CHEMICAL INHIBITION OF REGROWTH ON LEMON KMH, ALAR, AND NIA 1063

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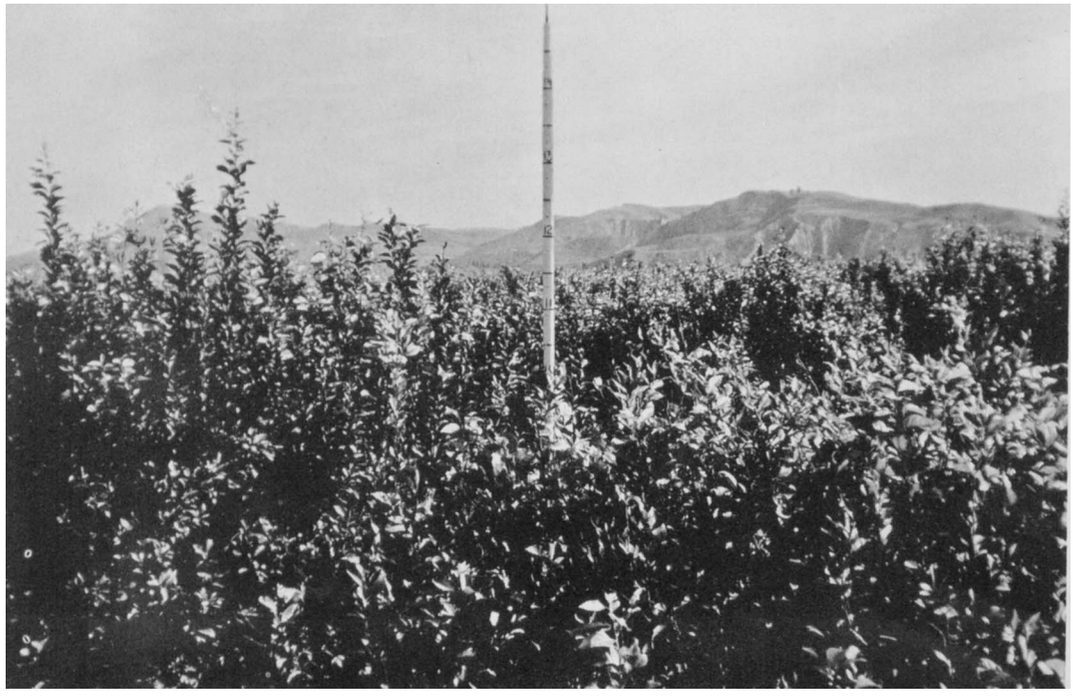
THE MECHANICAL CUTTING of top growth on lemon trees (see photo) has been a commercial practice in California for many years. However, pruning and brush disposal have become so expensive that it appears that growth inhibitors might offer an economical advantage.

A trial of the growth inhibitor maleic hydrazide (MH) was initiated in 1960 on plots belonging to the Ventura Coastal Corporation in Ventura. The results of this experiment showed that MH sprays of 500 and 1,000 ppm on the young regrowth of recently top-pruned lemon trees inhibited the growth for almost a year after treatment. Since federal registration of MH (30% diethanolamine salt) was not forthcoming, this practice could not be recommended.

Lemon top regrowth comparison five months after treatment. Tree on right received 2500 ppm NIA-10637, July 8, 1969. Tree on left was a control. Photo taken December 10, 1969.



Subsequently, a new formulation of maleic hydrazide—potassium salt of 6-hydroxy-3-(2H)-pyridacinone (KMH), and succinic acid,2,2 Dimethylhydrazide (Alar) showed promise of obtaining federal acceptance. A trial to test their effectiveness was started in September 1968 in Ventura. The lemon trees in the trial were 12-year-old Cascade Eurekas on sweet orange rootstock. The trees were topped to a height of 9 ft in the summer (1968) and the sprays were applied on September 17, when regrowth had reached 6 to 12 inches long.

