HISTOLOGICAL ANALYSIS OF THE BUDS OF POTATO TUBERS TREATED WITH GAMMA RADIATIONS TO INHIBIT SPROUTING

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The present investigation showed that gamma radiations brought about degenerative changes in the buds and leaves buttresses of potato tubers, the effective doses being 6,8 and 10 Krads. This degenerative effect was dependent upon the storage time. No such effect was observed immediately after irradiation and after 30 days of storage. After 90 days of post-irradiation storage, tunica was found to be intact while corpus destroyed and at 150 days of storage all the tissues had degenerated and were homogeneous. The procambium did not retain its distinctivity. This degeneration of buds might be one of the possible causes of sprout inhibition in potatoes by the gamma radiation treatment.

Introduction

Gamma radiations have been found to inhibit sprouting in potatoes.[1–6] This inhibition was attributed by Rubin and Metlitsky[7] to the malfunctioning of meristimatic nucleic acids. They also reported that after treatment with gamma radiations the boundary between tunica and corpus disappeared, while a part of procambium retained its distinct shape. Errington and MacQueen [8] have also reported similar results on the degenerative effect of these rays.

This study was undertaken to analyse in detail the histological changes occurring at various times of the storage period, in the meristimatic tissue of the irradiated tubers for ascertaining the cause of sprout inhibition.

Materials and Methods

Ultimus (Holland) variety of potato tubers was selected for this investigation. The tubers were irradiated with doses of 2,4,6,8 and 10 Krads of gamma irradiation in a Gamma cell-220 [9] at a dose rate of 600,000 rads per hour. The controls or non-irradiated tubers were kept under similar conditions of storage, temperature (83°F) and humidity (69 percent). Three tubers were selected from each treatment at random and then 4 to 6 eyes were taken out from each tuber for further studies. The eyes were thoroughly washed in water to remove starch and then fixed in Nawaschin's fixative for 24 hours. After fixation air was exhausted by a vacuum pump and the eyes were washed with water to remove the fixative. The Usual alcohol-xylol procedure was followed for dehydration and clearing. Paraffin wax (m.p. 58°C) was used for embedding purposes.

Sections were cut in longitudinal plane at a thickness of 10 micron. Safranin-Fast green combination was used for staining. Photomicrographs were taken by Leitz orthomat automatic camera.

Results

The results of this investigation are presented in Figs. 1 to 5.

(a) *Structure of a Normal Bud.* (Fig. 1).—The longitudinal sections of control or untreated buds showed the normal structure. The tunica consisted of a single layer of thin-walled cells, containing undifferentiated protoplasm with numerous vacuoles of extremely small size. The nuclei were round with densely stained nucleoli. The corpus was of many-celled thickness varying from isodiametric to polygonal in outline. Differentiation within the corpus cells was also observed. These cells contain large vacuoles and round nuclei. Beneath the corpus the procambial cells were seen as elongated in shape and containing somewhat elongated nuclei and densely stained cytoplasm. Leaf initiations were also observed. Mature leaves were also seen coming out of the side of the dome-like apical meristem and overarching it.

(b) *Structure of Buds Immediately after Irradiation.*—The buds studied immediately after irradiation with 2 to 10 Krads dose did not show any degeneration or structural abnormality. The structure was like that of the control.

(c) *Structure after 30 Days.*—The internal structure of the buds taken from the tubers irradiated either with 2 or 4 Krads doses showed no change when compared with that of the control. On the other

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hand the buds taken from the tubers treated with 6 to 10 Krads doses showed slight structural damage in the region of leaf buttresses. Degeneration in the cells of the mature leaves was also observed. However, the apical meristem was intact with normal tunica and corpus configuration.

(d) *Structure after* 90 *Days* (Fig. 2).—Radiation damage occurred in the corpus region of the apical meristem and also in the leaf buds of the tubers treated with doses from 6 to 10 Krads. The tunica layer was intact. Such radiation damage did not occur in the buds of the tubers treated with either 2 or 4 Krads doses. The nuclei appeared as clots located by the side of the cell wall.

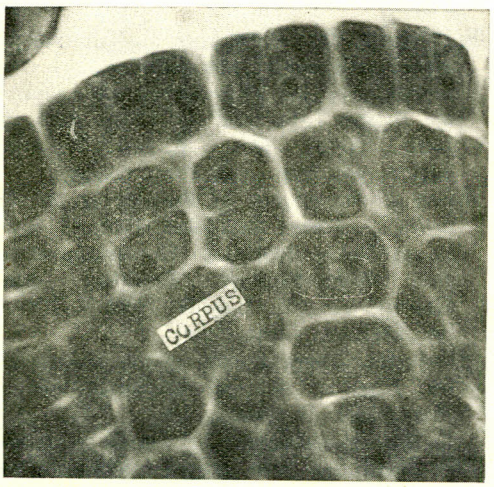

Fig. 1.—Structure of a control bud, under oil immersion showing tunica and corpus cells.

