



African Citrus Greening disease detected in Gqeberha, East London and Knysna

Paul Fourie, Wayne Kirkman, Elma Carstens and Vaughan Hattingh
Biosecurity division, Citrus Research International;
Email biosecurity@cri.co.za

Background

African Citrus Greening disease (Greening) is caused by a phloem-limited bacterium, *Candidatus Liberibacter africanus*. In brief, the bacterial infection blocks the phloem vessels, which results in a variety of fruit and foliar symptoms [branches with yellow blotchy mottle symptoms on leaves (Fig. 1); misshapen, smaller fruit with bitter taste (Fig. 2)] and eventual tree decline.



Fig. 1. Blotchy mottle symptoms typical of Greening disease; note the yellow chlorosis is asymmetrical relative to the leaf midrib.



Fig. 2. Typical Greening disease fruit symptoms; note the oblong shape and white sheen remaining after a thumb-pressure on the rind yellow; dissection will reveal aborted seed and brown discolouration of the vascular tissue in the stem end and in the columella.

Greening disease is closely related to Asiatic Citrus Greening, or Huanglongbing (HLB), which is the most feared disease of citrus worldwide. HLB has caused a >90% decline in the USA-Florida citrus industry, and it is the biggest threat to the southern African citrus industry. In and near Africa, HLB and its vector occur in Ethiopia, Mauritius and Reunion, and was recently reported in Kenya. The disease can be spread from an infected area through natural movement of the vector. Whereas such spread may be slow, the disease and the vector can unknowingly be introduced into southern Africa through long-distance illegal (or poorly controlled) movement of plant material from a place of occurrence anywhere in the world.

African Greening and its vector are heat sensitive, unlike HLB and its vector, the Asian Citrus Psyllid (ACP), *Diaphorina citri*. African Greening and its spread are consequently suppressed during warm summer periods, thereby reducing its economic impact in warmer production areas. In certain parts of South Africa, growers have learnt “to live with Greening”. However, Greening has led to the demise of some cooler citrus production areas, and



future incursion of ACP will exacerbate its spread and economic impact.

Greening is naturally spread (vectored) by the African Citrus Triozid, *Trioza erytreae*, which feeds on infected trees, acquires the greening bacterium in the plant sap it feeds on and transmits it to healthy trees nearby. Signs of present or previous infestation of *T. erytreae* are the very characteristic pockmarks seen on leaves (Fig. 3).



Fig. 3. The vector of Greening, *Trioza erytreae*, with typical breeding infestation pockmarks on leaves.

Control Measures

There is no cure for Greening (or HLB) and the disease is prevented by planting certified disease-free trees, removal of all infected trees, and effective control of the insect vector. Vector control is most effective using systemic insecticides, with or without additional contact insecticide applications. Unfortunately, market restrictions limit the available chemical control options and vector control is becoming increasingly difficult.

Without effective vector control and infected tree removal, Greening incidence and severity will increase to economically significant levels in cooler production areas.

Surveys and measures to prevent spread of African Greening in South Africa

In South Africa, Greening only occurs in certain provinces, viz. Limpopo, Mpumalanga, Gauteng, KwaZulu-Natal and certain districts in the Western Cape province. The Eastern Cape, Northern Cape, North-West and Free State provinces are regulated as Greening-free areas. Since it is an officially regulated disease, surveys are periodically conducted in Greening-free areas. Whilst fairly widespread in the Boland region, early detection and eradication were successful in the Malmesbury district, keeping the important Citrusdal and Clanwilliam production regions free from Greening. To prevent the spread of this disease by humans, movement of citrus propagation material from areas where Greening occurs into Greening-free areas is regulated by Regulation 110 of the Agricultural Pest Act (Fig. 4).

