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The Citrus Variety Improvement Program in Turkey

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ABSTRACT. Almost all of the citrus trees in Turkey are infected with one or more virus and virus-like diseases which induce large economic losses. The establishment of a Citrus Variety Improvement Program for Turkey (CVIPT) was needed to solve this problem. To accomplish this, computer controlled greenhouse facilities covering 7,000 m² plus 1,800 m² of screenhouses were established to conduct biological indexing and to maintain virus-tested, foundation plants, and also to propagate budwood increase plants. These facilities are located at the Antalya Citrus Research Institute in Serik. The program began with 36 candidate trees of ten cultivars which were selected from the best commercial groves in Turkey. A laboratory facility was constructed at Serik and equipped to do shoot tip grafting (STG), thermotherapy, ELISA and polyacrylamide gel electrophoresis (PAGE). At present, 382 STG plants have been obtained. Of these, 79 have been indexed to a variety of indicator plants and 69 were found free of the major virus and virus-like diseases of citrus. As of October, 1992, 5,000 healthy citrus plants were being grown under screen, and 25,000 sour orange seedlings were budded with virus-tested buds. A long term budwood release program is being planned with the establishment of a foundation block of trees. These trees will be derived from both STG and heat treated sources, and will be extensively indexed for a broad range of citrus pathogens.

Index words. Shoot-tip grafting *in vitro*, virus indexing, certification, clean budwood.

Virus and virus-like diseases are one of the main factors causing low citrus fruit production in Turkey (3,7,8). The use of budwood from infected trees for nursery propagation is primarily responsible for distributing diseases (12). The diseases of tristeza exocortis, cachexia, concave gum, psorosis, psorosislike pathogens, gummy bark, gummy pitting, vein enation and satsuma dwarf are known to be present in Turkey (1,2,3,4,5,7,8). Our objective is the freeing of citrus pathogens and the propagation of "virus-tested" citrus budwood for establishing new orchards of clean trees. We were supported in our efforts by a Technical Cooperation Program with the Food and Agricultural Organization of the United Nations (FAO) (10,11).

This program began in February 1988 and consisted of the following steps: 1) selection of trees; 2) indexing; 3) elimination of pathogens by shoot tip grafting (STG); 4) reindexing of the STG plants; 5) establishing foundation and budwood increase plants; 6) propagation and increase of healthy nursery stock.

Selection of trees. A ten-year selection program was carried out in

the Mediterranean and Aegean Regions of Turkey, and 36 candidate trees were established at the Antalya Citrus Research Institute. These consisted of ten sweet oranges, nine mandarins, and 17 lemons. Later varietal selections of three grapefruits, one lemon, three sweet oranges, and seven mandarins were added to the program. These candidate trees were carefully chosen for fruit bearing qualities and trueness to type.

Indexing. These 36 selected candidate trees were indexed for citrus tristeza virus (CTV), stem pitting tristeza (CTV-SP), seedling yellows tristeza (CTV-SY), citrus tatterleaf virus (CTLV), citrus exocortis viroid (CEVd), various citrus viroids (CVD), citrus cachexia viroid (CCaVd), stubborn disease, psorosis and psorosislike pathogens (PLP), satsuma dwarf virus (SDV) and vein enation (VE). The candidate trees were biologically indexed to indicator plants by the methods described by Roistacher (12). Table 1 lists the indicator plants used, the pathogens indexed and indexing conditions. Serological indexing using ELISA was later included for detection of stubborn, CTV and SDV.

TABLE 1
INDICATOR PLANTS, PATHOGENS INDEXED, AND INDEXING CONDITIONS

Indicator plants	Pathogens indexed	Replicates	Plants/ container	Temperature (C)	
				Night	Day
Mexican lime	CTV, VE	4	3	18-21	24-26
Sour orange	CTV, SP	4	3	18-21	24-26
Duncan grapefruit	CTV-SY	4	3	18-21	24-26
Sweet orange (Pineapple)	PLP	4	3	18-21	24-26
Mandarin (King, Kara, Dweet)	PLP	4	3	18-21	24-26
Lemon (Kara)	PLP	4	3	18-21	24-26
Citrange (Rusk, Troyer)	TLV	4	3	18-21	24-26
861-S-1	CEVd	5	1	26-29	32-36
Citron/rough lemon	CCaVd	5	1	26-29	32-36
Parson's Special mandarin/ rough lemon					
Madam Vinous sweet orange	Stubborn	5	1	26-29	32-36
White sesame	SDV	8	5	18-21	24-26

Biological indexing of candidate trees was completed after the first two years of the program. Thirty-three out of the 36 candidate trees were found infected with one or more graft transmissible pathogens (7). Thirty-two trees were found infected with CEV, 24 with cachexia, 14 with psorosis and psorosis-like pathogens, seven with stubborn, and two with SDV. Only three out of the 36 original candidate trees were found to be "virus-free". These were all satsuma mandarins. Indexing continues with the culturing for stubborn and using PAGE for detection of various citrus viroids.

