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Ethylene Treatment and Abscission of Olive Fruits[1]

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Abstract. **Ethylene gas promoted abscission of mature-green fruits of olive (*olea europaea* L.) but did not induce endogenous ethylene production. Ethylene readily penetrated and moved through olive fruits. Mature-black olives did not respond to ethylene.**

Ethylene, which is released from ethylene-releasing compounds (ERC), causes abscission of several plant organs in various species (1,8,9,10,12,13). Recently several reports have been published concerning the effects of ERC on abscission of olive fruits (2, 3,6,7,11). Only 4% of ^{14}C-(2 chloroethyl) phosphonic acid (ethephon) penetrated into olive fruits when fruits alone were treated and caused no reduction in fruit removal force (FRF). However, FRF was very significantly reduced when fruit stalks (which contain, in olives, the pedicel and part of the peduncle) were treated with small amounts of ethephon (5). These results support previous suggestions that ethylene directly affects the fruit stalks, where abscission occurs.

The present work attempted to determine the sensitivity of olive fruits to exogenous ethylene and to detect whether endogenous ethylene is produced after exogenous ethylene treatment.

There are several advantages to using ethylene instead of ethephon. Ethylene gas penetrates and moves through plant tissue more readily than ethephon (14). The rate of ethylene release from ethephon is a function of pH (2,3), temp (4), and humidity (Ben-Tal et al., unpublished data). These factors cannot be controlled in the field. Consequently, the exact concn of ethylene in the plant tissue is unknown, following ERC treatment. There are also degradation products and additional chemicals in ERC which might have an unknown physiological effects. Ethylene gas treatment provides exact control of ethylene concn in ambient air. Treatment duration is also precise, because the tissue is completely ventilated within 1 hr after the end of ethylene treatment. After ERC treatment ethylene is found in the tissue as long as ERC molecules are present.

A desired ethylene concn was achieved by mixing ethylene gas with a stream of air. Several small branches carrying at least 100 'Manzanillo' fruits each were enclosed in plastic sleeves into which a stream of ethylene containing air was passed at a flow rate of 1 liter/min per 100 fruits. The plastic sleeves were covered with brown paper to prevent over-heating. Fruit under similar conditions, but treated with air alone, served as controls. There were 4 replications per treatment and each experiment was repeated 3 times.

Fruits were ventilated for 1 hr after termination of the ethylene treatment, then detached and enclosed in flasks or syringes; the amount of ethylene in the containers was measured by gas chromatography. FRF was determined by a Chatillon dynamometer at the termination of the ethylene treatment and at several times afterwards.

Even 100 ppm ethylene did not cause a reduction in FRF if applied for 12 hr or less (Table 1). However, much lower concn caused a very significant reduction in FRF when applied for 24 hr or more. There was a tendency of interaction between treatment duration and concn. Higher ethylene concn for shorter periods caused FRF reductions similar to lower concn for longer periods. A lag period occurred between the termination of a 24 hr ethylene treatment and fruit abscission. The reduction in FRF continues after the cessation of ethylene applications of 24 hr or more. We assume that separation of cells in the abscission zone occurs during this period.

Ethylene treatment initiated no meaningful endogenous ethylene production in mature green olive fruits, and abscission occurred without autocatalytic ethylene production. The effect of ethylene treatment on detached fruits was basically similar (table 2) to that on attached fruits. Significant leaf abscission occurred only when high concn of ethylene were applied for long periods (48 hr or more).

Mature-green olive fruits do not abscise naturally, although they have the ability to activate an abscission zone in their fruit stalks in response to ethylene treatment.

Because ethephon movement in olive fruit is very limited (5), ethylene movement in fruit was tested. One half of each of 15 fruits was covered with a tightly fitted rubber cap. Head space was left between the fruit and the cap. Capped fruits were put into closed jars containing ethylene for 30 min. Air samples taken from the head space contained ethylene. In other tests ethylene was injected into the head

Table 1. Effects of duration and concentration of ethylene treatments on the fruit removal force of attached olive fruits[z]

Duration of ethylene treatment (hr)	Time to FRF measurement[y] (hr)	Ethylene concn (ppm)				
		1	5	10	25	100
12	0	80.8	72.0	–	83.7	–
12	12	82.2	–	88.6	–	98.3
12	24	75.0	–	81.0	–	73.9
12	36	89.1	95.3	–	98.3	–
12	60	81.0	–	–	–	–
24	0	68.8	47.3	–	42.1	–
24	12	41.0	–	35.3	–	0
24	24	41.3	30.9	10.5	12.0	0
48	0	26.7	12.5	–	0	–

[z]Values are given as percent of control (521 ± 31g).
[y]After termination of the ethylene treatment.

