TECHNICAL MANUSCRIPT 89

ACTION OF AUXIN ON LEAF ABSCISSION

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ACTION OF AUXIN ON LEAF ABSCISSION

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ABSTRACT

Experiments have been conducted to investigate a two-stage effect of auxin on abscission. The two stages were demonstrated on greenhouse-grown Black Valentine beans by applying IAA (1000 ppm in lanolin) to cut ends of the petioles of primary leaves at various times after deblading. An application immediately after deblading inhibits petiole abscission while the same IAA concentration applied 24 hours after deblading markedly promotes abscission.

Using the same abscission test, it was found that abscission of a debladed petiole was inhibited when the opposite primary leaf was left intact. When IAA was substituted for the leaf blade, abscission of the petiole upon which it was applied was inhibited while abscission of the opposite petiole was markedly promoted. However, when IAA was applied to a debladed petiole and the opposite leaf was not debladed until 48 hours later, both petioles were inhibited, thus suggesting that when both leaves were debladed simultaneously the applied IAA affected the opposite petiole after it had reached the second stage — the stage which is stimulated by auxin.

Similar experiments were performed with petioles of various lengths and ages. The implications of these results indicate possible sites of auxin action on leaf abscission.

ACTION OF AUXIN ON LEAF ABSCISSION

Indoleacetic acid (IAA) is one of the best known regulators of leaf abscission, although its exact mode of action is not yet understood. It is clear, however, that under different conditions IAA can either inhibit or accelerate abscission of the leaf. In order to accurately determine the mechanism of this growth regulator, it is essential to find out specifically where the IAA acts in the leaf. In other words, is the presence of the auxin molecule at the abscission zone the necessary requirement for its effects or does it act indirectly by influencing the metabolism of the petiole? We are currently working on this problem and some results are reported here.

The abscission test consisted of greenhouse-grown bean plants (Phaseolus vulgaris L. var. Black Valentine). Fourteen days after seeding, either auxin (1000 ppm in lanolin) or plain lanolin was applied to debladed petioles of various lengths. Time until 50 per cent abscission was then measured.

Recent results using petiole explants have demonstrated two stages of abscission — a first stage during which abscission is inhibited by auxin and a second stage when abscission is promoted.* These experiments have been repeated using IAA on the debladed petioles of intact plants with similar results, as shown in Figure 1. It can be seen that IAA applications immediately after deblading inhibit abscission of the petiole compared with the debladed control; the same IAA concentration applied to the same part of the petiole 17 hours later promoted abscission.

In order to gain further understanding of the auxin action and perhaps an insight as to the site of its action, we ran experiments using an intact leaf at the primary node. The results as shown in Figure 2 were very surprising. It was found that the intact leaf could markedly inhibit the opposite debladed petiole at the same node. Experiments similar to these had been performed by other workers on Coleus,[2]** but no such effect was ever found. Assuming the inhibition to be due to endogenous IAA in the leaf, auxin was put on only one debladed petiole at the primary leaf node, but here abscission of the opposite petiole was accelerated (Figure 2).

The possibility existed, therefore, that the applied IAA was acting on the second stage of the opposite petiole while endogenous IAA from uncut leaves acted on the first stage, so IAA was applied immediately to one

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* Rubinstein, B., and Leopold, A.C. "Analysis of the auxin control of bean leaf abscission," Plant Physiology 38:262-267, 1963.

** Jacobs, W.P. "Longevity of plant organs: Internal factors controlling abscission," Annual Review of Plant Physiology 13:403-436, 1962.