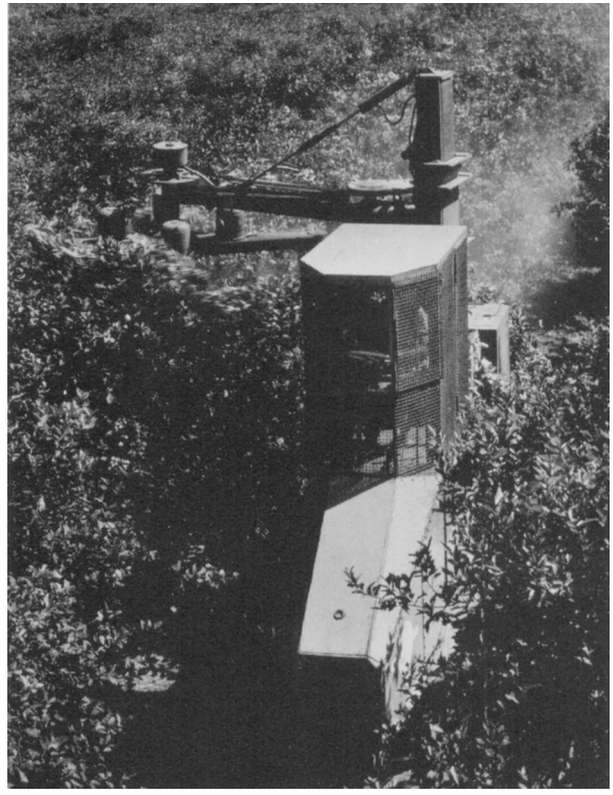
KMH sprays were used at concentrations of 0, 250, 500, and 1,000 ppm of the active ingredient. Alar sprays of 2,500 and 5,000 ppm were applied for comparison with unsprayed controls. The KMH contained a surfactant in the liquid formulation, but the Alar was used with the equivalent of 50 milliliters (ml) of X-77 wetting agent per 100 gallons of spray mixture. Only top growth was sprayed and this was done with a mist to minimize runoff. A randomized block experimental design was used with five single tree replications for each treatment.

After one week there was some downward curling of new growth on the trees sprayed with KMH. However, the trees sprayed with Alar showed no such symptoms. Two months after the treatment there were very definite symptoms of chlorosis and tip dieback of the new growth that had been sprayed with 500

TOP

TREES WITH

7 SPRAYS



Machine-topping of lemons.

Sprays of maleic hydrazide, potassium salt of maleic hydrazide, and NIA 10637, (growth inhibitors) effectively inhibited top regrowth of top-pruned lemon trees in Ventura County tests. These compounds have not been registered for use on citrus, however, and cannot be recommended for use at this time.

and 1,000 ppm KMH. Growth sprayed with Alar at 5,000 ppm showed some leaf chlorosis. Eight months after spraying, height measurements indicated a significant reduction in top growth and shoot length from the KMH sprays. Growth was reduced by the Alar sprays, but not significantly.

Height measurements taken one year after spraying showed a trend of growth limitation related to the use of chemicals and to their concentrations; however, the reduction with KMH was not significant. Alar sprays had not significantly inhibited top regrowth by the end of one year.

NIA 10637 sprays

The experimental growth inhibitor, ethyl hydrogen 1-prophylphosphonate (NIA-10637, Niagara Chemical Division) has shown promising results for use in retarding shoot growth of wild cherry, poplar, ash, maple, and other ornamentals. In past studies, a significant retarding effect on *Eucalyptus globulus* labill 'Compacta' Hall seedlings at the Citrus Research Center was obtained by spraying with NIA-10637. On the basis of these results, preliminary tests were initiated on mature lemon trees in an orchard east of Ventura. The trees were all mechanically topped to a height of 10 ft in May 1969 and the sprays were applied July 8, 1969, when regrowth was from 9 to 12 inches long.

Top growth was sprayed with a mist to minimize runoff with 625, 1,250 and 2,500 ppm NIA-10637 in water with 0.02% X-77 as wetting agent. A randomized block experimental design was used with five single tree replications. Plant height was measured prior to treatment on July 8, and then afterwards on September 11, and on December 10, 1969. Treatment effectiveness was measured by

TABLE 1. EFFECT OF KMH AND ALAR INHIBITOR SPRAYS ON REGROWTH ON TOP-PRUNED LEMON TREES

Treatment†		Average regrowth				
		9–17–68	5–24–69	Average increase	9–11–69	Total average increase
ppm		ft	ft	ft	ft	ft
0		10.0	13.1	3.1 Z*	15.3	5.3 NS
250	KMH	10.0	13.2	3.2 Z	15.2	5.2 NS
500	KMH	10.0	12.4	2.4 Y	15.0	5.0 NS
1,000	KMH	10.0	12.3	2.3 Y	14.5	4.5 NS
0		10.0	12.8	2.8 NS	15.1	5.1 NS
2,500	Alar	10.0	12.9	2.9 NS	15.1	5.1 NS
5,000	Alar	10.0	12.4	2.4 NS	14.0	4.0 NS

* All ranking is at the 5% level; averages are significantly different if they do not have subscript letter in common.

† Trees topped summer 1968 and sprayed September 17, 1968.

NS—not significant

TABLE 2. EFFECT OF NIA-10637 SPRAYS ON REGROWTH OF SHOOTS ON TOP-PRUNED LEMON TREES

Treatment†	Average regrowth				
	7–8–69	9–11–69	Average increase	12–10–69	Total average increase
ppm	ft	ft	ft	ft	ft
0	11.0	12.6	1.6 NS	14.7	3.7 Z*
625	11.0	12.5	1.5 NS	14.3	3.3 YZ
1,250	11.0	12.2	1.2 NS	13.6	2.6 Y
2,500	11.0	11.4	0.4 NS	12.0	1.0 X

* All ranking is at the 5% level, averages are significantly different if they do not have subscript letters in common.