Knysna. African Greening was detected in residential gardens in Knysna in 2017 by surveillance teams of CRI and DALRRD. The area was designated a Greening-free buffer zone, but despite repeated surveys and infected tree destruction orders, it has become evident that the disease is too widespread to eradicate. The official African Greening working group has recommended that the affected wards of the Knysna magisterial district be declared an Area of Low Pest Prevalence (ALPP). Like the requirements for a Greening-free buffer zone, control measures in the ALPP will include mandatory removal of infected trees and prohibited movement of citrus propagation material to Greening-free areas (this will directly affect retail nurseries selling citrus trees). CRI and DALRRD teams will concentrate future surveillance on sentinel locations surrounding the Knysna ALPP to ensure early detection and to enable containment measures to prevent spread of Greening to commercial production areas.

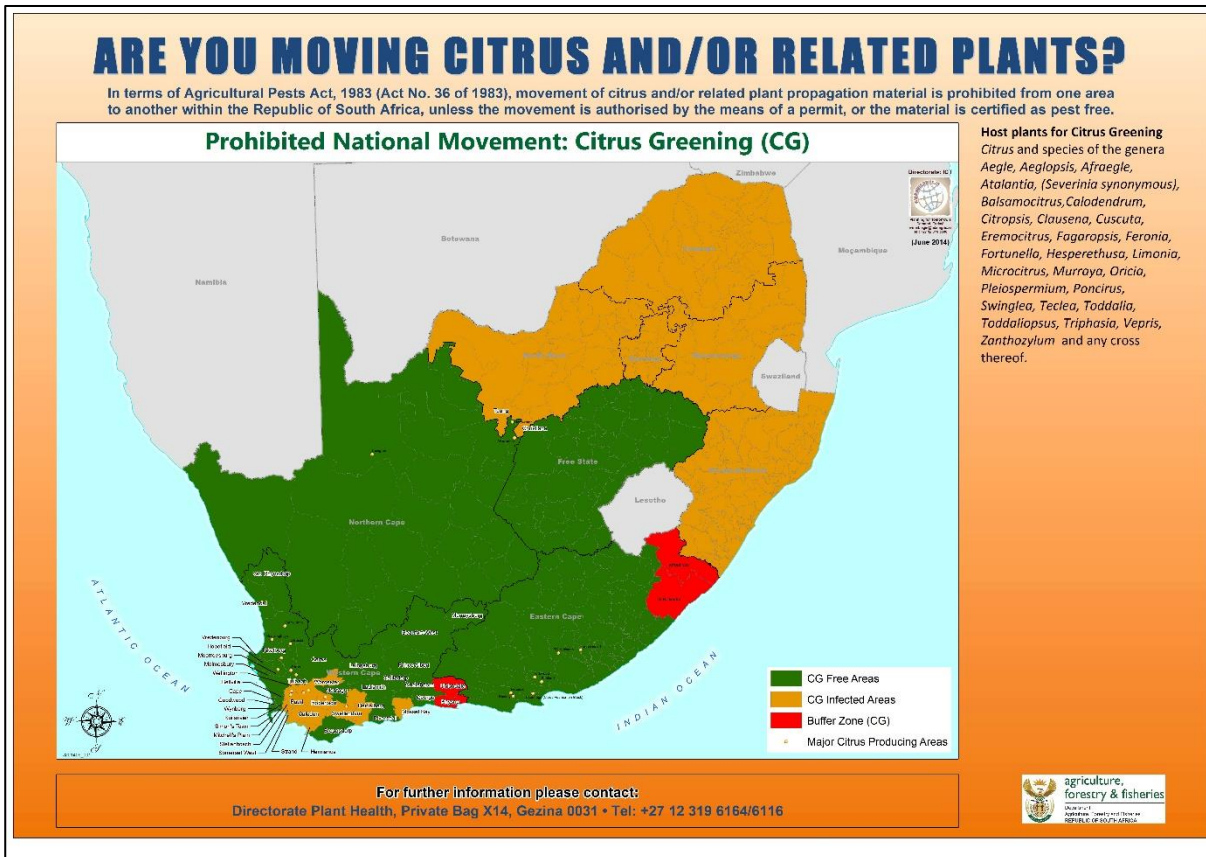


Fig. 4. Map indicating the regulated movement of vegetative citrus propagation material due to Greening : material cannot be moved from areas where Greening occurs or designated buffer zones (in orange and red) to Greening-free areas (in green).