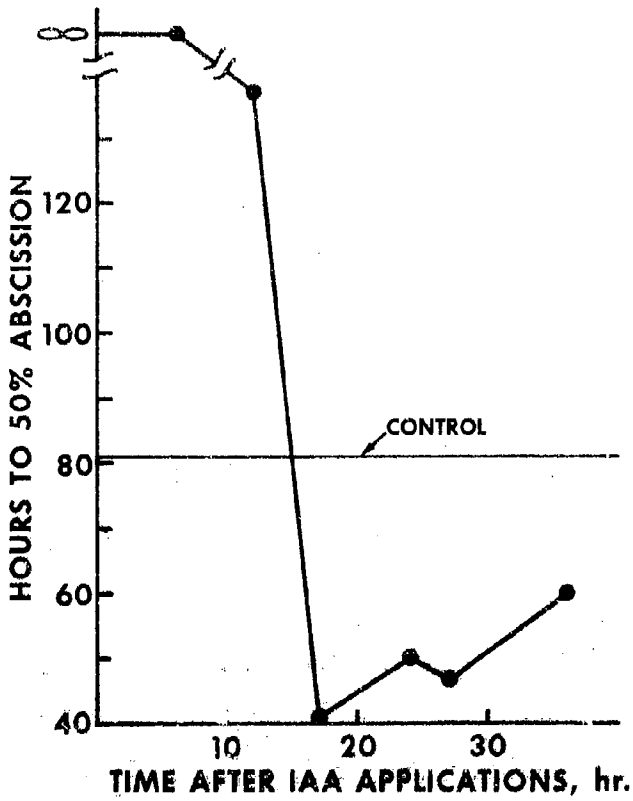
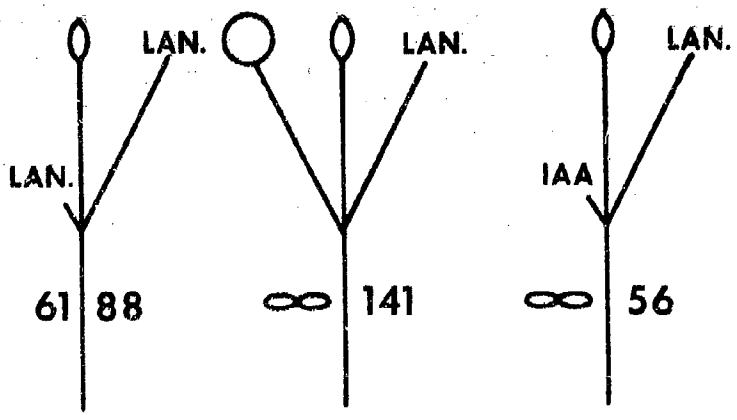


Figure 1. Abscission Responses of Petioles of Intact Bean Plants to Applications of IAA (1000 ppm in Lanolin) at Various Times After Deblading.



Numbers indicate hours to 50% abscission

Figure 2. Effect of Leaf Blade or IAA on Abscission of Opposite Petiole.

debladed petiole and the opposite leaf was debladed at various times after the auxin additions. This treatment should keep the petiole in the first stage until the IAA could exert its effect. Figure 3 shows how removing the blade 48 hours after the auxin was applied inhibited rather than accelerated abscission of the petiole. Figure 4 shows graphically how the IAA effect on the opposite petiole goes from a promotion to an inhibition.

Another way to insure that a petiole would remain in the first stage until the applied auxin could act would be to vary the age of the test plants. Chatterjee and Leopold[3] * have shown that younger plants must remain debladed for longer periods of time before an auxin application will stimulate abscission. Therefore, we used plants of different ages to see how the age would affect the stimulation caused by the IAA on the opposite petiole. These results are shown in Figure 5. Each point represents the time of abscission of a six-centimeter petiole opposite a one-centimeter petiole onto which IAA was applied. It can be seen that six-centimeter petioles from younger plants are inhibited by auxin on the opposite petiole, but this inhibition lessens with age and soon the petiole abscission is accelerated compared with debladed controls. This experiment, then, provides further evidence that auxin on a debladed petiole stimulates abscission of the opposite petiole after it has entered the second stage.

