The Effect of Continuous Gamma Irradiation on the Growth Hormone Content of Green Plants[1]

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INTRODUCTION

As early as 1935, Skoog (4) showed that both native auxin preparations and pure IAA in solution were highly labile when exposed to X-radiation. Moreover, when plant tissues were exposed to moderate doses there was a reduction in auxin levels, showing a radiosensitivity both *in vitro* and *in vivo*. This sensitivity of auxin to irradiation has been confirmed by Gordon and Weber (2) who have also shown that one of the major loci of the radiosensitivity lies in the lability of the enzyme controlling the conversion of indoleacetaldehyde to indoleacetic acid (6). Recently these same workers (3) reported that the lowering of auxin levels in plants exposed to low doses of ionizing radiation cannot be explained on the basis of a direct auxin photolysis, and that the causes of this initial decrease in auxin must therefore be looked for elsewhere. The results reported in this paper show that the changes in auxin level following exposure to continuous gama irradiation depend upon the dosage of irradiation received.

METHODS

The effect of continuous irradiation was studied by growing the experimental plants (*Calendula, Nicotiana, Cosmos, and Xanthium*) near a constant source of gamma rays. This source consisted of a 300-curie radiocobalt slug suspended in a stainless-steel pipe placed in the center of a large cultivated field (5). The plants were grown in concentric circles around this source and the dosage level was regulated by the distance of the plants from the source. The plants were irradiated continuously, except for short periods of time during the day when it was necessary to enter the gamma field to collect material. The gamma irradiation at various distances in the field were measured by Victoreen r-meter cobalt chambers. After the plants had grown in the gamma field for approximately one month, they were sampled for auxin analysis. In all cases, except *Xanthium*, the leaves were removed and the main veins were separated from the rest of the leaf blade. The interveinal tissue was then rapidly dried in a force-draft oven at 70°C and extracted overnight at 0°C with peroxide-free ether. The extract was then assayed for auxin activity by the standard Avena assay method. In the case of *Xanthium*, the top 6 inches of the stem was used for analysis. In all analyses identical tissues were used from the plants grown at the various dosage levels, even though irradiation may have brought about considerable changes in the morphological appearance of the plants.

RESULTS AND DISCUSSION

Four different species of plants, *Calendula, Nicotiana, Cosmos*, and *Xanthium* were grown in the gamma field at various dosages and then analyzed for growth hormone content. The results of these analyses are shown in Table I. While the results of single analyses are shown in this table, similar analyses made at other times gave approximately the same results. The plants grown 40 meters from the source were normal in appearance and may be considered as control plants with a normal auxin content. Those plants growing closer to the source and receiving a greater daily dosage of gamma irradiation showed a decreasing auxin content with increasing dosage of irradiation. This decrease in auxin with increasing dosage continued until a certain level was reached at which time further increases in dosage of irradiation resulted in an increase in auxin

[1] This work was carried out at Brookhaven National Laboratory, Upton, N. Y. while the author was research collaborator.

content. The level of irradiation resulting in the minimum auxin content varied with the plant species. In general, this minimum auxin was reached at lower dosage levels with those plants most sensitive to irradiation, *Nicotiana* being the most sensitive plant used in this study.

The decrease in auxin with increasing dosage of gamma irradiation may easily be accounted for by the previous work by Skoog and Gordon and Weber. However, the increasing auxin content with the higher dosages of irradiation is dificult to explain. Cooke (1) showed an increase in ascorbic acid content following irradiation, the greatest increases occurring with the highest dosages used. It has been shown that with low dosages of irradiation there is an interference with the enzymatic systhesis of indoleacetic acid. With high dosages of irradiation it may be possible that the enzyme systems responsible for the destruction of IAA in the plant are inhibited and consequently an apparent increase in auxin results.

TABLE I

Effect of continuous gama irradiation on the free auxin content of four different species of plants as measured by the standard Avena assay.

Distance from source in meters	Dosage in r/day	*Degrees curvature of Avena*			
		Calendula	Nicotiana	Cosmos	Xanthium
3	755	10.8	9.1	.....	7.2
4	460	5.6	.....	.....	3.4
5	300	3.3	14.7	9.6	10.5
6	213	3.0	8.7	4.7	9.7
7	156	.....	4.4	5.9	9.1
10	77	8.2	6.1	9.3	.....
14	39	15.4	6.0	.....	12.2
20	19	16.1	7.3	.....	.....
40	4	16.0	11.2	10.1	.....
No of days of irradiation:		19	28	57	38

LITERATURE CITED

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