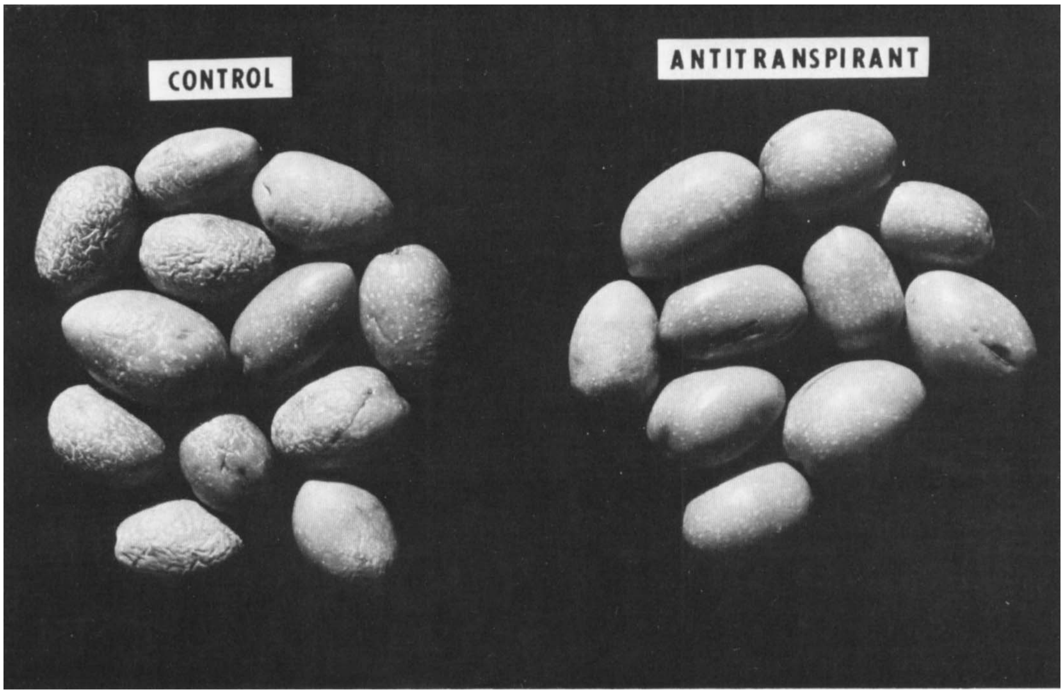


Reduction of fruit shrivel by antitranspirant sprayed on Sevillano olive trees is shown in photo to right, as compared with untreated fruit to left.

Antitranspirants reduce plant water stress by decreasing water loss through the leaves of olive trees — thus increasing fruit growth. In areas, such as Northern California, where dry northerly winds occur, antitranspirants can markedly reduce the incidence of shrivelled fruit. The antitranspirants in this study were used on an experimental basis and have not yet received EPA approval, although efforts toward approval are being made. Therefore, the results presented indicate the potential of these materials for fruit sizing and are not intended as a recommendation at this stage.

ANTITRANSPIRANTS increase size, reduce shrivel of olive fruit

D. C. DAVENPORT • K. URIU • P. E. MARTIN • R. M. HAGAN

THE ACTION OF ANTITRANSPIRANTS was studied during October 1971 in a Sevillano olive orchard near Corning, Tehama County, where the fruit has difficulty achieving maximum size some years because of rather poor, shallow soil and a high incidence of strong, dry north winds. Not only is size reduced, but the fruit may also on occasion actually shrivel on the trees, becoming unacceptable for processing and marketing.

The antitranspirants tested are waxy emulsions. When sprayed on plant foliage, they dry to form thin, invisible films over the stomata-bearing surfaces (the underside) of leaves. Since the stomatal pore is a common passage through which water vapor escapes and carbon dioxide enters the leaf, such a film over the stomatal aperture could be expected to slow both transpiration and photosynthesis.

Since most of the transpiration is via the stomatal pores, curtailing water losses involves spraying the lower surfaces of as many leaves as possible. The effect of any spray that reaches the fruit itself is merely incidental. The antitranspirant film on the leaves increases fruit size by reducing transpiration — which increases the water potential of the tree (increasing the water content of the plant tissue), and in turn causing the cells to become more turgid and therefore to expand more readily. Thus, growth is increased.

