Discussion

The use of relatively low concentrations of captan in hot water significantly inhibited stem-scar and surface mold of cantaloupes. From the standpoint of optimum disease control and minimum heat injury, a 30-sec immersion in 130° or 135° F water containing 600 ppm captan was the most promising of the treatments tested.

Although mean values for all replications indicated that 135° F treatments for 30 sec did not cause significant injury, objectionable suture browning did result from these treatments in some replications. Johnson (2), working with melons from Texas, stated that water at 135° to 145° for 30 sec did not cause injury. Further work with California melons is needed to determine the reasons for the sensitivity of some melons to 135° treatments, and whether these melons constitute a significant portion of commercial shipments.

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Response of Mature Avocado Fruits to Ethylene Treatments Before and After Harvest[1,2]

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Abstract. Unpicked avocado fruit showed no response to ethylene treatments given at 50 ppm for 48 hr. Picked 'Hass' fruit did not respond to ethylene treatments given immediately after harvest. A good response was observed to treatment given 25 or 49 hr after harvest. This may be explained by assuming the existence of an endogenous factor inhibiting ethylene action.

Ethylene has long been known to trigger the ripening of harvested fruit. In an atmosphere of at least 10 ppm, avocado fruit enter the climacteric phase immediately and soften within days. Raising the concentration of ethylene to 100 or 1000 ppm does not hasten the process (2, 3).

In the early sixties the development of more sensitive methods enabled the ethylene in the internal atmosphere of preclimacteric fruits to be measured. Ethylene at concentrations of 0.1–1.5 ppm was found in various fruits still on the tree. The application of similar concentration induces ripening in picked fruits (5). The inactivity of ethylene or the lack of response to it by unpicked fruit are ascribed to the presence of inhibitory substances transmitted from the tree (5, 6). Burg and Burg (4) found the concentration of ethylene in avocados at picking time to be 0.1 ppm. This concentration is sufficient to induce ripening when applied to picked fruit. Biale (2, 3) found only a partial response of avocado fruits to 0.1 ppm ethylene. The present study set out to test the effect of ethylene applied to mature fruit on the tree, and at different times after picking at an optimal concentration for triggering the ripening process in picked avocado fruits.

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Materials and Methods

Ethylene treatments were given by a constant flow of an air-ethylene mixture. The concentration of ethylene was determined by the aid of a Packard gas chromatograph. Repeated analyses during and at the end of treatment showed that the mixture remained constant.

Trials with harvested fruit. Avocados of the 'Hass' variety were picked at noon on 3 consecutive days in mid-December, 1968. Each fruit was relatively uniform in size and shape, with an average weight of 190 g and average oil-content of 12%. The fruit from each picking was divided into 4 groups of 30, each group being placed in a 10-liter glass jar. A constant flow of ethylene-air mixture, at a rate of 400 cc/min/jar was administered for a period of 24 hr. The concentrations given were 0, 10, 100, 1000 ppm ethylene. All ethylene treatments were started at the same time, 1 hr after picking on the third day, i.e. 24 and 49 hr after picking on the second and first days respectively. After treatment the fruit was transferred to 17°C. The day on which the fruit reached an edible state (hand-tested) was recorded.

Trials with fruit in the orchard. A mobile apparatus fitted with cylinders of compressed air and ethylene, was set up to supply a constant concentration of ethylene. After a 2-stage mixing of air and ethylene, the desired

concentration of about 50 ppm was delivered to a central container under the experimental tree. Thirty polyethylene tubes conducted the gas mixture from the container to avocado fruits placed in polyethylene bags. The gases flowed through the tube at a constant rate of a little over 100 cc/fruit/min into the bottom of each bag, from which they escaped through spaces left where the bag was tied to the fruit stalk. The rate of flow and gas mixing were controlled by pressure regulators and 4 flowmeters.

Both picked fruit and those on the tree were treated. Uniform supply of the gas mixture was ensured by a forked supply-tube, one branch reaching fruit on the tree, the other a picked fruit. A third group of fruits was picked as control and held in the orchard untreated for the duration of the ethylene treatment. When treatment ended, all picked fruits were held at 17° C.

Ten separate experiments were performed from September to March in the 1967–68 season, and from September to December in 1968–69. The ambient temperature during the field tests ranged from 8 to 18°C. Similar tests done in spring when the ambient temperature ranged from 15 to 25°, gave similar results. Treatments were given to the varieties 'Hass' (Guatemalan) and 'Fuerte' (Mexican-Guatemalan) to immature fruit with an oil content of 3–4%, almost mature with 8% oil, and fully mature when oil content reached 20%.

