

Synopsis of Strategies to Reduce Populations of Citrus Psylla, *Trioza erytreae*, and the Spread of Greening

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ABSTRACT

Measures to control citrus psylla or to prevent the build-up of large populations and the spread of greening are discussed. The most important of these are: restricting citrus growing to hot, low-lying regions of the country; strict chemical control of vectors in nurseries; planting orchards with one cultivar of the same age; and planting only cultivars with flushing periods that coincide in the same area. The need for further research is also discussed.

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Recommandations pour réduire les populations de psylle des agrumes et le développement du greening.

RÉSUMÉ

Des mesures pour contrôler et pour éviter l'accroissement des populations des psylles des agrumes sont recensées. Le développement de la maladie du "greening" est ensuite examinée. Les principales recommandations sont : limiter la plantation des agrumes aux régions chaudes et peu humides du pays, effectuer un contrôle chimique strict des vecteurs dans les pépinières, aménager des vergers avec des arbres d'un même cultivar et du même âge et planter, dans une même zone, des cultivars ayant des poussées végétatives saisonnières qui coïncident. La nécessité de réaliser des travaux de recherches complémentaires est aussi discutée.

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Recomendaciones para reducir las poblaciones de psylle en los cítricos y el avance de "greening".

RESUMEN

Se presentan medidas para controlar la psylle de los cítricos y para evitar el desarrollo de las poblaciones de este insecto. El avance de la enfermedad de "greening" es analizada. Las principales recomendaciones son : limitar las plantaciones de cítricos a regiones calientes y poco húmedas, controlar estrictamente los vectores en los viveros, establecer huertos con árboles de una misma edad y efectuar plantaciones en zonas donde coincidan la brotación vegetativa y el período estacional. La necesidad de efectuar trabajos de investigación complementarios es también discutida.

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KEYWORDS

Trioza, citrus fruits, disease control.

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MOTS CLÉS

Trioza, agrume, contrôle de maladies.

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PALABRAS CLAVES

Trioza, frutas cítricas, control de enfermedades.

The presence of citrus psylla, *Trioza erytreae* (Del Guercio) (Hemiptera: Triozidae), was first reported in southern Africa by LOUNSBURY (1897). VAN DER MERWE (1923, 1941) considered this insect to be a minor pest of citrus nursery trees and occasionally of new flushes in citrus orchards. The status of citrus psylla was raised to that of a major pest in 1965 when McCLEAN and OBERHOLZER (1965) demonstrated that *T. erytreae* adults are vectors for greening disease of citrus in South Africa. Two short review papers on citrus psylla have appeared, one by VAN DEN BERG and NEL (1981) and the other by AUBERT (1987), and recently two comprehensive reviews were published by ÔTAKE (1990) and VAN DEN BERG (1990a). The present synopsis endeavours to give practical suggestions for reducing psylla populations and containing the spread of greening disease, aspects that have not been dealt with in sufficient detail in previous publications.