How, then, is it possible to use these results in investigations into the site of auxin action in leaf abscission? One way is shown in Figure 6. Here we are comparing the debladed controls with a six-centimeter and a one-centimeter petiole that were debladed after 48 hours. The results indicate that the longer the petiole the more pronounced is the inhibition and thus seem to imply that auxin action is indirect, at least during the first or inhibitory stage. If the action were direct, we would expect the same abscission time independent of petiole length.

These investigations have demonstrated an experimental system whereby we may observe how auxin applied to one petiole affects the opposite petiole at the same node. Since transport characteristics would be similar, the length of the opposite petiole may be varied to determine direct or indirect auxin effects. The results (Figure 6) seem to indicate that auxin action is dependent on petiole length, but an examination of other results indicates that a petiole with auxin will be inhibited regardless of length. We feel, then, that the auxin inhibition is an effect at the abscission zone, and that a longer petiole merely intensifies the inhibition. It is hoped that future work will provide further evidence of the location of auxin action during the first stage as well as indicate the auxin site during the second, stimulatory stage.

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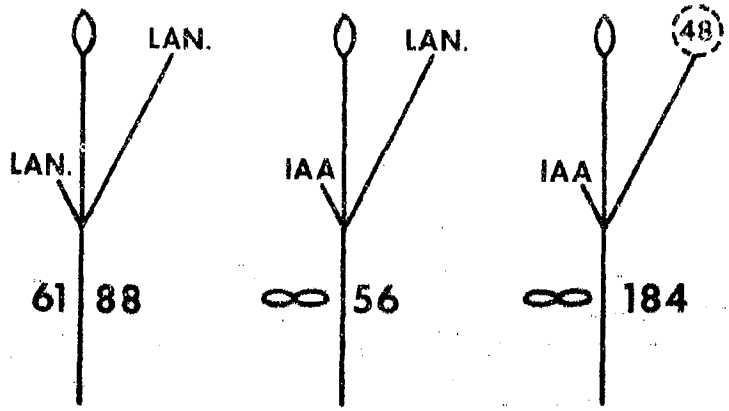
* Chatterjee, S. and Leopold, A.C., Plant Physiology (In Press).



Numbers indicate hours to 50% abscission

Figure 3. Effect of IAA on Abscission of Opposite Petioles Debladed at 0 and 48 Hours After Treatment.

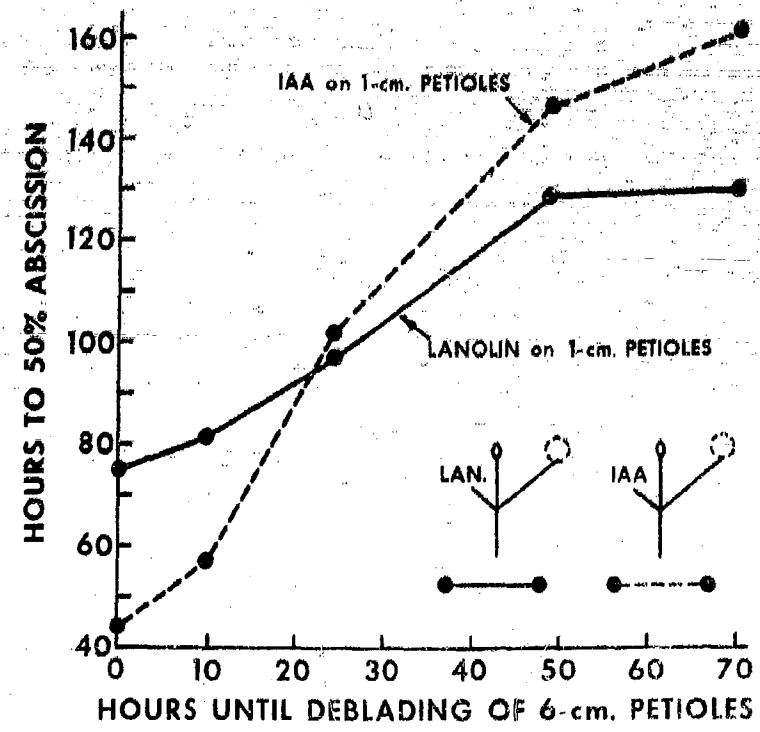


Figure 4. Effects of Time of Deblading on Abscission of 6-Centimeter Petioles Opposite 1-Centimeter Petioles With and Without 1000 ppm IAA.