East London. CRI and DALRRD teams detected African Greening in residential trees and in a small orchard in East London in 2022. As in Knysna, delimitation surveys indicated that the disease was too widely spread in the residential areas to eradicate. The African Greening working group has also recommended that the affected wards of the East London magisterial district be declared an ALPP, with control measures similar to those applying to Knysna.

Gqeberha. This area is of major importance given its proximity to the Sundays River Valley production area (SRV), as well as to the Citrus Foundation Block (CFB), which is South Africa's primary source of certified disease-free budwood from which nurseries produce citrus trees. African Greening was detected in a home garden in Summerstrand in 2023, after which delimiting surveys indicated that it occurs in an area spanning 15 km across the city. Surveys will continue, but to expedite and focus control measures, the African

Greening working group proposed an ALPP for the affected areas. Control measures will be focussed on containing African Greening within the ALPP and preventing its spread across the Nelson Mandela Metro towards the CFB and SRV. These measures will include infected tree removal, ongoing surveillance, public awareness, and orders on restricted movement of trees out of the ALPP.

Awareness and urban control measures

Eradication of African Greening in urban areas has proven to be very difficult. CRI and DALRRD will work on developing awareness materials to inform nurseries and homeowners on good growing practices for home garden citrus trees, including pest and disease management principles and remedies. The awareness material will include identification tools for African Greening and its vector (Figs. 1-3). Early detection of infected trees is key to enable rapid response and prevent the spread of the disease. Unfortunately, there is no



cure for African Greening and infected trees must be removed. Homeowners can use the same chemical control measures as described below.

Control measures in commercial citrus production areas

Citrus growers in commercial production areas close to the reported finds in Gqeberha, East London and Knysna, most notably the Sunday's River Valley and Gamtoos River areas, are advised to survey for the African Greening vector *T. erytrae*, and to improve control measures where the vector occurs. Surveillance is done by scouting for signs of the vector (Fig. 3), as well as using yellow sticky traps. Traps can be sent to CRI's Citrus Research Centre (CRC) in Nelspruit for analysis. The numbers of trapped *T. erytrae* adults are recorded, and by means of a state-of-the-art PCR test, the diagnosticians will be able to determine whether the adults carried the African Greening bacterium or not. It is widely reported that this is the most efficient means of surveying for Greening, as it can take several months, even years, before an infected tree starts to show symptoms. In the absence of characteristic symptoms of the disease, sampling and testing of leaves with signs of the vector (Fig. 3) can also be used in surveillance.

The critical periods for vector control are during any vegetative flush period; mostly spring and autumn. The insect vector can be effectively controlled by means of a root zone soil drench with imidacloprid insecticide. However, restrictions applicable to certain export markets might prohibit its use, and growers will have to resort to the use of other contact or systemic insecticides. Dimethoate (soil drench and foliar application), methamidophos, acephate, methamidaphos, acetamiprid (trunk treatments), chlorpyrifos, (not later than 90% petal fall for EU), tau-fluvalinate, mevinphos, and profenofos (foliar applications) are currently registered for *T. erytrae* control. Several insecticides that are effective against mealybug and scale insects are likely to suppress *T. erytrae* populations for at least 2 weeks (consult the CRI Production Guidelines for restrictions and more information).

With the assistance of the local growers, CRI has initiated a coordinated area-wide suppression

programme in the cooler Buffeljags region near Swellendam, where Greening has increased to problematic levels. Infected trees are continuously removed, and vector control is conducted on a coordinated area-wide basis. Such area-wide management programmes are considered the key to successful management of African Greening and HLB, and this Buffeljags project is a good 'dress rehearsal' for the future when growers will have to deal with HLB in parts of southern Africa.

Conclusion

Citrus diseases that are spread by insect vectors are notoriously difficult to control, particularly in areas with many home garden citrus trees and neglected orchards. Unfortunately, not all home- and landowners will effectively control the disease and insect vectors, enabling further spread. Commercial citrus growers bordering urban areas where the disease has been reported must therefore be particularly vigilant in surveying and managing African Greening and its vector, *T. erytrae*.

