and starch over the entire cut surface. Investigation revealed that these "case hardened" layers were valueless from the standpoint of protecting exposed cut surfaces.

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Induction of Multilocular Ovary in Tomato By Gibberellic Acid[1]

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Abstract. Gibberellic acid (GA3) applied to pre-floral tomato plants stimulated a significant increase in the number of 'carpels' and locules per ovary. In 'Vantage' the number of locules was doubled by this treatment whereas in 'Viceroy' a 30% increase was obtained. The styles of treated flowers were thicker and contained more vascular bundles than did those of untreated flowers. Ovary size of treated flowers at anthesis was also increased by this treatment. The significance of chemical manipulation of locule number in tomato ovaries and the possible mode of action of GA3 in this system is discussed.

In most cultivars of tomato (*Lycopersicon esculentum Mill.*) the number of locules in the fruit ranges from 2 to 12. In some large, canning type cvs. e.g. 'Santa Clara', the number of locules may exceed 20 (6). Ovaries of the first flower on the first inflorescence may have more locules than do ovaries of flowers subsequently produced (20); if so, the first fruit produced on a truss is generally larger than the rest. Since fruit size, an important economic character, is usually correlated with increasing locule number, a knowledge of the morphogenetic basis of this character seems worthwhile.

The genetic basis of locule number in the tomato has been widely studied. In addition to the genes *lc* (many locules) and *f* (fasciated) some authors suggest that numerous other genes also affect locule number (2, 10, 20). To our knowledge, however, no attempt has been made to modify locule number through the application of chemical stimulants. Growth substances have commonly been implicated in the development of sex organs. Auxins (3, 7) and ethylene-releasing substances (11, 12) are associated with the stimulation of female organs; whereas gibberellins play a role in the initiation and development of stamens (1, 5, 15, 17). This paper presents results which demonstrate a significant increase in the number of "carpels" (as observed externally) and locules (as observed in cross-section) per ovary following gibberellic acid (GA3) application to pre-floral plants of 'Vantage' and 'Viceroy'.

Materials and Methods

Seeds of 'Vantage' and 'Viceroy' (Stokes Seed Ltd., St. Catherines, Ont.) were planted in flats with a mixture of peat, loam and sand. Young seedlings were transferred to growth chambers maintained at 24°C during the day (9 hours) and 17°C during the night (15 hours). Artificial light of 1,000 f.c. was provided by fluorescent (Gro-Lux) tubes and incandescent bulbs. Plants were treated weekly with a commercial fertilizer. GA3 (Eastman Organic Chemicals No. 7444) was applied, with the aid of a disposable micro-pipette (Drummond "Microcaps") in the axil of the leaf nearest the apex of plants which had 6 to 7 visible leaves. Two applications of 10µl (10^{-3}M) were separated by an interval of 5 days. For sectioning, mature ovaries were fixed in FPA (formaldehyde-propionic acid-alcohol), embedded in "Paraplast" and stained with safranin-fast green (8).

Results and Discussion

Plants treated with GA3 developed elongated stems. The leaves produced subsequent to the application had entire margins similar to those reported by Gray (4). Significant increases in the number of 'carpels' (Figs. 1,2,3 and 4) and locules (Figs. 5 and 7) per ovary were observed in the flowers produced on the first and second inflorescence following GA3 treatment compared with the untreated controls. Ovaries from GA3-treated plants of 'Vantage' produced twice the number of 'carpels' and locules as did ones from untreated plants (Table 1). In 'Viceroy', a multilocular cultivar, a 30% increase in the number of locules was obtained with GA3 application. In the cross section of the young ovaries (Figs. 5 and 7) of 'Vantage', the additional locules were peripheral to the central placental core. In 'Viceroy', however, locules were observed even in the central region, in both treated and untreated flowers. In addition to the increase in the number of 'carpels' and locules at anthesis, ovary diameter of GA3 - treated flowers was larger than that of untreated flowers (compare Figs. 3 with 4, and 5 with 7). Increase in ovary size at anthesis was not due to a stimulation of parthenocarpy. Flowers of these treated plants