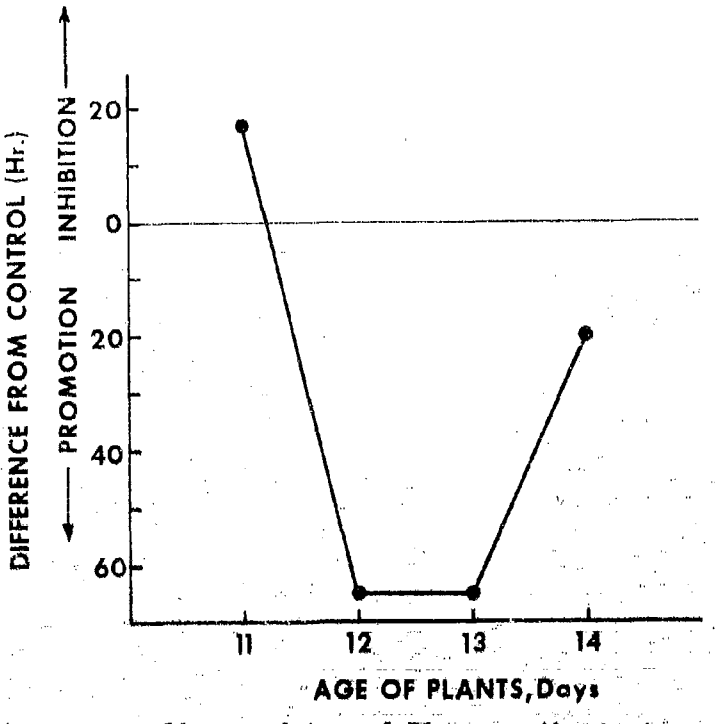
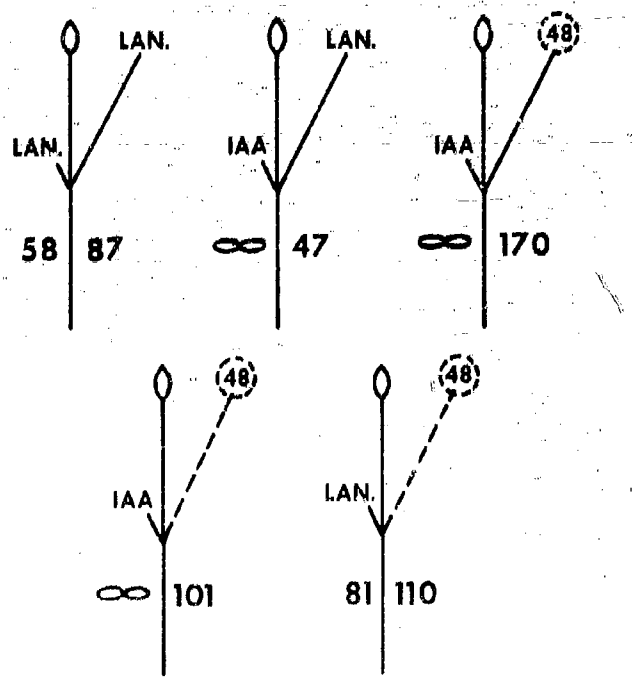


Figure 5. Effects of Age of Plant on Abscission of 6-Centimeter Petioles Opposite 1-Centimeter Petioles With 1000 ppm IAA.



Numbers indicate hours to 50% abscission

Figure 6. Effect of IAA on Abscission of Opposite Petioles Trimmed to Various Lengths at 48 Hours After Treatment.