measures to reduce citrus psylla populations and the spread of greening disease

1. The psylla problem can be largely avoided by restricting citrus growing to hot, low-lying regions of the country where high temperatures combined with low humidities restrict psylla breeding (MORAN, 1968; AUBERT, 1985).
2. Certain citrus trees are either less attractive to adult psylla or less suited for nymphal development than others (VAN DEN BERG *et al.*, 1991a). Apparently "resistant" trees should be tested to verify these observations and, if found to be resistant, they should be propagated and used in breeding programmes.
3. The selection and breeding of greening-tolerant citrus cultivars could offer an alternative method for control of this disease (DE LANGE *et al.*, 1984).
4. Each flush cycle should be reduced to as short a period as possible (CATLING, 1969a; VAN DEN BERG, 1986). This can be achieved by tree selection, application of growth retardants (VAN DEN BERG, unpublished data) or with an irrigation regime to encourage winter tree dormancy and well-defined flushes in summer (CATLING, 1969a). The latter method has been evaluated on four citrus cultivars, but it was only successful on lemons where, despite the suppression of new growth for about 17 weeks, there was no significant loss of yield (VAN DEN BERG, 1986).
5. In order to restrict psylla breeding to a minimum period in a particular area, only cultivars with flushing periods that coincide should be planted (VAN DEN BERG, 1986). Valencia and grapefruit can be grown in the same area, but any combination of citrus cultivars with lemons or to a lesser extent with navels, will probably result in more severe psylla infestations due to extended breeding opportunities. The highest risk cultivar combination in one area would most likely be lemons and navels (VAN DEN BERG, 1986). It should also be borne in mind that orchards have to be at least 1.5 km apart before they can be regarded as isolated from each other (VAN DEN BERG and DEACON, 1988).
6. Pest control measures vary with tree age and cultivars (VAN DEN BERG, 1982). It is therefore recommended that each orchard be planted with a single cultivar. Planting of young trees between older trees is not recommended but, when practised, the younger trees should be treated more often for psylla than the older trees since flushing is prolonged in young trees (VAN DEN BERG, 1982).
7. Pruning of trees to restrict size, stimulates new growth and is not recommended in areas which are subject to psylla infestations (VAN DEN BERG, 1987). If pruning is unavoidable, due to inadequate spacing, pruning should be timed to ensure that the ensuing new growth coincides with the main flush in spring.
8. Skirting of trees for ant control may also stimulate new growth and should be implemented at the same time as pruning (VAN DEN BERG, 1982; 1987).

9. The spread of greening and its vectors can be limited through sound nursery practices (SCHWARZ, 1967; KOTZE, 1982; KOTZE, 1985; AUBERT, 1988) and by enforcing existing legislation that prohibits the transfer of citrus propagation material from Transvaal, Natal or Orange Free State to Cape Province (R.S.A. ACT 36, 1983).

10. Greening disease can only be contained if infected plant material is eradicated in the orchards (SCHWARZ, 1967; GREEN and SCHWARZ, 1970; KOTZE, 1982). Infected branches should be sawn off flush with the main stem during June and July (VAN DEN BERG, 1982; VAN VUUREN, 1983; BUITENDAG, 1986; VAN DEN BERG, 1987) and any further developing shoots should be removed.

11. Neglected and dying citrus trees can serve as a source of greening disease inoculum and should either be removed or undergo the same psylla control programme as well-managed orchards (VAN DEN BERG and VERCUEIL, 1985).

12. The recommendation of AUBERT (1988) that new orchards should be established as far as possible from indigenous rutaceous host plants is well founded. Since False Horsewood trees can also be infected with greening (VAN DEN BERG *et al.*, 1992), this recommendation takes on even greater importance. Eradication of indigenous host plants from the vicinity of orchards is therefore advised (VAN DER MERWE, 1923; VAN DEN BERG *et al.*, 1992).

13. Adult citrus psylla have been observed in feeding positions on plants which are unsuitable for nymphal development. Furthermore, psylla can "overnight" on other non-host plants (VAN DEN BERG and DEACON, 1989). Other plant species can therefore be symptomless carriers of greening disease. Such plants should be identified and removed from the vicinity of orchards.

14. Citrus psylla populations appear to be regulated by more than just an availability of young developing leaves and high temperatures combined with low relative humidities (termed saturation deficit index) (VAN DEN BERG *et al.*, 1991a). Other

factors should therefore be investigated to control or predict psylla outbreaks.

15. Several citrus groves in the Cape were found to have trees infected with greening disease. These trees originated from Transvaal nurseries (SCHWARZ, 1967). Furthermore, citrus psylla from Stellenbosch is capable of transmitting greening disease (VAN DEN BERG *et al.*, 1987b). Spread of the disease thus appears to be inevitable, and it is still unclear why this has not occurred in these areas, further studies are needed to elucidate this question.

