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GIBBERELLIN IN THE INDUCTION OF PARTHENOCARPY
IN ZEPHYRANTHES

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Although fruit setting is known to be an auxin controlled phenomenon, not all plants can be made to produce parthenocarpic fruits by the artificial application of growth substances like IAA and other synthetic compounds (1, 2, 4). This has no doubt kept up the interest of the physiologist in discovering new chemicals concerned with fruit set.

Recently, Wittwer and his coworkers (8) have reported that gibberellins are remarkably efficient in producing parthenocarpy when applied to the floral parts of tomato. Preliminary trials with the unpollinated ovaries of cucumbers and egg plant have also yielded a similar response (6, 7). In the present investigation evidence is presented for the induction of parthenocarpy by gibberelin in a member of the Amaryllidaceae, Zephyranthes. In addition, the development of seeds lacking embryos within these parthenocarpic fruits is also reported.

1 Received September 2, 1958.
2 The bulbs of Zephyranthes were obtained from Calcutta Botanical Gardens.
3 The plant has been tentatively identified as Zephyranthes x Lancastri Traub by Dr. H. P. Traub, of La Jolla, California.

METHODS

Zephyranthes, grown in the Varsity Botanic Garden, was selected for experimentation. The flower buds were emasculated and bagged 1 day preceding anthesis. The treatment was carried out the following day.

A hypodermic syringe was used to inject 0.5 ml of an aqueous solution of the chemical being tested into each ovary. Ten ovaries were used for each treatment. Since the ovary was unable to accommodate all of the treatment solution, a good portion of it was injected inside the hollow peduncle. Unpollinated controls and normally pollinated ovaries were also grown simultaneously.

A freshly prepared aqueous solution of gibberelin was employed. The gibberelin was obtained through the courtesy of Dr. L. G. Nickell, Chas. Pfizer & Co. Kinetic and IAA were dissolved in water with the aid of a few drops of HCl and NH4OH respectively. Observations were recorded every 2 days until the fruits were completely ripe (2 weeks). The circumference of the fruit was used as an index of growth.
RESULTS AND DISCUSSION

The unpollinated controls shrivelled on the 4th day after emasculation (fig 1), thus establishing the absence of natural parthenocarpy. Unpollinated ovaries, treated with indoleacetic acid, produced parthenocarpic fruits, but these were smaller than naturally pollinated fruits and their shapes were also different (fig 2A and B). The 3 locules appeared flaccid and the fruits had a more elongated outline. This was due to the absence of fully grown seeds within (fig 3A and B). Only the fruit wall exhibited a positive response. The partition walls of the locules, instead of remaining thin as in controls, became swollen (fig 3B). The behavior of the perianth tube also deserves mention. In pollinated ovaries it shrivelled and abscissed on the 4th day. In the treated ovaries it persisted throughout, turning dark green towards the base. There was also a prominent swelling at the junction of the pedicel and the peduncle and the latter became considerably swollen and curved. While the naturally maturing fruits dehisce 16 days after pollination, the IAA-treated fruits failed to open. Kinetin (10 and 50 ppm) had no stimulatory effect on the fruit wall or the seeds and both became attenuated as in the unpollinated controls.

Mixtures of kinetin and IAA were tested to determine if they had any synergistic action. However, only seedless fruits with thickened walls appeared (figs 2C, 3A and B), indicating that kinetin was not active in fruit setting either alone or in the presence of IAA (fig 1).
Gibberellin induced fruit set over a wide range of concentrations (1 to 1000 ppm). In all the gibberellin-treated sets the fruit size was greater than that in the pollinated controls (fig 1). At concentrations lower than 500 ppm the size remained more or less constant, the largest fruits having been obtained with a concentration of 500 ppm (figs 1, 2 D to F). Higher concentrations (1000 ppm) gave no further increase in the size of the fruit.

Fig. 3 A. Top view of mature fruits (2 weeks old). From left to right: naturally pollinated, treated with IAA (500 ppm), IAA + kinetin (500 + 10 ppm) and gibberellin (500 ppm). B. Same in cross section. The seeds in gibberellin-treated fruits are larger than pollinated controls. × 0.78.

The growth behavior during fruit development was similar to that in the pollinated controls (figs 3 A, B). There were no malformations of the vegetative parts and the treated fruits were practically indistinguishable from the normally pollinated ones except for their larger size. The gibberellin-treated fruits produced a greater number of seeds (fig 3 B) than the naturally pollinated ovaries. The smaller number of seeds in the naturally pollinated ovaries is due to a high degree of seed abortion (approximately 28 to 30 ovules out of 75 to 80 develop into seeds) whereas in the treated ovaries, almost all the ovules developed into seeds. The size of these seeds was also larger than those from naturally pollinated fruits (10 : 8 mm). However, dissections of seeds from the treated fruits showed no embryos.

Tomato is the only other plant extensively studied for its parthenocarpic response to gibberellin. However, it is not mentioned whether the parthenocarpic fruits were larger than or even as large as the naturally pollinated fruits (5, 8). Recently, Persson and Rappaport (3) induced fruit setting with gibberrellin in a male-sterile tomato by spraying the foliage and also by soil application. This, according to them, indicated that, like auxin, gibberellin is also able to produce physiological effects remote from the site of treatment. Our observations are in conformity with the above findings, since most of the gibberellin was injected into the peduncle from where it presumably migrated upwards and brought about fruit setting. The ovaries of tomato, whether treated with auxin or gibberellin, produced only seedless fruits (7). This was not the case with Zephyranthes. Incidentally, it may be mentioned that so far gibberellins have not been reported to promote the growth of seeds. Contrarily, there are a few reports saying that gibberellin can reduce the percentage of seed production (5).

It would be interesting to study the effect of gibberellins on plants in which auxin has failed to produce the desired results.

Summary

The present study revealed that gibberellin is far more effective in bringing about fruit set in Zephyranthes than indoleacetic acid. It is of interest that this chemical is effective over a wide range of concentrations without producing abnormal effects on the vegetative and floral parts of the plant. In contrast, IAA resulted in the prevention of abscission of the perianth tube, while the peduncle became swollen and curved due to unequal growth.

Kinetin, used at 2 concentration levels (10 and 50 ppm) was ineffective in bringing about parthenocarpic fruit set. No synergism was observed between kinetin and indoleacetic acid. Gibberellin treated ovaries yielded fruits which exceeded even the naturally pollinated fruits in size. Although IAA-treated ovaries contained degenerating remains of ovules, with gibberellin the seed coat developed normally. The seeds lacked an embryo, but externally they looked like normal seeds. Seed setting was 98 to 100 %, while in nature it is only 40 to 42 %.

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