Table 2. Effects of duration and concn of ethylene treatments on the fruit removal force of detached olive fruits[z]

Duration of ethylene treatment (hr)	Time to FRF measurement[y] (hr)	Ethylene concn (ppm)		
		1	5	25
24	0	82.5	45.8	56.2
24	24	22.8	20.5	0

[z]Values are given as % of control (550 ± 29g).
[y]After termination of the ethylene treatment.

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space and fruits placed in closed containers with air. Air in the containers contained ethylene when tested after 30 min. In both tests, the gas had moved through the fruit tissues.

Rates of ethylene production and respiration were measured in treated fruits and fruit stalks. Fruit stalks produced 1.5μl/kg per hr ethylene, while the amount produced by the fruits was undetectable. Respiration rate was 3x larger in fruit stalks than in fruits 150 ml/kg per hr vs. 50 ml/kg per hr. These results support the above conclusion that ethylene applications did not induce high endogenous ethylene production.

Ben-Tal and Lavee (2) showed an increase in ethylene production 72 hr after Ethrel treatment of olives and assumed that it was endogenous ethylene produced in response to the treatment. We propose that the delayed increase results from a delayed breakdown of Ethrel caused by its low pH. Buffered ethephon and Alsol do not have delayed breakdown because of their much higher pH (2,3).

Natural abscission does not occur in olive because the fruits or fruit stalks do not produce enough endogenous ethylene to induce abscission. Abscission in green-mature fruit is induced by ethylene gas treatment or by ethylene released from ERC. Black-mature olive fruits with functional fruit stalks do not respond to ethylene treatments probably because they have lost the ability to separate in the abscission zone.

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Translocation of NAA in 'Washington' Navel Orange[1]

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Abstract. **Naphthaleneacetic acid (NAA) applied to young 'Washington' navel orange trees [*Citrus sinensis* (L.) Osbeck] as a 1% sodium salt or ethyl ester formulation was translocated from the treatment site and inhibited growth of the untreated portion of the tree. The Na salt formulation translocated farther than the ethyl ester formulation.**

Effective control of undesirable sprouts by NAA has been recently reported for ornamental shrubs and trees (5, 7) as well as for many species of fruit trees including apple (9, 12), avocado (1), citrus (3, 4, 11), fig (2, 10), olive (7, 8), peach (6), pear (12), pomegranate (8), prune (8), and walnut (8). Apparent translocation of NAA in fig trees has been reported (10), otherwise little or no translocation of NAA from the treatment site and no significant reduction of growth on untreated portions of the plant has been mentioned in literature. This study was initiated to determine the extent of translocation of NAA in sweet orange following preliminary trials with small numbers of citrus seedlings, which indicated probable movement of NAA in citrus.

Navel orange trees on Troyer citrange [*Poncirus trifoliata* (L.) Raf. × *C. sinensis* (L.) Osbeck] were grown as single-trunk plants in 4 liter containers in the greenhouse. They were cut off prior to NAA treatment 40 cm above the bud union when the average diam at the base of the scion was 0.7 cm. Two formulations of NAA and 2 treatment methods were used. Aqueous solutions of 1% Na salt or 1% ethyl ester were sprayed on leaves and stems, or brushed on the stems after leaves were removed. There were 15 single-tree replications of each treatment, including controls.

The top 5 nodes of the 40-cm scion portion of each plant were treated. A wax pencil line between the 5th and 6th nodes marked the demarcation line between treated and untreated tissue; this line was subsequently used for measuring distance of translocation. The internode was tightly wrapped with plastic tape to exclude NAA after removal of the leaves at the 6th and 7th nodes. The balance of the tree was protected from spray drift by a plastic bag attached tightly to the wrapped portion of the stem.

Leaves and stems of the top 5 nodes were sprayed to run-off with a hand sprayer for the "leaves on" treatments. The top 5 leaves were removed and NAA was applied to the stem with a small brush for the "leaves off' treatments. Control trees were established with leaves on the leaves removed; the top 5 axillary buds on control trees were excised with a razor blade. Protective bags and tape were removed after spray treatments were completely dry and trees were placed in the greenhouse for observation.

Growth measurements were made 6 weeks following treatment. The distance from the treatment demarcation line to each growing shoot was recorded and the length of each shoot was measured. Only the top 4 shoots were allowed to grow, others were removed, as were all rootstock shoots.

There was considerable variation among replications within each treatment (Table 1). Six of the 15 "leaves

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