However, since growth also reflects the accumulation of dry matter (from photosynthesis), and since the film slows photosynthesis, the spray should be applied when fruit growth depends more upon maintaining turgid cells than upon accumulating dry matter. For the California olive crop, this period is in October (during the last three weeks before harvest), when there is a rapid increase in the moisture content and fresh weight of the fruit, but very little further increase in dry-matter content. (The olive fruit accumulates dry matter rapidly from June to August.)

Selection

Fifteen Sevillano olive trees, about 10-12 ft high and 12 years old, were selected on the basis of uniformity of appearance. Five were left unsprayed, five were sprayed with CS-6432 (1½%), an experimental antitranspirant from the Chevron Chemical Company, and five were sprayed with RD-9 (1:8), an antitranspirant from the Mobile Chemical Company. Experimental measurements included: (1) temperature and humidity; (2) water status of the trees; and (3) size, dry weight, and texture of the fruit.

Fruit tagging

Twenty fruit, distributed all around the tree, were tagged on each tree (100 tagged fruit per treatment). The diameter of each tagged fruit was measured periodically with calipers, beginning October 5 and ending November 2 (at harvest). Diameters were converted to volume per fruit by using a regression equation relating fruit diameter to volume (obtained by water displacement in a measuring cylinder). On October 20 the antitranspirant emulsion was applied at about 8 gallons per tree with a hand gun from an orchard sprayer operated at a pressure of about 250 lbs per sq inch.

The antitranspirant film was an effective barrier to transpiration according to measurements obtained with a diffusion porometer (rate hygrometer). This instrument showed that the antitranspirant films greatly increased resistance to the diffusion of water vapor out of the lower surfaces of the leaves (table 1), i.e., transpiration rate was reduced.

After the resistance was measured the leaf was cut from the tree and placed in a pressure bomb to determine its water potential, i.e., the degree of internal water stress. Table 1 shows that by reducing transpiration, the antitranspirants reduced the level of water stress in the leaves by about 50%, i.e., water potential was increased from -20 to -10 atms. As a result, water potentials were also significantly increased in the fruit.

The effects of the antitranspirants on water stress of the trees was also assessed by measurement of the daytime shrinkage of the tree trunk, using a dendrometer attached to the trunk. Water loss by transpiration from the leaves tends to be faster than replenishment by uptake through the roots. The trunks then shrink imperceptibly, even when soil-water is not limiting. The hotter and drier the day, the greater the shrinkage. The antitranspirants, by reducing transpiration, greatly decreased the amount of trunk shrinkage during the day (graph 1).

In other words, far more water was being held in the sprayed trees than in the unsprayed trees. The trunks began to recover (swell) by about 5:00 p.m. (daylight saving time). Normally, relative humidity at night increases to over 90%, but on the nights of October 27 and 28 the night humidity never rose above 35%, and daytime humidities dropped as low as 15%. As a result, the trees had little opportunity to rehydrate at night, thereby minimizing trunk shrinkage the next day and reducing the difference between the treated and untreated trees.

Fruit growth

Thereafter, nighttime humidities again rose to over 90%, allowing rehydration of the tree trunks at night and shrinkage during the day. As a result, on November 1 the control trees shrank more than 20 units during the day, whereas sprayed trees shrank less than 10 units, showing a continued effect of the antitranspirant. The period of extended low relative humidity beginning on the morning of October 27 and ending on the night of October 29, had a disastrous effect on the sizing and quality of fruit on unsprayed trees, as detailed in the next paragraphs.

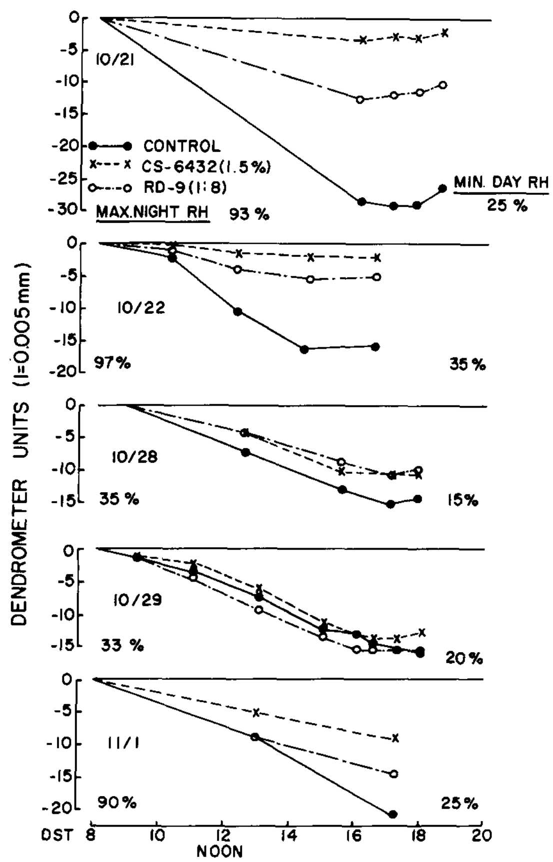
Prior to spraying, on October 20, all tagged fruit grew at approximately equal rates, as indicated by the parallel growth curves in early October (graph 2). The differences in actual fruit volume were merely random up to October 20. From October 20 to 22, however, the fruit on treated trees grew much faster than fruit on the control trees. During the period of extended low relative humidities, October 27-29, all the fruit shrank, though much less on treated trees.

