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GIBBERELLIC ACID EFFECT ON THE GROWTH OF *PHASEOLUS VULGARIS* L PLANTLETS FROM GAMMA IRRADIATED SEEDS

EFEITOS DO ÁCIDO GIBERÉLICO SOBRE O CRESCIMENTO DE PLÂNTULAS DE *PHASEOLUS VULGARIS L* DESENVOLVIDAS A PARTIR DE SEMENTES IRRADIADAS COM RAIOS GAMA

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SUMMARY - Seeds of *Phaseolus vulgaris* L cv bico-de-ouro were irradiated with gamma-ray doses ranging from 1.2 kR to 80 kR. The seeds were soaked during 48 hours at 27° C in water or in a 10 mg/1 solution of gibberellic acid (GA_3). The plantlets were harvested 5 days after planting and their hypocotil and epicotyl length were measured. The growth of these structures was significantly increased after GA_3 treatment. It is concluded that post-irradiation GA_3 treatments show modulatory effects reducing the severity of the radiation-induced growth inhibitions to the plantlets.

RESUMO - Sementes de *Phaseolus vulgaris* L cv bico-de-ouro foram irradiadas com raios gama nas doses 1,2 kR atè 80 kR. Em seguida foram colocadas para germinar, durante 48 horas, a 27° C, em água ou em uma solucão de 10 mg/1 de ácido giberélico (AG_3). Decorridos 5 dias após o plantio das sementes germinadas mediu-se o comprimento do hipocótilo e do epicótilo. O tratamento com AG_3 promoveu, de modo estatisticamente significativo, o crescimento destes órgãos. O tratamento com AG_3 demonstrou características modulatórias, reduzindo a inibição do crescimento das plântulas provenientes das sementes irradiadas.

INTRODUCTION

The responses to ionizing radiation can be modified by several post-irradiation tratments (Klein and Klein 1971). These treatments can result in a decrease or an augmentation of the severity of injury (Latarjet and Gray 1954). The study of the conditions which ultimately lead to decreases of the radiation-induced damage to biological systems is of surmount importance. Under the host of treatments and agents that can induce post-irradiation modulations the growth substances have been enlisted. As to the auxins there is a large body of evidence that their commitment represent an important step in the development of the ionizing-radiation effects on plants (Gordon and Buess 1973). Some results showing that cytokinins might be involved in the growth-inhibition of irradiated tissue cultures were presented also (Jonard and Bayonove 1976).

Post-irradiation modulation of the growth-capacity of radiation stunted maize seedlings (Gaur and Notani 1960), wheat seedlings (Haber and Luippold 1960) and pinto bean plants (Lockhart 1961) by gibberellic acid tretments have been reported.

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The characteristic response of *Phaseolus vulgaris* plantlets to gibberellic acid treatments (Feucht and Watson 1958, Greülach and Haeslop 1958) associated to its high radiation-sensitivity when grown in darkness (Hell and Silveira 1976) make this material suitable to further investigate the role of gibberellic acid on irradiated seedlings.

MATERIALS AND METHODS

Seeds of *Phaseolus vulgaris* L cv bico-de-ouro of a single batch and with 13 percent humidity were used. The seeds were irradiated with gamma rays from a ^{137}Cs source at a dose rate of 1700 roentgens per hour. The seeds were subsequently sterilized and germinated at 27º C in plastic boxes on humid filter paper, or on filter paper soaked in a gibberellic acid (GA_3) solution at a concentration of 10 mg per liter. After 48 hours the seeds which showed radicles with the same lenght were selected and transferred to plastic boxes on humid vermiculite.

The plantlets were grown in a dark-room at 27 ± 2º C and harvested 5 days after planting. Each treatment consisted of 50 plants. Their hypocotyl and epicotyl lengths were measured. Pairs of observations for each treatment were carried out. Nonparametric statistics (Median test for two samples) were adopted due to the absence of normal distribution of the analyzed parameters mainly at the high doses of radiation (Dixon and Massey 1969).

RESULTS

Table 1 shows the median length of the hypocotyl together with the values of the nonparametric X^2 median test. The comparison of the treatment A (non-irradiated seeds germinated in water) with the treatment B (gamma irradiated seeds germinated in water) shows that no growth inhibition was detectable at the 1.2, 2.5, and 10 kR doses. At the 5 kR dose the median of the hypocotyl length of the irradiated plants was significantly higher than the median of the non-irradiated control plants. Growth

TABLE 1 – Median and nonparametric X^2 test (P 0.05 = 3.84) of hypocotyl lenghts of 5 days old plantlets.