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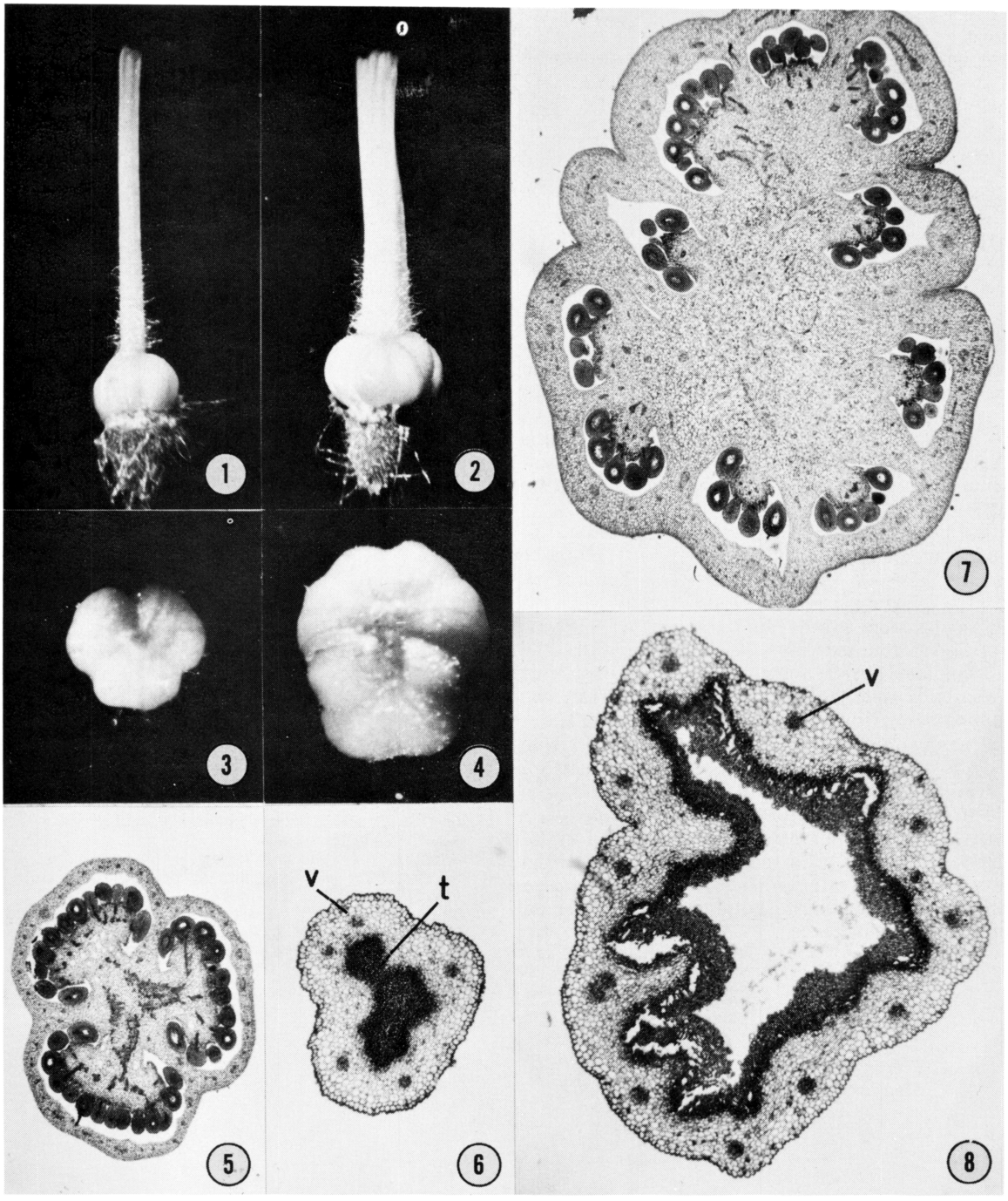