Fruit recovery

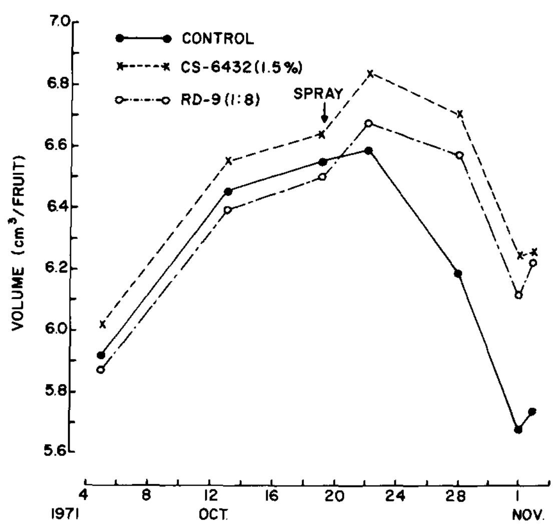
The fruit showed no signs of recovery until just before harvest, on November 2. Since all the fruit grew equally fast prior to spraying, each fruit just before spraying was assumed to be the same size, say 6550 mm^3. From this common base, the antitranspirants increased fruit volumes by about 2%, 7%, and up to 9% on October 22, 28 and November 2, respectively (table 2).

Since the antitranspirant is expected to reduce photosynthesis, fruit dry weights were measured at harvest. (Because the dry weight of a

GRAPH 1. EFFECTS OF ANTITRANSPIRANTS ON DAYTIME SHRINKAGE OF SEVILLANO OLIVE TREE TRUNKS



GRAPH 2. EFFECTS OF ANTITRANSPIRANTS ON GROWTH OF SEVILLANO OLIVE FRUIT



fruit is correlated with its size, the data are expressed in table 3 as dry weight per unit volume of fruit. Since the antitranspirant fruit on October 28 and on November 2 were about 8% larger than the controls, control volumes were adjusted upward by about 8% before the calculation of dry weight per unit volume.) As expected, the antitranspirant did not affect dry weights significantly. Thus, the increase in final fruit size by antitranspirant treatment was caused by improving the water status of the tree.

Fruit shrivel

The dry north wind in late October not only decreased fruit size but also caused extensive fruit shrivel on the unsprayed trees. The most striking effect of the antitranspirants was that they greatly minimized the incidence of the shrivelled fruit (see photograph and table 4). While 85% of the fruit on control trees were shrivelled and therefore unacceptable to the cannery, only 8 to 10% of fruit on antitranspirant-treated trees showed any signs of shrivel. The treated fruits were firmer and thus had a higher texture rating than the controls.

TABLE 1. ANTITRANSPIRANT EFFECTS ON DIFFUSIVE RESISTANCE AND PRESSURE POTENTIAL OF SEVILLANO OLIVE LEAVES AND FRUIT TWO DAYS AFTER SPRAYING

	Leaves		Fruit
	Resistance	Potential*	Potential*
	(min cm^{-1})	(atm)	(atm)
Control	0.077	-20.2	-24.9
CS-6432 (1.5%)	0.802	- 9.1	-17.3
RD-9 (1:8)	0.425	-10.6	-18.1
SEM ±	0.165	0.3	0.9
P <	0.05	0.001	0.001

*Greater negative value indicates more water stress.

