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Mutagenic Effectiveness and Efficiency in *Cajanus cajan* (L) Mill sp.*

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In a study of induced mutagenesis with two varieties of *Cajanus cajan*, the effectiveness and efficiency of two mutagens were estimated. Gamma rays were found to be more effective than DES in inducing both chlorophyll and viable mutations. Gamma rays were more efficient than DES in inducing chlorophyll and viable mutants when estimated on the basis of lethality in SA-1. DES was more efficient than gamma rays in both the varieties when estimated on injury basis in inducing viable and chlorophyll mutants.

Konzak *et. al.* (1965) put forward the concept of mutagenic effectiveness and efficiency. They proposed the term "effectiveness" as a measure of gene mutations in relation to dose and efficiency" as an estimate of the mutation rate in relation to other biological effects induced, such as lethality, injury and sterility. In the present experiment redgram, an important pulse crop was taken to study the effectiveness and efficiency of two mutagens namely gamma rays and Diethyl sulphate.

MATERIAL AND METHODS

To redgram(*Cajanus cajan*) varieties SA. 1 and CO. 2 formed the material for the study. Gamma irradiation was carried out using a ^{60}Co Gamma cell with the doses of 1. 5, 10, 15' 20, 25, 30 and 40 krad. Treatments with chemical mutagen (Diethyl sulphate) were performed by keeping the pre-water soaked seeds immersed for 6 hours in the concentration of 3. 6, 9, 12 and 15 mM of DES with intermittent shaking. After mutagenic treatments M_1 generation was raised. The M_2 generation was raised as individual M_1 plant and M_1 branch progency bases. The frequency of chlorophyll and viable mutations per 100 M_1 branches were estimated. The survival reduction and height reduction percentages of all M_2 seedlings on the 30th day after sowing were recorded. The seed sterility percentage of all M_2 population was also worked out. The effectiveness and efficiency of mutagens in inducing chlorophyll and viable mutations were estimated adopting the formula suggested by Konzak *et al.* (1965).

RESULTS AND DISCUSSION

i) EFFECTIVENESS

In the variety SA. 1. the effectiveness ranged from 26.3 to 942.0 and 13.2 to 628.0 for chlorophyll and viable mutations respectively for various doses of gamma rays. The effectiveness for both chlorophyll and viable mutations

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decreased as the doses of gamma rays increased. In treatment with DES, the effectiveness was high at 3 mM for chlorophyll mutations and at 6 mM for viable mutations and it decreased for both the mutations at higher doses (Table 1). In CO. 2, the effectiveness after gamma irradiation ranged from 41.7 to 1016 0 and 19.2 to 664.0 for chlorophyll and viable mutations respectively. The effectiveness decreased as the doses of gamma rays increased for both chlorophyll and viable mutations. In treatment with DES, the effectiveness for chlorophyll mutations decreased with increase in doses For viable mutations the effectiveness was maximum at 9 mM (Table 2).

The usefulness of any mutagen depends upon the mutagenic effectiveness. In both the varieties gamma rays were found to be more effective in inducing both chlorophyll and viable mutations. High effectiveness of gamma rays over EMS was reported by Sundram (1974) in redgram and Vindhiya Varman *et al.* (1980) in *Vigna marina*. In the present study, the effectiveness in inducing chlorophyll and viable mutations was found to decrease with increasing doses of mutagens. This inverse relationship observed herein could be explained as due to the failure of mutations to increase proportionately with increase in doses of mutagens.

ii) EFFICIENCY

In SA. 1. the efficiency in terms of chlorophyll mutations was the highest at 1 krad on lethality, at 20 krad on injury and at 15 krad on sterility bases. For viable mutations, the efficiency was maximum at 1, krad on lethality, at 10 krad on injury and at 15 krad on sterility bases after gamma irradiation. Maximum etficiency for chlorophyll mutations was observed at 3 mM on lethality and injury bases and 3mM on sterility basis. In respect of viable mutations, the efficiency was high at 9mM of DES on lethality and at 3mM on injury and sterility bases (Table 1). In the variety CO. 2, the efficiency for chlorophyll mutations was the highest at 5 krad on lethality. at 1 krad on injury and at 10 krad on sterility bases. In terms of viable mutations, the efficiency was maximum at 15 krad on lethality. at 1 krad on injury and at 20 krad on sterility bases. In treatments with DES, the efficiency in terms of chlorophyll mutations was the highest at 6 mM on lethality and sterility bases and at 3 mM on injury basis. In respect of viable mutations the efficiency was high at 9mM on lethality and sterility bases and at 3mM on injury basis (Table 2).