Elimination of pathogens by STG. Shoot tip grafting (9) is now an integral part of the CVIPT. All candidate trees were shoot-tip grafted beginning in 1990 as the third step in our program. Three hundred eighty-two plants were obtained after STG from the original 36 candidate trees. Most of the STG plants were taken directly from the test tube and top-grafted to large seedlings of rough lemon as described by de Lange (6).

Reindexing of SGT plants. Out of the 382 STG plants, 79 were indexed. At least two selections were made of each of the 36 candidate trees. The results of indexing are shown in Table 2.

As of October 1992, five STG plants were found positive for CEV, six were positive for psorosis-like pathogens and none were found positive for CCaVd, CTV, VE, TLV, SDV, and stubborn. Three of the six STG plants which were found positive for PLP came from trees which originally tested positive for PLP. However, the other three came from trees which were negative. This suggested that seed transmission could have been involved during the STG process. We used Troyer citrange as the seedling rootstock for STG. When we indexed the Troyer citrange seed source trees, we discovered that two of five trees were positive with PLP. These two positive trees were destroyed.

Establishing the foundation and budwood increase blocks. Two programs are planned for the production of virus-tested trees. These are shown in Fig. 1. The first is the Short-Term Release Program based on the indexing of virus-tested buds from STG plants. After the STG mother plants have fruited and the fruit is found true-to-type, buds and/or plants will be released to nurseryman for increase propagation. The second projected program is the Long Term Release Program. Here STG plants will be

TABLE 2
RESULTS OF THE FIRST 4 YEARS OF THE CITRUS VARIETY IMPROVEMENT PROGRAM IN TURKEY

Variety	No. of STG plants	No. of indexed plants	STG Incidence of symptoms							
			CTV	VE	CEVd	CCaVd	TLV	PLP	Stubborn	SVD
Sweet oranges	118	27	—	—	—	—	—	1	—	—
Mandarins	127	22	—	—	—	—	—	3	—	—
Lemons	102	25	—	—	5	—	—	2	—	—
Grapefruits	35	5	—	—	—	—	—	—	—	—
Total	382	79	0	0	5	0	0	6	0	0

Fig. 1. Diagram of the steps of the Citrus Variety Improvement Program in Turkey.

further treated by subjecting them to thermotherapy. After a complete reindexing using PAGE and other advanced techniques, trees will be established in a foundation block for evaluation of horticultural tree and fruit characteristics and certified buds will be propagated for distribution to nurserymen (Fig. 1).

The virus-tested foundation trees originating in Turkey or those developed from introduced budlines will be grown in containers and held in an

insect-proof screenhouse to prevent reinfection from insect-transmitted diseases. These trees will be used as the primary source material for propagation of clean budwood until field grown foundation block trees are large enough for budwood release. The program will be expanded as new material is obtained from domestic or international sources.

Propagation and increase of healthy nursery trees. Propagation of healthy budwood is continuing at the

greenhouses and screenhouses at the Antalya Citrus Research Institute at Serik. We now have 60,000 budwoods which have been derived from STG and indexed sources. These include Valencia and navel sweet oranges, Clementine and satsuma mandarins, lemons and grapefruits for the first release of healthy citrus budwood.

Also, propagations of virus-free nursery plants are being done at the Serik facilities to demonstrate to growers and nurserymen how to apply the techniques required for production of healthy plants. In October, 1992, some 5,000 virus-tested citrus plants were released to growers and 25,000 sour orange seedlings were budded with virus-tested buds.

There is a large demand by growers for these virus-tested plants in Turkey. Approximately 400,000 to 500,000 nursery trees are required by the citrus industry each year in Turkey. The clean budwood propagating capacity of the facilities at Serik are believed to be large enough to meet the demand for budwood. Presently, two large state nurseries are preparing their facilities to propagate virus-tested certified citrus buds.

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