

Breeding Canning Tomatoes

canning strains resistant to *Verticillium-Fusarium* wilts further developed by plant-breeding program

G. C. Hanna

The principal canning variety of tomato in California in 1940 was the Santa Clara, but because of the spreading of *Fusarium* wilt in the Woodland area, it was thought that a *Fusarium*-resistant Santa Clara was needed.

Resistance to *Fusarium* wilt was found in a small wild species—known as Red Currant—that had been introduced by the United States Department of Agriculture. In addition to *Fusarium* resistance, Red Currant had about five times the ascorbic acid content—vitamin C—and about two times as much soluble solids as Santa Clara.

By crossing the Santa Clara and the Red Currant types, resistance at as high a level as the resistant parent was transferred to the progeny. The soluble solids and ascorbic acid content were about 75% of the Red Currant level.

Unfortunately, the size of the fruit was only slightly larger than the Red Currant. The only way to increase fruit size was to cross the progeny back to Santa Clara. Resistance to *Fusarium* wilt was maintained by inoculating the seedlings of this backcross and selecting those that were resistant. Fruit size was increased from a half to about an inch in diameter. However, even with testing and rigid selection, there was a further loss of ascorbic acid and solids content. After the third backcross, accompanied by testing and selection, a resistant strain—with slightly higher solids and ascorbic

acid content but otherwise essentially a Santa Clara—was ready for release in 1946.

However, growers were not interested in the new Santa Clara type because by 1944, it had become apparent that Pearson would become an important variety—it matured earlier, had a smaller vine, and harvesting labor definitely preferred to pick it—but canners objected to the large core.

In 1944, Pearson was crossed to several small derivatives of the Santa Clara-Red Currant lines in order to incorporate the genes for resistance, high solids and ascorbic acid content. By repeated backcrosses to Pearson—with selection for resistance, small cores, high solids, and high ascorbic content—a number of strains were developed with yield and quality superior to Pearson.

Two major difficulties were encountered in the breeding work on the Pearson type: when the tomatoes are picked, the stems remain on the fruit, and—when the core has been reduced—the fruit is too soft to be handled as they are handled by the industry. By rigid selection, some strains have been developed to the point where the adhering stems are not too serious, but the soft fruit remains a definite problem.

By 1950, a strain of tomatoes, developed by the United States Department of Agriculture and resistant to *Verticillium* wilt, became available. Because of

the wide distribution of *Verticillium* wilt in the canning tomato area, it was considered advisable to incorporate the factor for *Verticillium* resistance into the *Fusarium*-resistant strains.

Several crosses of the two resistant strains were made in 1950, and—at the present time—most of the strains being grown in the experimental plots are completely resistant to both *Verticillium* wilt and *Fusarium* wilt.

Since the original *Verticillium*-resistant parent had rather soft flesh and adhering stems, these problems remain to be overcome.

In 1953, Webb Special—a firm, deep-red-flesh tomato with a small core—was grown for the first time at Davis. It matures later than Pearson and does not yield as well, but because it does have the desirable features that the present breeding strains lack, it has been crossed to some of the more promising strains in an attempt to overcome the soft fruit character.

In 1947, looking ahead to the possibility of mechanical harvesting, San Marzano was crossed with Gem—a small determinate vine type—because, without any preliminary trials, it was considered necessary to have a small vine with a concentrated set of fruit so that all the crop could be harvested at one time.

By 1950, a number of small-vine San Marzano types had been developed—but all of them were susceptible to *Verticillium* wilt. Although yields were satisfactory, the leaves in the center of the plant died before the fruit ripened. The results were piles of sunburned fruit. To overcome this difficulty, several of the more promising strains were crossed with the *Verticillium*-resistant round type—also a result of a breeding program.

By 1953, a number of F_3 —third generation—lines, which were resistant to *Verticillium* wilt and which retained their leaves fairly well, were developed. It appears that—with further selection—suitable resistant lines can be developed.

To maintain the high level of solids and high viscosity of San Marzano—two of the major attributes of the variety—in the progeny of the crosses, many laboratory tests were required. In fact, it was necessary to develop a method for testing viscosity of small samples. The new

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Distribution of All the Breeding Strains of Round Tomatoes Grown at Davis for the Past Four Years as to Quality Ratings on Canned Samples

Soluble solids		Color		Wholeness		Ascorbic acid	
No. of strains	Values in per cent	No. of strains	Values**	No. of strains	Values**	No. of strains	Mg/100 cc
3	4.6	3	24.0	2	15.5	5	14
18	4.8	2	24.5	4	16.0	22	16
36	5.0	9	25.0	2	16.5	49	18*
35	5.2	9	25.5	16	17.0	45	20
28	5.4	53	26.0*	38	17.5	51	22
60	5.6*	67	26.5	84	18.0	51	24
38	5.8	97	27.0	83	18.5*	41	26
57	6.0	31	27.5	84	19.0	30	28
25	6.2	31	28.0	14	19.5	16	30
15	6.4	11	28.5	13	20.0	9	32
6	6.6	3	29.0			2	34
1	6.8					4	36
						2	38

* Four-year average.