Afrika Sitrusvergroeningsiekte waargeneem in Gqeberha, Oos- Londen en Knysna

Paul Fourie, Wayne Kirkman, Elma Carstens
en Vaughan Hattingh
Biosekuriteit-afdeling, Citrus Research
International
E-pos biosecurity@cri.co.za

Agtergrond

Afrika Sitrusvergroeningsiekte (Vergroening) word deur 'n floëem-bepaalde bakterium, *Candidatus Liberibacter africanus* veroorsaak. Kortom, die bakteriële infeksie blokkeer die floëemvate, wat 'n verskeidenheid vrug- en blaarsimptome tot gevolg het [takke met geel, vlekkerige kol-simptome op blare (Fig. 1); misvormde, kleiner vrugte met bitter smaak (Fig. 2) en uiteindelijke boom-agteruitgang.



Fig. 1. Vlekkerige kol-simptome tipies van Vergroeningsiekte; let op die geel chlorose is asimmetries relatief tot die blaarmiddelnerf.



Fig. 2. Tipiese Vergroeningsiekte vrugsimptome; let op die langwerpige vorm en wit glans wat oorbly na 'n duimdruk op die geel skil; disseksie sal geaborteerde saad en bruin verkleuring van die vaskulêre weefsel in die stingel-end en in die kolumella toon.

Vergroeningsiekte is naby verwant aan Asiatische Sitrusvergroening, of Huanglongbing (HLB), wat die mees gevreesde siekte van sitrus wêreldwyd is. HLB het 'n afname van >90% in die VSA-Florida-sitrusbedryf veroorsaak, en dit is die grootste bedreiging vir die suider-Afrikaanse sitrusbedryf. In en naby Afrika, kom HLB en sy vektor in Ethiopië, Mauritius en Reunion voor, en is onlangs in Kenia gevind. Die siekte kan vanaf 'n besmette gebied versprei word deur die natuurlike verspreiding van die vektor. Terwyl sulke verspreiding stadig kan wees, kan die siekte en die vektor onwetend in suider-Afrika ingebring word deur langafstand onwettige (of swak-beheerde) beweging van plantmateriaal vanaf 'n plek waar dit voorkom.

Afrika Vergroening en sy vektor is hitte-sensitief, anders as HLB en sy vektor, die Asiatische Sitrus Bladvlooi (ACP), *Diaphorina citri*. Afrika Vergroening en die verspreiding daarvan word gevolglik gedurende warm somerperiodes onderdruk, wat die ekonomiese impak daarvan in warmer produksie-areas verminder. In sekere dele van Suid-Afrika het

produsente geleer “om met Vergroening saam te leef”. Vergroening het egter tot die ondergang van sommige koeler sitrusproduksie-areas gelei, en toekomstige inkomste van ACP sal die verspreiding en ekonomiese impak daarvan vererger.

Vergroening word natuurlik versprei (gevektor) deur die Afrika Sitrus Triosied (psylla), *Trioza erytreae*, wat op besmette bome voed, die Vergroeningsbakterie opneem in die plantsap waarop dit voed, en dit na gesonde bome in die omgewing oordra. Broei-tekens van *T. erytreae* is die baie kenmerkende knoppe wat op blare gesien word (Fig. 3).



Fig. 3. Die vektor van Vergroening, *Trioza erytreae*, met tipiese knoppe op blare wat broei aandui.

Beheermaatreëls

Daar is geen genesende beheer vir Vergroening (of HLB) nie en die siekte word voorkom deur gesertifiseerde siektevrye bome

te plant, alle besmette bome te verwyder, en effektiewe beheer van die insekvektor. Vektorbeheer is die doeltreffendste met behulp van sistemiese insekdoders, met of sonder addisionele kontak insekdodertoedienings. Ongelukkig beperk sekere markte die beskikbare chemiese beheer-opsies, en vektorbeheer word al hoe moeiliker. Sonder effektiewe vektorbeheer en die verwydering van besmette bome, sal die voorkoms en erns van Vergroening tot ekonomies beduidende vlakke in koeler produksiegebiede toeneem.