† Trees topped May 1969 and sprayed July 8, 1969. The F test showed that the differences were significant at the 1% level. Duncan's Multiple range test was used to determine the significance of difference of the treatment averages.

NS—not significant

the amount of reduction of top growth in comparison with the unsprayed trees.

At two weeks

Two weeks after application no visual symptoms were observed in any treatment; however, 50 days after treatment, growth differences were noticeable. At that time trees treated with all concentrations showed some degree of leaf tip shrivel in the area of new growth that was sprayed. As the NIA-10637 concentrations increased, a greater percentage of the larger leaves of the 9 to 12 inches of new growth that was treated, shriveled, and stopped growing.

Height measurements are given in table 2. The amount of growth inhibition was directly related to the concentration of the treatment. Growth reduction, in comparison with the check, was significant (see photo) for the 1,250 and 2,500 ppm treatments in this experiment.

Earlier trials

In earlier trials, MH sprays did not affect yield or fruit quality significantly, but some thickening of the rind was noted on some fruit near the sprayed area. Rind measurements made of random fruit samples from the NIA-10637-sprayed trees showed no appreciable rind difference due to sprays.

Eight months after the spraying of young regrowth of topped lemons with 250, 500, and 1,000 ppm of KMH, there was a significant inhibition of growth. There was still a growth reduction due to treatment after 12 months, but it was not statistically significant. Similar sprays of Alar at 2,500 and 5,000 ppm caused a slight reduction in top growth of some trees after eight months but there were no significant differences either eight or 12 months after treatment. A third new growth inhibitor, NIA-10637 at 625, 1,250 and 2,500 ppm inhibited some top growth two months after spraying. Five months later, these growth differences were significant at all concentrations.

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J. P. Corkins of Uniroyal, and E. A. Kurtz of Niagara Chemical Division supplied the chemicals used in these studies. S. F. Wear of Ventura Coastal Corporation, and J. C. Tobias of the Gardner Venture Grove furnished the trees used in the field trials.

Effects of PHOTOCHEMICAL ON AND NAVEL

C. R. THOMPSON O. C. TAYLOR

Los Angeles Basin smog, caused principally by automobiles, consists of ozone, oxides of nitrogen, carbon monoxide and peroxyacyl nitrates plus some fluorides and sulfur oxides. It causes much leaf injury to leafy vegetables, grapes and ornamentals in this basin and elsewhere; citrus is very resistant to this kind of damage. Because little overt injury was seen on citrus but yields were continuing to decline, a unique, broadly based cooperative effort was begun in 1960 to find out if and, if so, how much actual injury was being caused by air pollutants.

Research program

The Agricultural Air Research Program of the Statewide Air Pollution Research Center was organized to do the job and was supported by agriculture, industry, local and national government and private organizations with a total expenditure of $1.5 million over a period of eight years. Studies were begun on two lemon groves near Upland, California because of their rapid growth and the existence of both automobile smog and some fluorides in the area. Navel oranges were added later.

TABLE 1. EFFECT OF AIR POLLUTANTS ON LEMON LEAF DROP UCR, 1962

Air Pollutant	Per cent leaves dropped, Lemon 1	
	12 mo.	18 mo.
Filtered air	8.4	32.0
Filtered air + HF	6.9	23.1
Low ozone air	12.3	40.2
Low fluoride air	37.3	93.7
Low ozone, low fluoride air	14.8	58.5
Ambient air	19.2	70.1
Check	12.8	56.9

The experimental procedure was to enclose young, vigorous bearing trees in plastic covered greenhouses (see photo) and supply fractions of the atmospheric pollutant complex to find out which components were having the greatest effect. Removal of the most toxic materials was done with activated carbon and limestone filters. Carbon removed ozone, peroxyacyl nitrates and nitrogen dioxide, while limestone removed fluorides. Six treaments of four trees each were used in the three locations to find out whether ozone, peroxyacyl nitrates or fluoride was causing injury. The ambient levels of total oxidants (mostly ozone) and fluoride were measured continuously with checks on oxides of nitrogen and peroxyacetyl nitrate during certain periods. The amount of carbon dioxide absorbed by lemon trees was recorded for several monthts.

Water use

Shortly after the experimental study was actually begun in 1962, differences appeared in the amounts of irrigation water needed to maintain soil moisture levels. Irrigation was on a bimonthly schedule. The trees which received carbon-filtered air required significantly more water than others, indicating that removal of ozone, peroxyacyl nitrates and nitrogen dioxide from the air allowed the trees to transpire water faster.

The yield results (table 2) were grouped into two categories—those trees receiving carbon-filtered air and those without treatment. The addition of ambient levels of hydrogen fluoride to the carbon-filtered air (filtered air plus HF) showed no statistical difference. It was