast neutrons and the average seed weight did not vary markedly.

TABLE 3

Effects of fast neutrons and gamma rays on yield in N1 & G1

Treatment	No. of spikes per plant.		Yield of seed per plant.		100 seed weight in grams
	Mean	% over control	Mean	% over control	
Fast neutrons integrated flux Cn/Cm²/Sec.					
1. Control	5·6	100·(	110·1	100	31·6
2. $2·5 \times 10^{12}$	11·5	205·:	174·4	157·4	32·2
3. 5×10^{12}	7·4	132·:	117·7	106·8	31·2
4. 1×10^{13}	11·3	201·:	162·1	129·1	32·6
5. 5×10^{13}	5·6	100·(	20·4	18·5	30·0
Gamma rays :					
1. Control	5·0	100	24·7	100	31·0
2. 2,500r	6·0	120	30·1	121·8	30·7
3. 5,000r	6·0	120	29·64	120·0	30·4
4. 7,500r	4·2	84	22·0	89·0	30·5
5. 10,000r	3·6	72	18·5	74·7	30·6
6. 15,000r	5·0	100	24·7	100·0	30·4

(5) *Cytological observations:* Anaphase bridges, fragments and ring chromosomes were observed in meiotic cells of plants treated with both kinds of tradiations, but a few polyploid cells and binucleate cells also were observed in the case of those treated with fast neutrons.

(6) *Leaf characters:* The number of chlorotic leaves found were presented in table 4. The observations reveal that there were more number of chlorotic leaves in case of fast neutrons than gamma rays. This reveals that the fast neutrons are more harmful to the plant than gamma rays.

TABLE 4

Frequencies of N1 and G1 progenies showing chlorophyll changes

Type of change	Fast neutrons		Gamma rays	
	Number	% in 312 plants	Number	% in 180 plants
Chlorotic leaves	23	7·0	7	3·0
Sectorial chlorotic	2	0·5	4	2·0
Reduced leaves	1	0·3	1	0·5

Effects in N2 and G2 generations: The frequencies of various morphological changes occurred were presented in table 5. Plants with combinations of various stem colours and fruit characters were found. However, the number of such combinations was more in the effects caused by fast neutrons.

TABLE 5

Frequencies of N2 and G2 progenies with specific types of morphological changes

Type of change	Gamma rays		Fast neutrons	
	Number	% based on 561	Number	% based on 6228
1. Red stem & spiny fruits	34	6·0	313	5·0
2. Red stem & non-spiny fruits	10	1·7	254	4·08
3. Green stem & spiny fruits	11	1·9	162	2·6
4. % female plants	2	0·35	10	0·1

Discussion: The occurrence of the anaphase bridges and fragments during the first mitotic and meiotic cycle after seed germination is an index of the relative biological effect of radiation on the seed. These aberrations are the direct results of the breaks and reunions in the chromosomes. This is in agreement with observations made by various workers (Caldecott *et al* 1954, Sparrow and Konzak 1958).

Paul *et al* (1957) reported the non-linear relationship of the fragment frequency with X-Ray dosage in the case of tomato, and that the thermal neutron had more profound effect than X-Rays. The occurrence of more number of chlorotic leaves in case of fast neutrons on castor reveals its profound effects when compared to gamma rays.

Sparrow *et al* reported a linear relationship of gamma rays upto 2500r. However, the results of this study showed a linear relationship in the case of fast neutrons and non-linear relationship with gamma rays from the lowest to the highest dose administered.

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REFERENCES

Caldecott, R. S., B. N. Beard, and C.O. Gardner — 1954 Cytogenetic effects of X-rays and thermal neutron irradiation on the seeds of barley. *Genetics.*, **39**: 240—59.

Chandramouli, N. Ganga Prasad Rao, B. V. Ramana Rao and H. A. Razvi — 1962 Fast neutron induced morphogenetic effects in Castor. *Indian Oilseeds J.*, **5**: 98—105.

Jayaprakashnarayan, R. K. — —— *Effects of Fast neutrons on Castor M_2, M_3 generations*, M.Sc. Thesis of Osmania University.

Murty, G. S. and K. V. Krishnamurty — 1962 Studies on the germination of tobacco seeds irradiated by neutrons and gamma rays. *Sci. & Cult.*, **28**.

Paul Yagyu, Rosalind Morris. — 1957 Cytogenetic effects of X-rays and thermal neutrons on dormant tomato seeds. *Genetics* **42**: 222—38.

Sparrow, A. H. and C. F. Konzak — 1958 *The use of ionising radiation in plant breeding accomplishments and prospects.* Camellia culture. The Macmillan Co., 425—52.

Sparrow, A. H. and J. E. Gunkel — —— The effects on plants of chronic exposure to gamma radiation from radiocobalt. *Proceedings of the Radio active Isotopes and Ionizing radiation in Agriculture, physiology and Biochemistry.* Vol. 12, 52—59