Opnames en maatreëls om verspreiding van Afrika Vergroening in Suid-Afrika te voorkom

In Suid-Afrika kom Vergroening slegs in sekere provinsies voor, nl. Limpopo, Mpumalanga, Gauteng, KwaZulu-Natal en sekere distrikte in die Wes-Kaap provinsie. Die Oos-Kaap, Noord-Kaap, Noordwes en Vrystaat provinsies word as Vergroeningvrye gebiede gereguleer. Aangesien dit 'n amptelik gereguleerde siekte is, word opnames periodiek in Vergroeningvrye gebiede gedoen. Alhoewel dit redelik wydverspreid in die Boland-streek was, was vroeë opsporing en uitroeiing suksesvol in die Malmesbury-distrik, wat die belangrike Citrusdal- en Clanwilliam-produksiestreke vry van Vergroening gehou het. Om die verspreiding van hierdie siekte deur mense te voorkom, word die beweging van sitrusvoortplantingsmateriaal vanaf gebiede waar Vergroening plaasvind, na Vergroeningvrye gebiede, deur Regulasie 110 van die Wet op Landbouplae, gereguleer (Fig. 4).

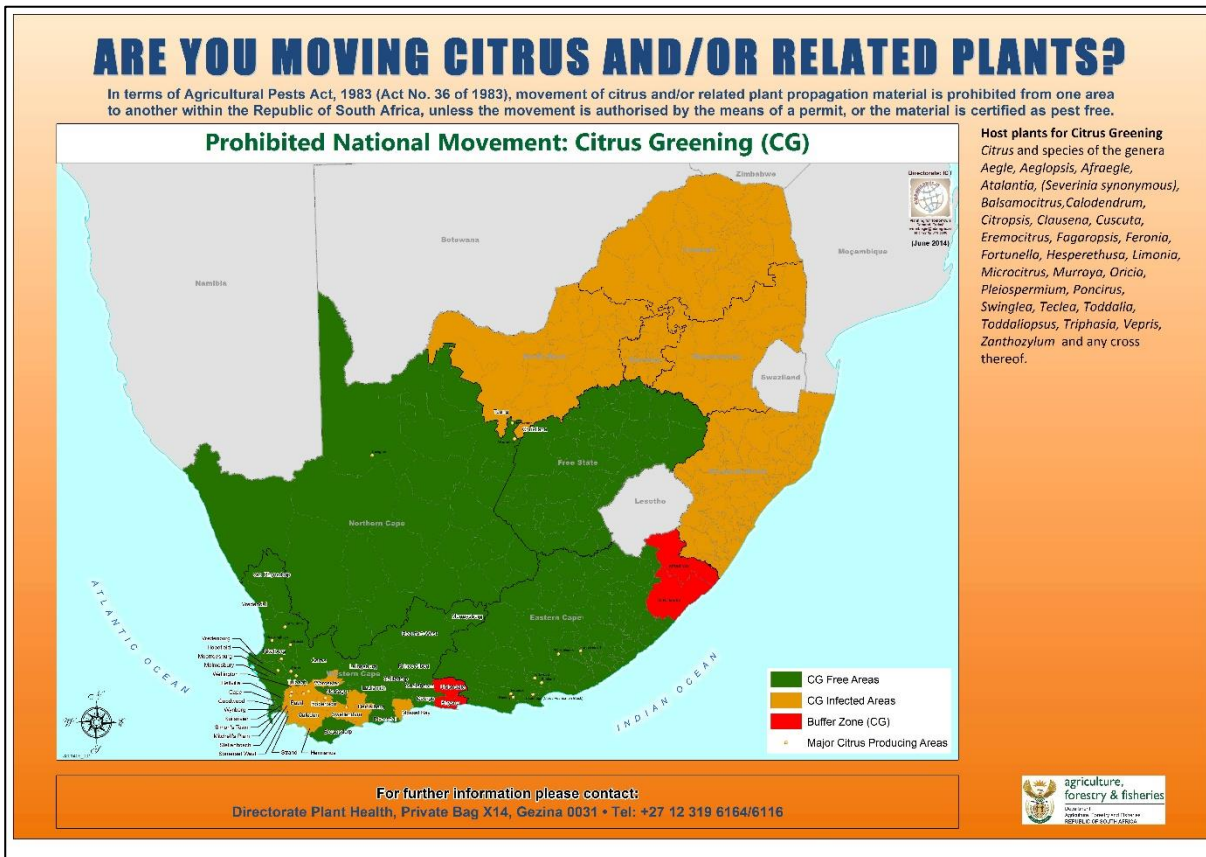


Fig. 4. Kaart wat die gereguleerde beweging van vegetatiewe sitrusvoortplantingsmateriaal as gevolg van Vergroening aandui: materiaal kan nie vanaf gebiede waar Vergroening plaasvind, of aangewese buffersones (in oranje en rooi), na Vergroeningsvrye gebiede (in groen) verskuif word nie.

Knysna. Afrika Vergroening is in 2017 in residensiële tuine in Knysna deur opname-spanne van CRI en DALRRD opgespoor. Die gebied is as 'n Vergroeningvrye buffersone aangewys, maar ten spyte van herhaalde opnames en lasgewings om besmette bome te verwyder, het dit duidelik geword dat die siekte te wydverspreid is om uit te roei. Die amptelike Afrika Vergroeningswerkgroep het aanbeveel dat die geaffekteerde wyke van die Knysna-landdrostdistrik tot 'n Gebied van Lae Plaagvoorkoms (ALPP) verklaar word. Soos die vereistes vir 'n Vergroeningvrye buffersone, sal beheermaatreëls in die