Growth and Development of Tomato Fruit as Affected by 2, 3, 5-Triiodobenzoic Acid (TIBA) Applied to the Peduncle

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Summary

Effect of 2, 3, 5-triiodobenzoic acid (TIBA) on growth of pollinated tomato (Lycopersicon esculentum Mill. cv. Momotaro) fruits was investigated. Lanolin with and without TIBA was applied to peduncles of tomato trusses and the flowers pollinated by vibrating them. In TIBA-treated plants, indole-3-acetic acid (IAA) level was maintained higher in fruits up to 21 days after pollination, the seeds weighed less than those from normally pollinated fruits, the degree of puffiness was more severe, and many fruits had symptoms of a physiological disorder, blossom-end rot.

Key Words: blossom-end rot, indole-3-acetic acid, pollination, puffiness, seed.

Introduction

Auxin is related to the abnormal growth of tomato fruit. Asahira and Hosoki (1977) realized that a high level of auxin in tomato fruits enlarged by in vitro induced puffiness, results in poor development of the locale tissue. Bangerth (1976) reported that parthenocarpic tomato fruits induced by TIBA, known as an anti-auxin (Katayama and Marumo, 1994) or an inhibitor of auxin transport (Christie and Leopold, 1965; Goldsmith, 1977), showed a high percentage of blossum-end rot. Hamamoto et al. (1996) reported that the application of TIBA to the peduncles of 4-chlorophenoxy acetic acid-induced parthenocarpic fruits increased the IAA level and the occurrences of puffiness in the fruits and greater prevalence of blossom-end rot.

Parthenocarpic fruits were used for the studies described above. In addition, Asahira and Hosoki (1977) did not use intact plants. It is not certain if the same results could be obtained by using pollinated fruits of intact plants. Hamamoto et al. (1996) also tried to use pollinated fruits, but were unsuccessful in setting fruits, because of low temperature. Accordingly, we carried out this study to confirm the phenomena that the inhibition of auxin transport from fruit causes puffiness and blossom-end rot using pollinated intact plants. Additionally, we observed the effect of the inhibitor of auxin transport on seed development.

Materials and methods

Tomato ‘Momotaro’ (Takii & Co., LTD.) plants were planted in 18 cm diameter pots, filled with fertilized soil (0.3, 1.2, and 0.3 g of N, P, and K, respectively, per liter of soil). At the flowering stage of the 3rd flower of the 1st truss (July 1996), 0.8% TIBA in lanolin or 0% TIBA (untreated control) was applied to the peduncles. Then the flowers were pollinated by vibrating them with a vibrator and the trusses were thinned except for the 1st, 2nd, and 3rd flowers.

On days 0, 7, and 14 after pollination, flowers and young fruits of the 1st truss were collected and analyzed for endogenous IAA. On the 21st day after pollination, fruits were sampled from 7 plants of each treatment. All fruits on the 1st truss were weighed; the 2nd fruits were then analyzed for IAA, whereas the 1st and 3rd fruits were cut equatorially and the cross sections photographed to record the degree of puffiness (i.e., the ratio of puffy area to the whole cross section area). The seeds that appeared on the surface of the cross section were collected and weighed.

Each fruit for IAA analysis was inoculated with indole propionic acid as an internal standard and homogenized with 80% acetone containing 50 µg of butylated hydroxy toluene (BHT); then the homogenate was filtered. The filtrate was evaporated in vacuo at 40°C to a small aqueous solution, which was adjusted to pH 3 with 4N-HCl, and partitioned three times against ethyl acetate. The ethyl acetate fraction was partitioned three times against a saturated NaHCO₃ solution. The aqueous fraction was adjusted to pH 3 with 4N-HCl.

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and partitioned three times against methylene chloride. The methylene chloride fraction to which 50 µg of BHT was added was dehydrated with anhydrous Na₂SO₄, and then concentrated in vacuo at 40°C. The concentrate was then partially purified on HPLC (Japan Spectroscopic Co., Ltd.) with a N(CH₃)₂ column using a mixture of methanol: acetic acid (99.5% : 0.5% volume) as a solvent. The partially purified methanolic extract was fractionated with HPLC with a reversed phase C₁₈ column using a 30 min gradient of 20-80% acetonitrile containing acetic acid (0.5% by volume). The eluate was monitored with a spectrophotometer (Japan Spectroscopic Co., Ltd.). The excitation wave length was 280 nm and the emission wave length was 350 nm.

