Citrus Rehabilitation in Indonesia

Arry Supriyanto and A. M. Whittle

ABSTRACT. The Indonesian citriculture has been severely retarded by an epidemic of greening disease since the early 1960s. As a result the average national productivity is less than 8 t/ha despite a rapid increase in planting areas. Of the important citrus-growing areas only the province of West Kalimantan remains essentially free of the disease. In the past a programme of antibiotic infusion was attempted, but without success. The province of Bali has implemented an eradication programme, resulting in the destruction of more than four million trees, pending the availability of disease-free plants. Since early 1987 an integrated rehabilitation programme has been operating based on the production of disease-free plants obtained by shoot-tip grafting (STG). Indonesia is peculiar in having very many local cultivars and, to date, more than 120 cultivars are in the process of being indexed after STG. Four foundation blocks are being strategically established in different islands, in addition to a supplementary protected foundation block in Bali to meet the special demands of the province. It is expected that the initial release of some 1.6 million plants will occur in 1991, with capacity to produce more than 12 million per annum by 1994. The strategies to be used for the release of disease-free plants are discussed together with recommendations for vector control.

Since the early 1960s citrus growing in Indonesia has been severely affected by greening disease, known locally as citrus vein phloem degeneration (CVPD), and it now occurs in most provinces with the notable exception of West Kalimantan. In all epidemic areas substantial economic losses are recorded. Tristeza is found in almost all trees, and exocortis, psorosis, vein enation/woody gall and cachexia recorded or suspected. Tatter leaf has not been positively identified although its occurrence is likely given the importation of plant material from East-Asia over a long period.

Past efforts to combat the disease have included selective eradication and antibiotic infusion but have had no success. In 1985 a programme to produce virus-free plants was initiated, and substantially intensified from 1987. In this context "virus-free" means free of systemic pathogens, including viroids and bacteria-like organisms. The current programme uses as its basis the large-scale production of virus-free plants and the development of a package of efficient pest and disease control measures to protect new plantings from reinfection. Such a programme also offers the opportunity to introduce improved orchard management procedures, including rootstock diversification, thereby creating a modern citrus industry able to meet demands of a national population of 170 million.

CITRUS VARIETY IMPROVEMENT PROGRAMME

The overall scheme being followed is shown in Fig. 1 (12, 13). The selection of mother trees is based primarily on horticultural qualities of each variety, rather than on initial phytosanitary standards, as most collection trees are infected with at least greening and tristeza. The Indonesian citrus variety collection at Tlekung has been the main source of materials, though it has been supplemented by some varieties from other provinces and from certified material from overseas. The variety collection currently contains 67 varieties of mandarin, 35 of sweet orange, 8 pommelo, 22 of grapefruit and 22 others.

Varieties are cleaned-up using standard Shoot Tip Grafting (STG) techniques as developed by Navarro *et al.*, (7) which has been reported to eliminate many of the pathogens occurring in Indonesia. Shoot tips are normally collected from the field directly, but some have been obtained from pot-grown plants or from cuttings. Successful grafts are regrafted one month later onto young and vigorous seedlings in a warm screenhouse to promote growth and flushing; depending on the

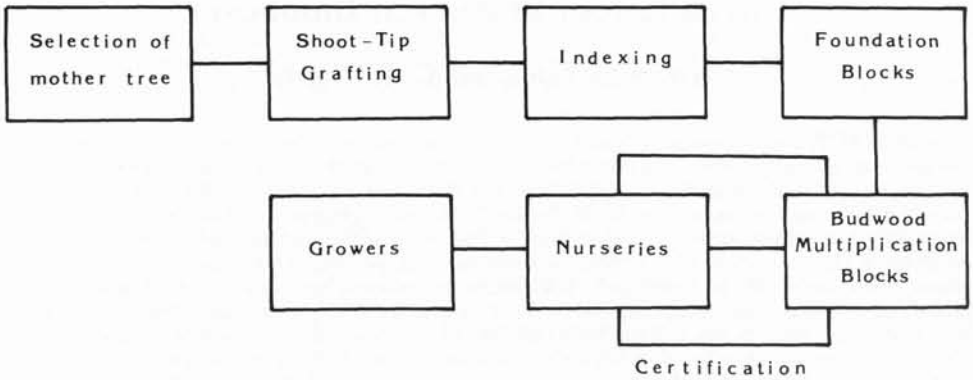

Fig.1. Scheme of the Indonesian Citrus Variety Improvement Programme.

variety, indexing can commence two to four months after regrafting.