TABLE 2. ANTITRANSPIRANT EFFECT ON SEVILLANO OLIVE FRUIT VOLUME (SPRAYED 10/20/71)

	Pre-Spray	Post-Spray					
	10/19	10/22		10/28		11/2	
	mm^3	mm^3	%	mm^3	%	mm^3	%
Control	6550	6596	100	6188	100	5744	100
CS-6432 (1.5%)	6550	6744	102	6614	107	6166	107
RD-9 (1:8)	6550	6722	102	6630	107	6274	109
SEM ±		2		4		54	
P <		0.001		0.001		0.001	

TABLE 3. ANTITRANSPIRANT EFFECTS ON SEVILLANO OLIVE DRY WEIGHT PER UNIT VOLUME (SPRAYED 10/20/71)

	Dry wt./vol (g/cm^3)		
	Pre-spray	Post-spray	
	10/20	10/28	11/2 (harvest)
Control	0.290	0.305*	0.321*
CS-6432 (1.5%)	0.285	0.311	0.319
RD-9 (1:8)	0.284	0.310	0.322
P <	NS	NS	NS

*Volumes adjusted by + 8% to compensate for smaller post-spray fruits.

TABLE 4. ANTITRANSPIRANT EFFECT ON FRUIT SHRIVEL AND TEXTURE OF SEVILLANO OLIVES AT HARVEST (11/2/71)

	Percent Shrivelled Fruit/Tree	Texture Rating*
Control	85	91
CS-6432 (1.5%)	10	107
RD-9 (1:8)	8	105
SEM ±	3	3
P <	0.001	0.001

*Arbitrary pressure units. Higher values indicate firmer fruit.

Fruit processing

Since removal of waxy materials from the fruit is desirable, samples of antitranspirant treated fruit were sent to a commercial cannery. The results were very encouraging in that one of the two antitranspirant materials was completely removed from the fruit surface by the normal lye and water process for black ripe olives, and the other material remained in only small amounts that were easily rubbed off. One of the materials was also completely removed by a green-ripe home process. The effects of remnants of wax films on olive grading and processing equipment, however, have not yet been evaluated.

Benefits

In summary, the benefits from antitranspirant treatment of olive trees include: (1) increased yield; (2) better dollar returns since more fruit will fall into higher and more favorably priced size grades; and (3) substantial reduction of fruit shrivel in areas where drying winds may desiccate the fruits, as in Northern California. In the Corning area during 1971, for example, antitranspirants could have made the difference between harvesting a satisfactory crop and no crop at all.

D. C. Davenport is Assistant Research Water Scientist, P. E. Martin is Staff Research Associate IV, and R. M. Hagan is Professor of Water Science, in the Department of Water Science and Engineering; K. Uriu is Pomologist, Dept. of Pomology, University of California, Davis. *Funds were provided by the United States Department of the Interior, Office of Water Resources Research, as authorized under the Water Resources Research Act of 1964 and by the University of California Water Resources Center. Advice and help was received from J. Osgood (Tehama County Farm Advisor) and research assistance from J. Pearson, M.A. Fisher and E.B. Roberts (Staff Research Associates). A. Burling contributed the use of his orchard.*

In direct-seeded asparagus fields, areas where plants are missing (skips) can be filled in two times during the year following the seeding operation. Two methods discussed here have been used successfully to fill skips in direct-seeded experimental plantings at the University of California Agricultural Experiment Station at Davis: (1) transplanting one-year-old asparagus crowns or (2) planting asparagus seedlings that have produced secondary stems and roots.

Brian L. Benson

Transplanting into DIRECT

IT IS A COMMON CULTURAL PRACtice to leave the inverted bed open for a year following the direct seeding of an asparagus field. If skips are present they can be filled in the winter or early spring just prior to the time the beds are back-filled, with number 1, one-year old, dormant asparagus crowns. This method of filling in skips is quite similar to the crown transplanting of production fields. The transplanted crowns are approximately two to three inches nearer the soil surface than the established crowns after the beds are back-filled.

Transplanting seedling asparagus into skips while the beds are still open allows the transplants to grow at the same soil level as the established plants. Seedlings can be transplanted easily with a very low mortality rate over a period of several months using the tools and methods described here (see photos and sketch).

The tools can be made with a minimum of effort at a cost of less than $5 for the materials. The two coring tools (diagram) have 1-inch conduit pipe for handles. Three-inch and 2-1/2-inch thin-walled steel pipe is used to extract the cores. The beveled ends of the 3- and 2-1/2-inch steel pipe allow for easy removal of the soil cores. A piece of flat iron with a 1/8-inch slot, 3/4 inch deep, is used to bevel the ends of the pipes. A small amount of heat applied to the pipe will allow for a smoother bevel. A core extracting tool is used to