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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Additional index words. Citrus sinensis, growth regulator, shoot inhibition, naphthaleneacetic acid

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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Table 1. Distance to first shoot, buds growing, and total new shoot length 6 weeks following NAA treatment of 'Washington' navel orange trees.

Treatment	"Leaves on"			"Leaves off"		
	Distance to first shoot (cm)	Buds growing (no.)	Total new shoot length (cm/plant)	Distance to first shoot (cm)	Buds growing (no.)	Total shoot length (cm/plant)
1% Na salt NAA	18.2a[z] (4.0–32.1)[y]	1.1c	15.2C	8.0A[z] (2.3–29.3)[y]	2.3B	26.8B
1% Ethyl ester NAA	8.4b (0.5–30.2)[y]	1.9b	38.1B	6.0A (0.7–12.5)	3.5A	54.2A
Control	1.3c (0.1–5.0)	3.7a	65.6A	1.2B (0.5–3.3)	3.5A	54.0A

[z]Mean separation within columns by Duncan's multiple range test, 5% level (lower case letters) and 1% level (capital letters). Range included in parenthesis.

[y]Total length of plant from treatment demarcation line to bud union was measured where no buds grew.

on" trees sprayed with 1% Na salt had no new growth 6 weeks following NAA application. Bud break occurred from 4.0 cm to 28.0 cm below the treated portion on the other 9 plants in this treatment. Two trees in the 1% ethyl ester "leaves on" treatment made no new growth during the first 6 weeks. Bud break occurred from 0.5 cm to 9.4 cm below the treatment site on the other 13 plants in this treatment. All of the control "leaves on" trees had new growth within the top 5.0 cm below the treatment demarcation line.

Average distance from the treatment demarcation line to the top new shoot on "leaves on" trees at 6 weeks was 18.2 cm for the 1% Na salt treatment, 8.4 cm for the 1% ethyl ester treatment, 1.3 cm for the controls (Table 1). These differences indicate that Na salt formulation did translocate a considerably greater distance than the ethyl ester formulation in citrus. NAA treatment also significantly affected bud break and total new shoot growth. The average number of new shoots present 6 weeks following treatment was 1.1 for Na salt, 1.9 for ethyl ester, and 3.7 for control trees in the "leaves on" group. Average new shoot length per plant was 15.2 cm, 38.1 cm and 65.5 cm for the Na salt, ethyl ester treatments, and controls, respectively.

Results with the "leaves off" treatments showed the same trends as "leaves on" results but the differences were considerably less (Table 1). Less translocation and growth inhibition effect could be expected because the total amount of NAA applied per plant was less, due to the absence of leaf surface. There were no differences in bud break and total new shoot growth between the 1% ethyl ester "leaves off" treatment and the control. This result is in agreement with previously reported work on the use of NAA as an inhibitor of sucker growth without affecting untreated portions of field trees.

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Control of Citrus Stump Sprouts with Chemicals and Plastic Tarpaulin[1]

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Additional index words. growth regulators, herbicide, *Poncirus trifoliata*

Abstract. **Herbicides, growth regulators, and polyethylene plastic tarpaulins were applied or covered 14-year-old 'Frost Valencia' sweet orange [*Citrus sinensis* (L.) Osbeck] on Troyer Citrange [*Poncirus trifoliata* (L.) Raf. × *Citrus sinensis* (L.) Osbeck] stumps to control sprouts. Ammonium sulfamate (Ammate X), 2,4-D Esteron Ten Ten, 2,4-D Lithate, ammonium ethyl carbamoylphosphonate (Krenite), and polyethylene plastic tarpaulin gave best results for controlling resprouting.**

The majority of citrus planted in California before World War II (1941-1945) was spaced 6.1 x 6.7 m or 6.7 x 6.7 m. Some valencia orange orchards were spaced 7.3 x 7.3 m and a few lemon orchards in the desert were spaced 9.1 x 9.1 m; however the tendency since 1945 has been toward closer planting distances. The latter are the result of growers' needs to off-set increased production costs, such as land values, higher taxes, labor, fertilizer and other materials. Earlier work reported by Klein (8) and Greene (6) showed that closely spaced trees averaged 50 to 60% more fruit per ha during the first 10 to 15 years after planting. Also, recent citrus trials have shown that close spacing increased yield in a shorter period (2,3,10).

Many close-planted (3.4 x 6.1 m) citrus orchards have reached the stage where crowding has made it necessary to remove alternate trees. The remaining trees then have ample room to attain full size and bearing capacity. Orchard thinning can be accomplished by bulldozing which removes the entire tree,

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