ALPP verpligte verwydering van besmette bome, en 'n verbod op skuif van sitrusvoortplantingsmateriaal na Vergroeningsvrye gebiede insluit (dit sal kleinhandelkwekerye wat sitrusbome verkoop direk raak). CRI- en DALRRD-spanne sal toekomstige opnames op die grens van die Knysna ALPP konsentreer, om vroeë opsporing te verseker en om maatreëls in plek te stel om verspreiding van Vergroening na kommersiële produksiegebiede te voorkom.

Oos-Londen. CRI- en DALRRD-spanne het Afrika Vergroening in residensiële bome en in 'n klein boord in Oos-Londen in 2022 opgespoor. Soos in Knysna, het afbakeningsopnames aangedui dat die siekte te wyd in die woongebiede versprei is om uit te roei. Die Afrika Vergroeningswerkgroep het ook aanbeveel dat die geaffekteerde wyke van die Oos-Londen landdrostdistrik tot 'n ALPP verklaar word, met beheermaatreëls soortgelyk aan dié wat op Knysna van toepassing is.

Gqeberha. Hierdie gebied is van groot belang gewese sy nabyheid aan die Sondagsriviervallei-produksiegebied (SRV), asook aan die Sitrus Grondvesblok (CFB), wat Suid-Afrika se primêre bron van gesertifiseerde siektevrye plantmateriaal is waarmee kwekerye sitrusbome produseer. Afrika Vergroening is in 2023 in 'n huistuin in Somerstrand opgespoor, waarna afbakeningsopnames aangedui het dat dit in 'n gebied wat 15 km oor die stad strek, voorkom. Opnames sal voortgaan, maar om beheermaatreëls te bespoedig en te fokus, het die Afrika



Vergroeningswerkgroep 'n ALPP vir die geaffekteerde gebiede voorgestel. Beheermaatreëls sal daarop gefokus wees om Afrika Vergroening binne die ALPP in te beperk, en om die verspreiding daarvan oor die Nelson Mandela Metro na die CFB en SRV te voorkom. Hierdie maatreëls sal die verwydering van besmette bome, deurlopende opnames, openbare bewusheid, en bevele oor beperkte beweging van bome uit die ALPP insluit.