Results

Behaviour of picked fruits. Fig. 1 shows the rate of softening of fruit treated with 100 ppm ethylene for 24 hr. Treatment started immediately after picking produced no special response, the fruit softening at a rate similar to that of the control fruits. Treatment started 25 and 49 hr after picking produced a markedly faster softening of the fruit, with no appreciable difference between softening rates of the 2 treatments. The softening rate of fruits treated 49–72 hr after harvest was more even than that of fruits treated 25–49 hr after harvest. Ripening of several fruits belonging to the latter group was delayed. Fruits treated with either 10, 100 or 1000 ppm ethylene softened at the same rate. Recurrent trials conducted with 'Hass' and 'Nabal' fruit gave similar results.

Behaviour of fruits treated on the tree. Fruit treated on the trees for 48 hr with 50 ppm ethylene neither abscised nor softened. During subsequent growth they did not differ from untreated fruit in growth, shape, color or behaviour. The biological effect of the treatments was tested on fruit just picked concurrently with fruit on the trees. The ethylene treatment did not hasten softening of the picked fruit. The reason for this unusual behavior was found later. At the end of December 1968 a further experiment aimed at ensuring response of picked fruits to ethylene was conducted with the 'Hass' variety. The effect of 40 ppm ethylene given for 48 consecutive hours to 30 fruits on the tree and 30 fruits picked 24 hr previously was tested. The picked fruit was kept in the orchard so as to be in identical temperature conditions as the fruit on the tree. The treated, picked fruits softened 3 days earlier than untreated control picked at the same time. Fruit treated on the tree remained firm and showed no changes in behaviour. Following Maxies' publication (10), experiments with ethylene treatments lasting 5–6 days were performed. This prolonged treatment consistently caused the firm fruit to drop 6 or 7 days after the start of treatment. Application of 0.2% NAA in lanolin paste to the fruit stalk did not prevent abscision.

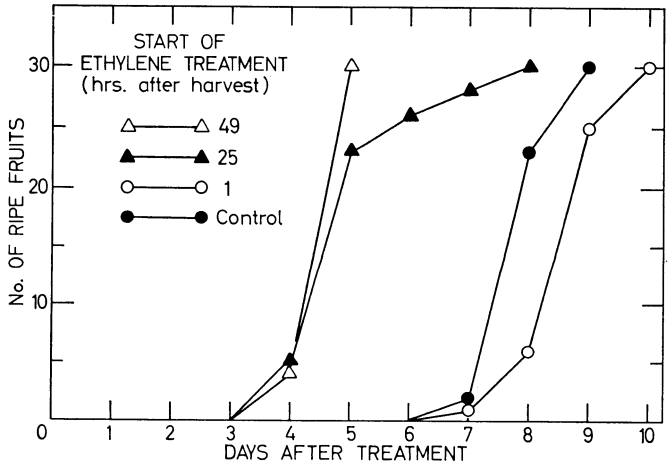

Fig. 1. Response of mature Hass fruits to 24 hr of 100 ppm ethylene treatment, started 1, 25, or 49 h after harvest.

Discussion

The absence of ripening response by unpicked avocados to ethylene, in concentrations a thousand times higher than that found in the fruit, and considered sufficient to trigger the ripening of picked fruit (9, 2, 3) clearly proves that this process in avocados still on the tree is not activated by physiological concentration of ethylene. These results support the assumption that substances reaching the fruit from the shoot system inhibit its response to ethylene. When the fruit is detached from this source of supply it becomes susceptible to ethylene and ripens (3, 6). Results of our work (Fig. 1) show that the change is not immediate and the avocado fruit may remain insensitive to ethylene during the first day after picking, a phenomenon hitherto unnoted either in commercial practice or in numerous experiments on avocados. Probably the main reasons for this are: a) Ethylene treatment did not generally start immediately after harvest. b) Usually the duration of the ethylene treatment was longer than 24 hr (3). c) Fruit may respond differently to ethylene at different stages of maturity (3).

Our trials showed great variability in response of picked avocado fruit to ethylene, ranging from extremely marked to none at all. This seems surprising since ethylene is considered a prime activator of ripening processes. All the fruit would be expected to respond to correct treatment by uniform softening. The reason for this non-uniform response may lie in the varying concentrations of inhibiting substance in different fruits, and the differences may be due to the supply-rate or production-rate or breakdown of the inhibiting substance in the fruit itself. If this is so, it may be surmised that the later the treatment is given after harvest the more uniform will be the response, because the number of fruits still containing an effective concentration of the inhibitor will be smaller. The results summarized. in Fig. 1 uphold this premise. Fruit treated 2 days after harvest ripened very uniformly while fruit treated one day after harvest ripened over a longer period.