Indexing is an important component of the programme in terms of the verifications of the virus-free status of the resultant plants. Tissue grafting, ELISA and electrophoretic techniques are all used. In order to reduce the number of plants required, shoot-tip source plants are indexed first to determine those non-vector transmissible pathogens present at source, and then the regrafted plants are indexed again to confirm the elimination of those pathogens indicated (6). All regrafted plants are indexed for tristeza and vein enation/woody gall, but indexing for greening on sweet orange is restricted to varieties other than mandarins and sweet orange, which are considered to be self-indicating.

It is noted that although the shoot tip size used in STG is 0.1 to 0.2 mm, consisting of the apical meristem and three leaf primordia as recommend by Navarro (7) for recovering pathogen-free plants, a relatively high percentage of STG plants, 19% of mandarins and 45.1% of sweet oranges was infected by CTV (6). Furthermore, CVPD can completely be eliminated by STG (Muharam, pers. comm.).

Foundation Blocks. Foundation Blocks (FB) are the Primary sources of budwood for the programme and consist of trees grafted with virus-free material following the confirmation of that status by indexing. They will be preimmunized with mild tristeza strains, although a completely virus-free collection is retained in a screenhouse. Under the programme four blocks are envisaged in strategic areas and planned in size and composition to meet the excepted demands for the zones they will serve (Fig. 2).

These FBs are being established in Zone 1 in East Java, in Zone 2 in Riau, in Zone 3 in West Kalimantan and in zone 4 in South Sulawesi (4). A subsidiary screenhouse protected block has been established in Bali to serve the special requirements of that province for a rapid replanting. All are government owned, and as isolated as possible to reduce reinfection risks, and subject to regular indexing.

Budwood Multiplication Blocks. Given the high costs of Foundation Block maintenance and the very large number of buds required a system of budwood multiplication is essential. A Budwood Multiplication Block (BMB) consists of densely planted small trees produced from buds from FBs and is the direct source of buds for nurseries. In order to reduce reinfection risks such blocks can only be harvested over a 3-year period before eradication, but during this period each plot should provide about 250 buds.

It is impractical to index trees in BMBs so vigorous vector control must be employed. Although in principle BMBs can be in the private sector the authorities in Bali and East Java, where first releases will occur, have kept them under Government owner-

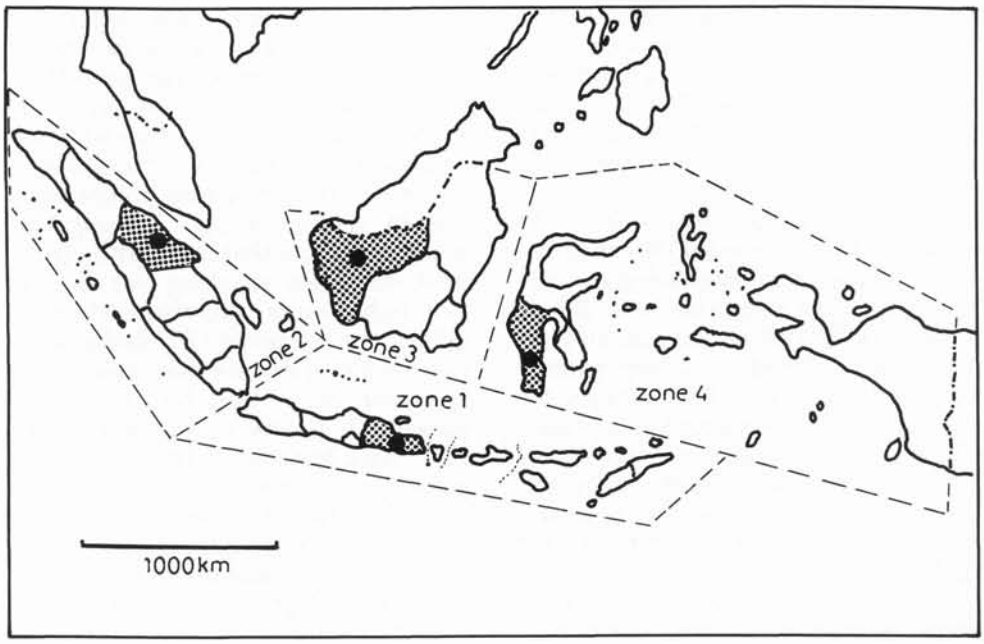

Fig. 2. Location of Foundation Block and its zone of budwood distribution.

ship. In other province where there are existing large nurseries these may in future maintain their own BMB.

