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First Results of the Certification Program in Morocco

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ABSTRACT. Although the citrus sanitary selection program started in Morocco in the 1960s, the citrus certification program began only in 1984 with the aim of producing citrus propagation material free from the main virus and virus-like diseases prevalent in Morocco. The work carried out by Société de Développement Agricole (SODEA) since 1981 has been based on the selection of virus-free citrus material by means of indexing, ELISA and shoot tip grafting. This program has provided citrus growers with certified material of 36 varieties and clones of clementine, mandarins, oranges, lemons and grapefruit.

Citrus cultivation in Morocco covers about 70,000 ha, most orchards having been planted between 1940 and 1960. Disease surveys conducted in the country indicated that several virus and virus-like diseases, especially psorosis and stubborn were widespread (3, 5). Isolated cases of tristeza, the most serious threat to Moroccan citriculture, were identified in orchards (11) and germplasm blocks (8). The sanitary selection program was initiated in Morocco in 1962. Virus-free mother trees were selected by indexing old-line and nucellar varieties. However, this program was based on field observations and open field indexing (10). In 1980, Société de Développement Agricole (SODEA) initiated a new sanitary selection program based on greenhouse indexing and the production of virus-free material through shoot-tip grafting (STG). Results obtained in this program permitted the production of the first certified citrus plants in Morocco through SODEA (7).

We report here the preliminary results of the SODEA sanitary selection and certification programs.

MATERIAL AND METHODS

Citrus certification program. Certification and propagation of certified citrus material is regulated by law in Morocco (1). The certification procedure is carried out by institutions with approved indexing capabilities under the supervision of the Plant Protection Administration "Direction de la Protection des Végétaux, du Contrôle Technique et de la Répression des

Fraudes" (DPVCTRF). The virus-free certified material is propagated by approved nurseries under the control of DPVCTRF (6).

Disease control

Biological indexing. Biological indexing techniques employed in our program were conducted according to standard procedures (4). Inoculated indicator plants and healthy controls were maintained in containers in greenhouses under controlled environment. Indicator plants used were:

- Hamlin sweet orange seedlings for psorosis, cristicortis, impietratura and infectious variegation.
- Madam vinous sweet orange seedlings for stubborn.
- Parson's Special mandarin budded on rough lemon for cachexia.
- Etrog citron 60-13 and Arizona 861 budded on sour orange for exocortis.
- Mexican lime seedlings for tristeza.

Enzyme Linked Immunosorbent Assay (ELISA). ELISA was also used for tristeza detection according to the procedure described by Bar-Joseph *et al.* (2). Polyclonal antibodies employed in these assays were obtained from SANOFI, France.

Indexing. Over 600 trees, from 12 varieties, true-to-type, productive and with no apparent disease symptoms were selected from various orchards for indexing. This program also included nucellar and old-line selections from National Agricultural Research Institute (INRA) obtained in Morocco since the 1960s.

TABLE 1
PRESENCE OF VIRUS AND VIRUS-LIKE DISEASES IN SELECTED CITRUS VARIETIES AS DETECTED BY BIOLOGICAL INDEXING

Varieties	No. tested	Number of trees					Total	% infected
		No. infected						
		Psorosis ^a	Cachexia	Exocortis	Stubborn	Tristeza		
Clementine	160	34	8	30	14	—	50	31
Mandarin	11	2	1	3	1	—	7	63
Navelina	12	10	0	10	6	—	10	83
Washington Navel	231	20	8	36	86	—	115	50
Navelate	3	3	0	3	0	—	3	100
Salustiana	24	0	0	2	4	—	6	25
Maltaise ovale	5	0	0	3	3	—	4	80
Washington Sanguine	5	5	1	5	1	—	5	100
Valencia late	105	2	2	20	20	—	36	34
Lemon	44	0	0	0	0	—	0	0
Grapefruit	9	0	0	0	0	—	0	0
Others	18	1	0	1	0	—	2	11
TOTAL	627	77	20	113	135	0	238	38
% infected	100	12	3	18	22	0	38	—

^aIncluding psorosis and other diseases inducing similar foliar symptoms.

In addition, more than 1000 trees from different citrus regions in Morocco were indexed for tristeza for surveillance of this disease.

Production of virus-free material by shoot tip grafting (STG). All varieties for which virus-free material was not obtained by indexing or nucellar selection were included in the STG program.

Imported citrus varieties are required by Moroccan quarantine regulations to undergo STG. Therefore, all varieties which were recently imported from abroad were included in our program.

The procedure we use for STG was adapted from the techniques described by Murashige *et al.* (6) and improved by Navarro *et al.* (9).

RESULTS AND DISCUSSION

Table 1 shows the results of indexing for psorosis, cachexia, exocortis, stubborn and tristeza. These results revealed that among 627 indexed candidates representing 12 old and nucellar lines, 238 were positive for one or more diseases. The incidence was over 25% for all varieties except nucellar lines of lemon and grapefruit. All old lines, Washington sanguine, navelina, navelate and some Clementine cultivars were 100% infected.

Although the candidates were selected from highly productive orchard trees with no apparent symptoms, indexing results indicated that

psorosis, exocortis and stubborn are widely distributed.

Over 1000 trees from 25 varieties and clones were tested for tristeza, but only 16 Meyer lemon trees were positive. Trees surrounding infected ones were double tested and were found to be negative, thus indicating a lack of natural spread of tristeza from Meyer lemon under Moroccan conditions. These results confirmed those reported by Nadori and Zebzami (8).

As shown in Table 2, the program carried out by SODEA has permitted us to obtain virus-free material of several varieties:

- Eighteen varieties and clones of Clementine, mandarin, orange, lemon and grapefruit were selected by indexing.
- Thirteen infected varieties and clones were freed from virus and virus-like pathogens by STG.
- Four imported varieties went through the STG program as required by Moroccan quarantine regulations.

The sanitary selection program permitted selection of mother trees which were used for production of certified plant material. Thus, during the period from 1985 to 1991, SODEA produced five million certified trees of Clementine, mandarin, navel, Salustiana, Washington sanguine and Valencia late oranges. Ten rootstock varieties were also selected for certified seed production.

TABLE 2
VARIETIES AND CLONES SELECTED FOR THE MOROCCAN CERTIFICATION PROGRAM

Varieties	Selection by:	
	Indexing	STG
Clementine	Fine, Cadoux, Courtois, Ain Taoudjat, Sidi Aissa	Azemmour, G. P., Carte noire, Nules, Oroval Marisol, Larache, tardive Janvier 1, tardive Janvier 2, Muska, Nour
Mandarin	Temple	Temple, Ortanique, Nova, Fortuna
Sweet orange	Old lines: Washington navel, Valencia late Nucellar lines: Washington navel, Salustiana, Maltaise Ovale, Valencia late	Navelina, Navelate, Salustiana, Washington sanguine
Lemon	Frost Eureka, Lisborn (nucellar lines)	
Grapefruit	Ruby, Marsh, Shambar (nucellar lines)	

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