Recently, Burg (7) suggested that CO_2 in the preclimacteric fruit acts as the endogenous factor, preventing the fruit from responding to its own natural concentration of ethylene by raising its threshold for ethylene action. The fact that very high concentrations of ethylene could not trigger the ripening process before and immediately after harvest contradicts this. Burg's hypothesis also does not explain the eventual activation of the ripen-

ing process and entry into the climacteric of fruit without a prerequisite diminution of CO_2 concentration (1, 3, 9). The lag period between harvest and ripening may be better explained if the cause is assumed to be inhibiting substances, whose quantity or disappearance rate varies in different fruits at different stages of maturity and under various growing conditions.

We have no indication as to the type of inhibitor involved in preventing response to ethylene. Antagonism between gibberellin and ethylene has been reported recently (8), but we have no evidence to uphold this in avocados. Further work is required in order to clarify this point.

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Pre-Storage Promotion of Leaf Abscission of Deciduous Nursery Stock with Bromodine[1,2]

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Abstract. The results of 4 years work with Bromodine show that it is an effective nursery stock defoliant for several species and cultivars. Thorough wetting (200–300 gal/A) with 1 to 3 applications at 6 to 7 day intervals of 0.25% Bromodine on cherry and pear and 0.50% on apple and prune was sufficient for 70 to 100% leaf abscission. Experimental work was confirmed with commercial trials.

It is desirable for nurserymen in many parts of the world to dig nursery stock prior to the time of natural leaf abscission. Hand stripping or other methods of leaf removal are expensive or limited in application. A search for a satisfactory chemical defoliant, as documented previously by the author (5), has thus been made for many years. Much work has been done on leaf abscission in general, as reviewed elsewhere (1, 2), but this work has not been well extended on an applied basis to deciduous woody plants. Indeed, laboratory results with such test materials as cotton or bean explants do not necessarily apply directly to highly vigorous woody nursery plants.

The effects of potassium iodide on leaf abscission of certain deciduous woody plants was previously reported by the author and other abscission work with iodine or its salts was reviewed in that report (5). The possibility of using another iodine containing material, Bromodine, was later reported by the author (6). Subsequent work with Bromodine has shown it to have considerable merit as a nursery stock defoliant. This paper reports 4 years' experimental work with Bromodine for this purpose.

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[2]Bromodine was supplied by C and R Products Development Co. Financial support was given by C and O, Columbia Basin, Heath, May, Milton, Pacific Coast and Van Well Nurseries.

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[4]40% Alkyl (C_{12}) (ethylcycloimidinium) 3-hydroxyl, 3-ethyl sodium alcoholate, 2-methyl sodium carboxylate-tridecylpolyoxyethylene ethanol-iodine complex and 20% triethanolamine sulfonate tridecylpolyoxyethylene ethanol-bromine complex.

MATERIALS AND METHODS

Bromodine[4] was applied as a spray between 1965 and 1968 inclusive at commercial nurseries in central Washington (Yakima, Wenatchee, Quincy, Brewster). Sprays were applied to runoff using hand operated bucket pump sprayers. The number of applications to a given plot varied from 1 to 3 at intervals of 6 to 7 days. At weekly intervals following treatment, until the plants were dug and stored by the nurserymen, the percentage leaf abscission was visually determined. Following winter storage, the plants were replanted for observation in commercial plantings or at Pullman in experimental plots.

In 1965, single applications of 2 and 3% Bromodine were applied on October 8 or 15 to 'Rome', 'Jonathan', 'Idared', and 'Winesap' apples, to 'Sunglo' apricot, 'Italian' prune and 'Montmorency' cherry, to 'Bartlett' pear and *Spiraea billiardi,* Herincq., and to 'Bartlett' pear, *Pyrus calleryana, Prunus mahaleb* L., and French crab apple seedlings. In 1966, single applications of 1, 2, and 3% Bromodine were applied on October 13 or 20 to 'Rome', 'Winesap', 'Golden Delicious', and 'Red Delicious' apples, to 'Chinook' cherry and 'Italian' prune, to 'Bartlett' pear and 'Greenleaf' barberry, and to 'Bartlett' pear, *Pyrus calleryana, Prunus mahaleb,* and French crab apple seedlings.

The application rates and plants treated in 1967 and 1968 are shown in Tables 1 and 2. The 1967 data are based on 10 plots of at least 3 plants each and the 1968 data on 3 plots of at least 3 plants each.

In 1968, large commercial trials were made, one of