Nurseries. The main problem of managing the virus-free nurseries in Indonesia will be the great number of them. In the latest data (1) there were 808 nurseries registered for the scheme for labelling plants "free from CVPD symptoms", producing 7,604,000 plants in 1986, but it can be assumed that the real total nursery figure is double that.

The nurseries can be classified into four groups, those are small, medium, large and very large scales with production capacity $< 2{,}000$, 2,000-20,000, 20,000-50,000 and $> 50{,}000$ stocks per year respectively. The majority of nurseries are relatively small, with widely varying production capacities and management levels. More than 85% of nurseries are classified as small or medium but account for only 40% of production, whereas the larger 15% produce almost 60%. It will therefore be necessary to reduce the number of nurseries to a more rational number by consolidation or closure.

Certification. The system for the distribution of virus-free budwood and stocks for FBs to the grower is so long that risks of reinfection cannot be avoided. In order to ensure that the plants available to growers retain their phytosanitary quality a certification programme is being currently planned, based on intensive inspections at critical periods, but a crucial aspect will be the development of nurserymen's associations through which information can be channelled in order to increase the professionalism of this vital sector.

RELEASE STRATEGIES

There are very few large orchards in Indonesia, with citrus being grown on a very large number of small holdings. Because of this, and notwithstanding the fact that *Diaphorina citri* is generally considered as a weak flier, the replanting of individual orchards when surrounded by existing infected orchards would be bound to fail. With greening being at epidemic levels, resulting in a high inoculum and almost uncontrolled vector populations, sani-

tation is of little value as a result of the delay between infection and symptom expression; it is necessary to eradicate and replant large areas. The CVIP has therefore been designed to reflect this need for an early large-scale plant requirement.

The first releases will be in East Java and Bali at the end of 1991 or early 1992, with initial releases being around 1 million in East Java (4) and 0.5 million in Bali (3). By 1993 a minimum annual production of 10 million nursery plants will be achieved, with the total replanting of more than 80 million being possible by 1997. Such high nursery production, coming from legally enforced larger nurseries, is necessary to saturate the market and permit total VF replanting.

For practical purposes the large areas required to be replanting will have to be based on administrative boundaries, rather than other criteria, although, because of local development plans administrative boundaries often closely follow citrus concentrations. In this respect the most suitable unit is the kabupaten, or regency, which is the first sub-unit of the province. In East Java, with 30 kabupaten, the total citrus trees in each kabupaten varies from 36,000 to almost 1 million.

The position is clear for the first release in Bali where, in Kabupaten Buleleng, all citrus has already been eradicated, but in East Java there has been no eradication programme, though one will have to be applied. It is for these reasons that the Indonesian CVIP has been developed on such a large scale, to produce a sufficient number of plants to enable very large areas to be eradicated and subsequently replanted in short time. Piecemeal replanting in endemic areas would have little effect, even with effective vector control in replanted areas. The strategy adopted, for a programmed eradication and replanting is a practical way of implementing the proposal that only a total eradication of all citrus in Java offered a chance of success (10).

Even with large-scale replanting with disease-free trees it is inevitable that some inoculum will remain, either though some reinfection in nurseries or with the retention of undetected backyard trees. The key to the ultimate success of the replanting programme lies in vector control. A computer model indicates that even with stringent sanitation anything less than a 70% reduction in transmission barely delays the epidemic (H. Rathgeber, pers. comm.); despite the almost total reduction of *D. citri* by introduced parasites in Reunion (2), experience in S.E. Asia has shown that the same parasites are unable to achieve such control levels (8) possibly due to the presence of hyperparasites. In Indonesia some control is exerted by parasites and predators (9), but this cannot be relied upon.

Following from the use of bark applications of monocrotophos (Azodrin 40) in South Africa (5) trials with bark painting using Azodrin 15 in Indonesia have shown very positive results (9; Nurhadi, pers. comm.), and its use is likely to be adopted for *Diaphorina* control. The most effective time to start the applications appears to be immediately before the main flush when adults are still feeding. The use of this system in South Africa has permitted large numbers of newly planted trees to remain greening free, even in endemic areas such as Nelspruit (Buitendag, pers. comm.).

SUMMARY

With the scale of the greening epidemic in Indonesia it seems unlikely that any steps short of wholesale eradication and replanting with disease-free material can succeed. Based on this assumption Indonesia has embarked on a programme for the production of very large numbers of disease-free plants, with a simultaneous development of a technology package offering an effective means of protecting these plants from later infection. Such a campaign also permits the introduction of

more modern cultural techniques, the adoption of alternative varieties and rootstocks, and a general improvement in productivity and quality, all of which should provide long-term benefits to the Indonesian citrus industry.

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