Gamma-ray Doses (kR)	Median (cm)			X^2 values	
	A*	B**	C***	A x B	B x C
1.2	21.7	21.5	25.5	0.03	30.44
2.5	21.7	22.5	25.2	0.45	16.02
5.0	22.0	23.2	25.5	4.66	17.74
10.0	25.5	25.7	28.5	0.04	10.29
20.0	25.0	22.2	25.5	11.80	12.20
40.0	23.0	4.7	8.0	95.04	36.01
80.0	23.5	2.5	4.0	95.04	56.76

* Non-irradiated seeds, germinated with water (A)
** Gamma-irradiated seeds, germinated with water (B)
*** Gama-irradiated seeds, germinated in 10 mg/1 GA_3 (C)

inhibition was detectable only at the 20 kR and higher doses. The effect of the gibberellic acid on the growth of the irradiated plantlets was assessed comparing the growth of water germinated seeds (B) with that of the seeds that were imbibed in the GA_3 solution (C). The hypocotyl median values of the irradiated material supplied with exogenous GA_3 were significantly higher than those of the irradiated and water soaked seeds. The lenght of the epicotyls (Table 2) of the plants irradiated with the doses of 1.2, 2.5, and 5.0 kR (B) did not differ significantly from those of the control plants (A). At the doses of 10, 20 and 40 kR the growth inhibition was clearly defined and at 80 kR the epicotyls degenerated completely. As in the case of the hypocotyl the irradiated and GA_3 soaked seeds (C) originated plants with larger epicotyls than the irradiated and water soaked seeds (B).

TABLE 2 – Median and nonparametric X^2 test (P 0.05 = 3.84) of epicotyl lenghts of 5 days old plantlets.

Gamma-ray Doses (kR)	Median (cm)			X^2 values	
	A*	B**	C***	A x B	B x C
1.2	0.7	0.5	2.7	1.35	67.09
2.5	1.0	1.0	5.0	0.19	60.45
5.0	0.7	0.8	2.7	1.69	54.02
10.0	2.5	2.0	5.0	5.21	24.20
20.0	1.5	1.0	3.5	4.53	33.36
40.0	1.0	0.2	1.5	89.98	84.12

* Non-irradiated seeds, germinated with water (A)
** Gamma-irradiated seeds, germinated with water (B)
*** Gama-irradiated seeds, germinated in 10 mg/l GA_3 (C)

DISCUSSION

The plantlets grown from irradiated and water soaked seeds became evidently stunted at the doses of 10 kR for the epicotyl and 20 kR for the hypocotyl. These results are in accordance with those described by Quastler and Baer (1948) for *Phaseolus aureus*. Nevertheless it has to be pointed out that the extent of the growth inhibition of the *P. vulgaris* cv bico-de-ouro plantlets grown from irradiated seeds varies during their germination and early growth (Hell and Silveira 1976). The absence of measurable inhibitory effects on the 5 days old plants at the doses ranging from 1.2 to 5.0 kR for the epicotyl and from 1.2 to 10 kR for the hypocotyl, simulating a threshold level for the growth-inhibitory effects, might be considered as due to auto-restoring processes acting during the early growth of the irradiated plants (Klein and Klein 1971). The higher values ($p<0.05$) of the hypocotyl length recorded for the plants grown from the 5 kR irradiated seeds might be considered as resulting from radiation induced growth stimulatory process acting during the early growth of these plants (Sax 1963). This effect has been previously described for the same (Hell and Silveira 1974, 1976) and also for different materials (Hell and Ludewigs 1975), irradiated with the same or with different doses of gamma-radiation.

Soaking the irradiated seeds in GA_3 solution resulted in a striking decrease in the growth-inhibitory effect of the gamma-radiation even at very high doses of radiation. These results showed that the irradiated seedlings did not loose their ability to respond to this growth promoting substance. Although gibberellic acid was supplied to the irradiated seeds during the first 48 hours of imbibition the results were similar to those described by Lockhart (1961) after applying drops of gibberellic acid to the leaves of irradiated pinto bean plants.

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