** Based on Federal Grades, where 30 is highest value for color and 20 is highest value for wholeness.

Use of Demeton on Citrus Trees

effective control of citrus red mite and green citrus aphid obtained with systemic insecticide

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Demeton has shown most outstanding promise for control of aphids and red spider mites on citrus.

Demeton, an insecticide which may be absorbed by the plant and translocated to other parts of the plant, is a brown liquid of low viscosity, insoluble in water but soluble in organic solvents. The commercial demeton—Systox—formulations contain 21.2% or two pounds of active material per gallon. The extender is an emulsifier which makes the resulting product the consistency of molasses. When added to a spray tank containing water under high agitation, excessive foaming results which may be lessened by reducing the agitation or by using a defoaming agent.

Demeton should not be applied within 21 days of fruit harvest; otherwise treatments may be made at any time of the year suitable for spray practice. Soil applications—either directly or in the irrigation water—have not been sufficiently effective for practical use under field conditions. Applications of the current commercial formulations to the trunks of orange trees have resulted in some bark-injury where applications were made.

Citrus Red Mite

Control of citrus red mite—as effective as that obtained by acaricides in general use—has been achieved by thorough coverage applications of the type normally used for applying petroleum oil. The spray should have not less than four ounces of the two-pound-per-gallon—

21.2%—formulation per 100 gallons. With spray blower equipment, 2½ to five pints per acre should be applied. The lower dosage should be utilized only on relatively small orange trees or lemon trees that would require 1,000 gallons of spray per acre for the thorough coverage type of application. For larger trees or when less volume of spray per unit area is applied, the amount per 100 gallons of spray should be proportionately higher.

Green Citrus Aphid

Experimental evidence has shown that demeton is considerably more effective in controlling the citrus red mite than the green citrus aphid. Dosages which will control the citrus red mite will give an excellent initial kill of the aphids attacking citrus. However, the residual effect is much shorter. Consequently, more than one treatment may be necessary for adequate control of the aphids during any one season.

Spray coverage is important. A uniform distribution of the finished spray is necessary because at economic dosage levels sufficient demeton is not translocated to cause mortality of the green citrus aphid on unsprayed portions of the tree.

When a thorough outside spray coverage is applied to mature trees with a conventional high-pressure spray rig or the oscillating boom type, not less than four ounces of demeton—21.2%—per 100 gallons should be used.

If the spray is applied by air carrier equipment, 2½ pints—or more—of demeton per acre should be applied at not less than 200 gallons per acre.

Experimental evidence further indicates that longer residual effectiveness is achieved as the dosage per tree unit is increased. In protecting replants or young nonbearing trees interplanted with other crops, it is often desirable to obtain maximum residual control of aphids and mites. Because of their small size and, therefore, the low volume of spray required, it may be economically feasible to increase the spray concentration to one-to-two pints per 100 gallons in order to lengthen the residual action and thus minimize the number of applications required. However, not more than one pint per 100 gallons may be used on trees

bearing fruit when demeton is applied as a full coverage spray.

Other Insects and Mites

In a limited number of tests, demeton—at the dosage for control of citrus red mite—resulted in effective control of the six-spotted mite—*Eotetranychus sexmaculatus* (Riley); the Yuma mite—*Eotetranychus yumensis* (McG.); and the Lewis mite—*Eotetranychus lewisi* (McG.). At the dosages for citrus red mite control, demeton can not be depended on for control of citrus bud mite—*Aceria sheldoni* (Ewing); citrus rust mite—*Phyllocoptata oleivora* (Ash.); or citrus flat mite—*Brevipalpus lewisi* (McG.); or other pests of citrus.

Sufficient information is not available to ascertain the effects of demeton applications on insect and mite predators and parasites of citrus pests. However—at the dosage used—it is unlikely that all stages of the parasites or predators would be eliminated. As demeton is readily absorbed by the plant, the residual toxicity to natural enemies of the citrus pests should be minimal.

Insufficient information is available to specify compatibilities of demeton with materials currently used on citrus. Demeton is relatively unstable in an alkaline medium, and any additions that tend to make the spray mixture more alkaline should not be used until further information is available.

Special Warning

Demeton, like certain other organic phosphate insecticides, is extremely toxic to human beings. No warning symptoms are apparent in advance of a dangerous degree of poisoning and the imminent possibility of death. Exposure to any dilution of this material in any form must be rigidly minimized. Precautionary recommendations on manufacturer's label must be followed without exception or modification. Antidotal treatments should be available without delay.

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resistant lines will be tested in 1954 for solids and for viscosity.

The San Marzano was chosen as suitable—for working out the basic principles of mechanical harvesting—because of the amount of labor in manual harvesting and because it can withstand comparatively rough handling. It is planned to have a mechanical harvester in the field to check the development of the basic principles on these new resistant strains.

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