**Results and Discussion**

The IAA level was maintained higher in TIBA-applied plants than it was in the control up to 21 days after pollination especially 7 and 14 days after the treatments (Fig.1). The application of TIBA inhibited IAA transport from fruits, which resulted in increased IAA activity in the fruits. Banuelos et al. (1987) reported that methyl 2-chloro-9-hydroxy-fluorene-9-carboxylate, another auxin transport inhibitor, also has similar effect.

The 1st and 2nd fruits on TIBA-applied plant were equally heavy as those of the untreated control 21 days after pollination (Table 1). The 3rd fruit was heavier in untreated control than those from TIBA-applied plant although the difference was not statistical significant. The fruits of TIBA-applied plant might be smaller than those of untreated control as fruit position in the truss was more distal. However, this is uncertain because flowers which formed after the 3rd flower were removed. Many of the seeds appearing on the surface of the cross section were larger and heavier in the untreated control than were those in TIBA-applied plants but the degree of fruit puffiness was higher for TIBA-applied plant. This result agrees with a report by Hamamoto et al. (1996) who used parthenocarpic fruits. Whereas the application of TIBA to the peduncle in this study resulted in a high degree of puffiness, Asahira and Hosoki (1977) found that direct application of TIBA to fruits suppressed puffiness. They reported that puffiness of parthenocarpic fruits in vitro was counteracted by the addition of TIBA to the medium. Hence, the application of TIBA to a fruit inhibits IAA activity in the fruit but application to a peduncle promotes it leading to puffiness.

Many of the 1st and 2nd fruits, and some of the 3rd fruits of TIBA-applied plants showed blossom-end rot (Table 2). This result is similar to that of Bangerth (1976) who used parthenocarpic fruit. Application of TIBA to peduncles reduced the Ca level in tomato fruit.

![Graph](image)

**Fig. 1.** Changes in the IAA level in pollinated tomato fruits. Flowers and fruits from 1st truss harvested on 0, 7th, and 14th day after pollination were analyzed for IAA. The data for 21st day are from the 2nd fruit. Solid circles represent IAA levels in the untreated control; the open circles represent fruits from TIBA-treated plants. Vertical bars represent standard errors.

| Table 2. Blossom-end rot as affected by TIBA-application to the peduncle. |
|-----------------------------|-----------------|
| Occurrence of blossom-end rot (%) |                      |
| Control                     | + TIBA           |
| 1st fruit                   | 0.0              |
| 2nd fruit                   | 0.0              |
| 3rd fruit                   | 0.0              |
| Fruit of 1st truss          |                  |

| Table 1. Effect of TIBA applied to the peduncle on the growth of tomato fruits. |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|
| Weight of a fruit (g)         | No. of seeds⁷   | Weight of a seed (mg) | Degree of puffiness (%)³  |
| Control + TIBA                | Control + TIBA  | Control + TIBA    | Control + TIBA    |
| 1st fruit                    | 56.8            | 10.4             | 12.8             | 1.8             |
| 2nd fruit                    | 53.7            | 7.5³             | 6.9³             | 4.1             |
| 3rd fruit                    | 32.9³           | 13.0             | 12.1             | 4.2             |

³ Fruit of 1 st truss.
⁷ Number of seeds appearing on the cut surface of the cross section.
NS * Nonsignificant, or significant at p ≤ 0.05.
fruits resulting in blossom-end rot, a Ca deficiency disorder. Ca transport is closely linked to basipetal auxin transport (de Guzman and dela Fuente, 1984). Banuelos et al. (1987) also reported that TIBA application to the peduncle of tomato led to the depression of the rates of basipetal auxin transport and acropetal Ca$^{2+}$ transport. Interestingly, direct application of TIBA lanolin to flowers also leads to blossom-end rot (Bangerth, 1976). Therefore, blossom-end rot may be enhanced by IAA transport inhibition, regardless of IAA activity.

Minerals may have a role, in part, for seed development. Okuse and Saga (1996) reported that seed minerals content, including Ca, P, K, Mg, Fe, and Mn, increased as the seed became heavier. The small size of seeds in tomatoes of TIBA-applied plant in this study could be partly explained by the inhibition of acropetal Ca transport.

**Literature Cited**


トマト果実の生育に及ぼす果柄処理 2, 3, 5-トリヨード安息香酸（TIBA）の影響

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**摘要**

トマトの果柄に 2, 3, 5-トリヨード安息香酸（TIBA）を含むラノリンペーストを塗布し、振動受粉で着果させて、幼果の生育と IAA レベルを調査した。TIBA 処理によって幼果内の IAA レベルは高くなった。果実の重量増加は TIBA 処理に影響されなかったが、空洞の大きさと尻腐れ果の発生が TIBA 処理で増加した。また、種子の発育は TIBA 処理によって抑制された。