Bewusmaking en stedelike beheermaatreëls

Die uitwissing van Afrika Vergroening in stedelike gebiede blyk baie moeilik te wees. CRI en DALRRD sal aan die ontwikkeling van bewusmakingsmateriaal werk om kwekerie en huis-eienaars oor goeie groeipraktyke vir huistuin sitrusbome in te lig, insluitend plaag- en siektebestuursbeginsels en -middels. Die bewusmakingsmateriaal sal identifikasie-hulpmiddels vir Afrika Vergroening en sy vektor insluit (Fig. 1-3). Vroeë opsporing van besmette bome is die sleutel om vinnige reaksie moontlik te maak en die verspreiding van die siekte te voorkom. Ongelukkig is daar geen geneesmiddel vir Afrika Vergroening nie en besmette bome moet verwyder word. Huis-eienaars kan dieselfde chemiese beheermaatreëls gebruik as wat hieronder beskryf word.

Beheermaatreëls in kommersiële sitrus-produksiegebiede

Sitrusprodusente in kommersiële produksiegebiede naby die gerapporteerde rekords in Gqeberha, Oos-Londen en Knysna, veral die Sondagsriviervallei- en Gamtoosrivier-gebiede, word aangeraai om opnames vir die Afrika Vergroeningsvektor te doen, en om beheermaatreëls te verbeter waar die vektor voorkom. Opnames word gedoen deur te soek na tekens van die vektor (Fig. 3), sowel as die gebruik van geel kleeflokvalle. Lokvalle kan na CRI se Sitrusnavorsingsentrum (CRC) in Nelspruit vir ontleding gestuur word. Die getal *T. erytrae* volwassenes wat gevang word, word aangeteken, en deur middel van 'n moderne PKR-toets sal die diagnostici kan bepaal of die volwassenes die Afrika Vergroeningsbakterie gedra het of nie. Daar word wyd gerapporteer dat hierdie die mees doeltreffende metode van opname vir Vergroening is, aangesien dit etlike maande, selfs jare, kan neem voordat 'n besmette boom simptome begin

toon. In die afwesigheid van kenmerkende simptome van die siekte, kan monsterneming en toetsing van blare met tekens van die vektor (Fig. 3) ook in opnames gebruik word.

Die kritieke periodes vir vektorbeheer is gedurende enige vegetatiewe stuwingsperiode (aktiewe groei); meestal lente en herfs. Die insekvektor kan effektief beheer word deur middel van grondbehandeling in die wortelsone met imidacloprid insekdoder. Beperkings wat op sekere uitvoermarkte van toepassing is, kan egter die gebruik daarvan verbied, en produsente sal hulle moet wend tot die gebruik van ander kontak- of sistemiese insekdoders. Dimetoaat (grond- en blaartoediening), metamidofos, asefaat, asetamipried (stambehandelings), chlorpirifos, taufluvalinaat, mevinfos, en profenofos (blaartoedienings) is tans vir *T. erytrae* beheer geregistreer. Verskeie insekdoders wat effektief teen witluis en dopluis insekte is, sal waarskynlik *T. erytrae* populasies vir ten minste 2 weke onderdruk (raadpleeg die CRI Produksie Riglyne vir beperkings en meer inligting).

Met die hulp van die plaaslike produsente, het CRI 'n gekoördineerde area-wye onderdrukkings-program in die koeler Buffeljagsstreek naby Swellendam begin, waar Vergroening tot problematiese vlakke toegeneem het. Besmette bome word voortdurend verwyder, en vektorbeheer word op 'n gekoördineerde area-wye basis uitgevoer. Sulke gebiedswye bestuursprogramme word as sleutel tot suksesvolle bestuur van HLB beskou, en hierdie Buffeljagsprojek is 'n goeie 'kleedrepetisie' vir die toekoms wanneer produsente met HLB in dele van suider-Afrika te doen sal kry.

Afsluiting

Sitrusziektes wat deur insekvektore versprei word, is moeilik om te beheer, veral in gebiede met baie sitrusbome in huistuine en verwaarloosde boorde. Ongelukkig sal nie alle huis- en grondeienaars die siekte en insekvektore effektief beheer nie, wat verdere verspreiding moontlik maak. Kommersiële sitrusprodusente wat grens aan stedelike gebiede waar die siekte aangemeld is, moet dus veral waaksaam wees met die opname en bestuur van Afrika Vergroening en sy vektor, *T. erytrae*.