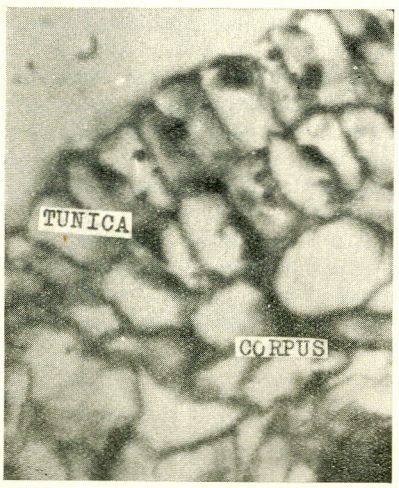

Fig. 2.—Structure of a bud after treatment with 10 Krads dose, showing intact tunica and degenerated corpus at 90 days of storage.

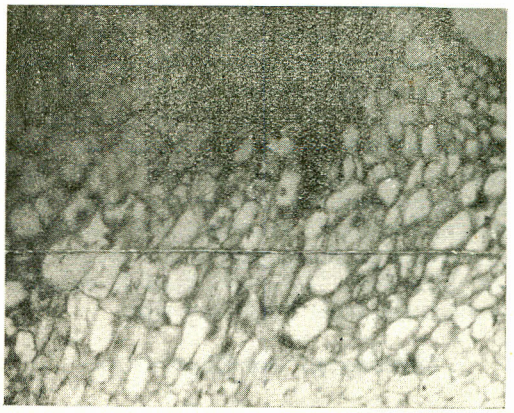

Fig. 3.—Structure of a bud after treatment with 6 Krads dose, showing a dried apex at 150 days of storage.

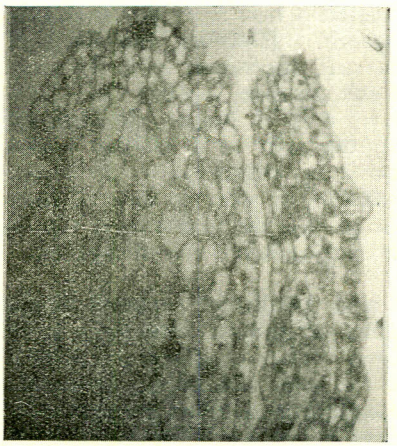

Fig. 4.—Structure of a bud after treatment with an 8 Krads dose, showing disfigured tissues at 150 days of storage.

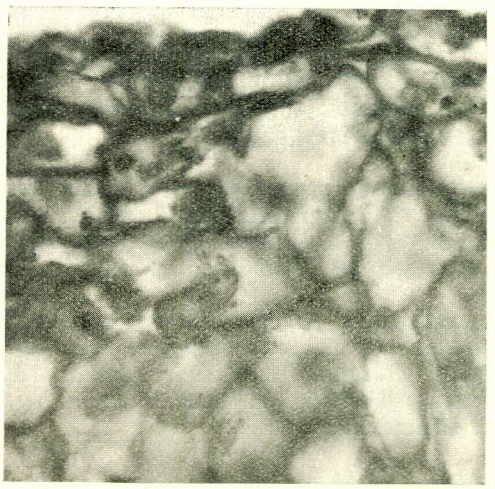

Fig. 5.—Structure of a bud after treatment with 10 Krads dose, showing the details of tunica and corpus degenerated cells under oil immersion, at 150 days' storage.

(e) *Structure after* 150 *days.* (Figs. 3 to 5.).—The buds of the tubers irradiated with 6 to 10 Krads were completely degenerated; no differentiation was observed between tunica corpus and procambial cells. The tip of the growing buds became shrivelled and dried; visible as a dark structure in the centre of the bud. The tunica was not intact and the cells of the corpus region showed degeneration. Irregular pattern of growth was observable in this region of the corpus. The cells of these three layers lost their heterogeneity and were of the same shape and size.

Discussion and Conclusion

Radiation damage occurred in the buds taken from the tubers treated with 6 to 10 Krads dose. This demonstrated the utility of the gamma radiations for the degeneration of buds. The irradiation prevented a bud from developing into a full fledged sprout. However, the effect of gamma radiations was dependent upon the storage time. This was evident from the fact that the radiations at a dose of 6 to 10 Krads, although effective in destroying the cells at a storage period of 150 days, showed no degenerative effect immediately after irradiation or after 30 days of storage. On storage for 90 days the tunica layer was still intact, while the corpus layer was disfigured.

Rubin and Metlitsky[7] reported similar results on the effect of gamma radiations in relation to storage time. They observed complete degeneration after 120 days with the exception that a part of the procambium retained its distinct cell shape. In present studies no such distinctivity of the procambium was observed.

It has been demonstrated[5] that the irradiation doses of 6 to 10 Krads are optimum for sprout inhibition. Since at these doses complete degeneration of the buds was observed, it can be concluded that this degeneration due to gamma radiations treatment might be one of the possible causes of sprout inhibition.

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