Gamma rays were more efficient than DES in inducing chlorophyll and viable mutants when estimated on the basis of lethality in SA. 1, while for inducing viable mutants only gamma rays were efficient on the basis of lethality and sterility in CO. 2. DES was more efficient than gamma rays inboth the varieties when estimated on injury basis in inducing viable and chlorophyll mutants, whereas on the basis of lethality in CO. 2 and sterility in SA. 1 in inducing chlorophyll mutations. Thus the results of the study show that the efficiency of mutagen varied with varieties. Similar results were observed by Muthiah (1975) in sesame. Amoung the

varieties, SA.1 responded better, in general, with higher efficiency values than CO. 2 In general, mutagenic efficiency for radiation and chemical mutagen were high at low and middle doses. This is in accordance with the results of Rajasekaran (1973) in blackgram. The greater efficiency of low doses of mutagens appeared to result from the fact that injury, lethality and sterility tended to increase with increase in dosage of the mutagen at faster rates than mutations themselves (Konzak *et al.*, 1965).

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TABLE 1 Effectivsness and Efficiency

SA. 1

Mutagen and dose	Effectiveness M×100 / te or krad		Efficiency					
			M×100 L		M×100 I		M×100 S	
	Chlorophyll mutations	Viable mutations	Chlorophyll mutations	Viable mutations	Chlorophyll mutations	Viable mutations	Chlorophyll mutations	Viable mutations
Gamma rays (krad)								
1	942.0	628.0	111.4	74.2	81.9	54.6	114.2	76.1
5	395.4	209.4	65.9	35.0	131.6	69.7	139.4	73.8
10	160.8	118.3	48.2	35.5	139.8	102.9	223.3	164.3
15	117.1	88.9	45.7	34.7	119.5	90.7	234.0	177.6
20	78.3	47.9	26.9	16.4	158.1	96.7	104.9	64.1
25	44.4	44.4	15.6	15.6	58.9	58.9	82.7	82.7
30	41.7	27.8	14.2	9 5	122.2	81.4	62.1	34.7
40	26.3	13.2	11.6	5.8	45.8	22.9	52.9	26 5
II. DES (mM)								
3	123.7	29.4	87.2	20.2	824.8	95.9	385.2	16.3
6	46.9	32.1	33.0	23.1	82.7	57.9	84.6	59.2
9	49.8	26.7	45.7	24.5	83.7	44 8	208.5	111.7
12	30.1	12 9	35.2	15.1	62.1	26.6	141.8	60.8
15	–	3.5	–	3.5	–	8.5	–	9.7

TABLE 2 Effectiveness and Efficiency
CO. 2

Mutagen and dose	Effectiveness M×100 / t or krad: Chlorophyll mutations	Effectiveness M×100 / t or krad: Viable mutations	Efficiency M×100 / L: Chlorophyll mutations	Efficiency M×100 / L: Viable mutations	Efficiency M×100 / I: Chlorophyll mutations	Efficiency M×100 / I: Viable mutations	Efficiency M×100 / S: Chlorophyll mutations	Efficiency M×100 / S: Viable mutations
1. Gamma rays (krad)								
1	1018.0	664.0	54.2	35.4	174.2	113.9	97.7	63.9
5	381.6	168 0	81.6	36.9	173.5	76.4	109.3	48.1
10	163.9	120.2	46.7	34.2	73.5	54.6	202.1	148.2
15	157 3	112.3	63.0	45.0	87.8	62.7	119.5	85.3
20	68.8	91:8	22.3	29.7	43.0	57.3	161.5	215.4
25	46.0	32.2	17.7	12 4	30.9	21.6	68.2	47.8
30	57 7	19.2	20.9	7.0	44.2	14.7	109.6	36.5
40	41.7	–	18.3	–	40.6	–	58.5	–
DES (mM)								
3	69.5	16.8	76.5	18 5	718.4	173 6	94.6	22 8
6	68.6	14.1	98.4	20 1	207.3	42.5	148.1	30.3
9	38.1	18.4	46.8	22.0	76·0	36.7	108.3	55.3
12	27.8	5.2	30.7	5 8	62.0	11.6	71.1	13.3
15	23.0	–	24 0	–	54.3	–	59.8	–