Figs. 1-8. Gynoecia from flowers of GA_3 - treated and untreated plants of tomato (cv. Vantage). 1. Normal gynoecium of untreated plant at anthesis (x6). 2. Gynoecium from GA_3 - treated plant at anthesis (x6). 3. 3-'carpel' ovary (style removed) from untreated plant (x10). 4. Ovary (style removed) from GA_3 - treated plant showing 8 'carpels'. (x10). 5. Cross section of ovary from untreated plant showing 3 locules (x24). 6. Cross section of the style from untreated plant showing 5 vascular bundles (v) and central transmission tissue (t) (x75). 7. Cross section of ovary from GA_3 treated plant showing 10 locules (x24). 8. Cross section of style from GA_3 - treated plant showing 11 vascular bundles and hollow center (x75).

were fertile and, following self pollination, produced fruits with viable seeds. Results with 2 other cvs. Bounty and Early Chatham, were essentially similar.

It is clear, from Figs. 1 and 2 that styles are also affected by the GA_3 application. Styles of treated flowers were thicker and contained more vascular bundles (Fig. 8) than did the styles of untreated controls (Fig. 6). In addition, styles of treated flowers were hollow throughout most of their length. The larger number of vascular strands in the styles of treated ovaries suggests that this phenomenon is, in part, a result of an increase in the number of carpel primordia forming the ovary. Direct observation of flowers at carpel initiation however, has not been attempted.

The role of gibberellins in promoting feminization in plants has been demonstrated in only a few cases (13, 18). There are, however, numerous reports available which document an indirect effect of gibberellin on ovary development. Wittwer et al. (19) demonstrated the induction of parthenocarpic fruits following GA_3 application to young emasculated flowers of tomato. It was later suggested by Sastry and Muir (16) that this response might be related to an increase in the diffusible auxin content since ovaries treated with GA_3 had concentrations of

Table 1. Effect of GA_3 on the number of carpels and locules in the ovary of tomato.

Cultivar	Treatment	Carpels per ovary[a] Mean	±Confidence[c] interval	Locules per ovary[b] Mean	±Confidence[c] interval
Vantage	Untreated	4.4	0.59	3.6	0.56
	GA_3	9.8**	0.48	9.2**	1.14
Viceroy	Untreated	9.0	0.58	13.6	2.59
	GA_3	12.9**	0.64	19.2*	2.65

[a]Sample number 15.
[b]Sample number 5.
[c]Confidence interval 95%.
*Difference significant from untreated at p = .05.
**Difference significant from untreated at p = .01.

diffusible auxin similar to those of pollinated ones. Kuraishi and Muir (9) and Nitsch and Nitsch (14) also demonstrated an increase in the amount of diffusible auxin following GA_3 treatment. It is possible, therefore, that an increase in the number of "carpels" and locules reported in this paper might well be a phenomenon regulated by GA_3 through its effect on auxin content.

That GA_3 did not stimulate the formation of parthenocarpic fruits in our experiments (as might be expected (19)) could be explained on the basis of the timing of GA_3 application. Wittwer et al. (19) sprayed GA_3 to young flower buds when the "carpels" and locules were already differentiated. At this time application of GA_3 resulted in swollen ovary walls and subsequently stimulated parthenocarpic fruits. In this study however, flower buds were not yet initiated when GA_3 was applied and unpollinated flowers did not produce mature fruits.

Preliminary observations indicate that mature fruits from flowers with GA_3 - induced multilocular ovaries are at least 1½ times as large as mature fruits from untreated controls. The available evidence strongly supports the suggestion of a relationship between locule number and the size of fruit of tomato. This report raises the possibility that chemical manipulation of locule number in tomato is possible and if used in conjunction with other genetic and cultural techniques, could prove to be of practical significance.

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