16. Indigenous parasitoids (CATLING, 1969b) and predators (CATLING, 1970; VAN DEN BERG *et al.*, 1987a), clearly suppress populations of citrus psylla, but they are unable to reduce numbers to economically acceptable levels. Introduction of the parasitoid *Tamarixia triozae* Burks (Hym.: Eulophidae) and the predatory anthocorids, *Anthocoris antevolens* White, *A. melanocerus* Reuter and *A. nemoralis* (F.), has been recommended (VAN DEN BERG, 1984) and requires investigation.

17. It is important to inspect orchards for citrus psylla outbreaks, preferably weekly, especially when they flush (VAN DER KOOIJ *et al.*, 1986; VAN DEN BERG, 1990b), or to use a monitoring method (SAMWAYS *et al.*, 1986; VAN DEN BERG *et al.*, 1991b). Populations can be monitored with a yellow sticky trap placed in the northernmost row, one in the southernmost row and one in the middle row of a citrus orchard. This will provide a standardized and reliable monitoring method (VAN DEN BERG *et al.*, 1991b). Young trees, especially lemon, develop new growth over long periods and should be inspected thoroughly (CATLING, 1969a; VAN DEN BERG, 1990b).

18. In young trees, citrus psylla are often only present in the northern rows of an orchard, especially if these are close to windbreaks. Chemical control could therefore be confined to these trees. During winter, the same strategy can be followed with older trees, but some edge rows may also be infested (VAN DEN BERG *et al.*, 1991b).

19. Preventive chemical control can be applied before the start of the major spring flush cycle in order to reduce psylla numbers before build up later in the season (CATLING, 1969c). A female needs up to four matings to be able to fertilize her full egg capacity; and some females have to mate within a month before laying fertile eggs in spring. At low population densities, some females may therefore lay infertile eggs throughout her lifespan or part of it (VAN DEN BERG *et al.*, 1991c). This would be a further advantage derived from keeping populations at low levels, especially during winter.

20. Since host searching is conducted shortly before sunset (VAN DEN BERG and DEACON, 1989) and citrus psylla usually remain on the same tree for several hours (VAN DEN BERG *et al.*, 1990), fast acting, contact and systemic insecticides are recommended for their control. Although these may not prevent the spread of greening to an orchard, they will probably kill adult psylla on the first tree on which they alight, thus reducing spread of the disease.

21. Observations indicate that adult citrus psylla are almost exclusively confined to young leaves and branches (VAN DEN BERG *et al.*, 1990). It is also known that nymphs can only survive on young tender flush (VAN DEN MERWE, 1923; MORAN and BLOWERS, 1967). For these reasons, foliar chemical sprays against this pest need only be applied as light cover sprays. This confirms the recommendations of BEDFORD (1985). The cost of the insecticide applied as a light cover spray is half that of a full cover spray (BEDFORD, 1985) and therefore represents a substantial saving.

22. Chemicals with long residual action applied to control pests such as citrus thrips, *Scirtothrips aurantii* Faure, and American bollworm, *Heliothis armigera* (Hübner), will also reduce the psylla population. The control of citrus psylla, citrus thrips and American bollworm should be integrated as an entity, especially during spring (VAN DEN BERG *et al.*, 1983). A single contact insecticide can replace bait for thrips and one or two contact insecticides for psylla and American bollworm larvae.

Control could therefore be more cost-effective.

23. Psylla can also be controlled by applying undiluted monocrotophos to the bark of citrus trees. If applied in the recommended dosage, this chemical is not phytotoxic towards various rootstocks and Valencia trees (BUITENDAG and BRONKHORST, 1984, 1986; BUITENDAG, 1986). This control method is effective and relatively cheap. ●

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references

- AUBERT B., 1985.
Le greening, une maladie infectieuse des agrumes d'origine bactérienne, transmise par des Homoptères psyllidés. Contribution à l'étude d'une stratégie de lutte appliquée au cas de l'île de la Réunion. Bordeaux (France): université de Bordeaux II, thèse de doctorat es Sciences Naturelles, 202 p.
- AUBERT B., 1987.
Trioza erytrae Del Guercio and *Diaphorina citri* Kuwayama (Homoptera: Psylloidea), the two vectors of citrus greening disease: Biological aspects and possible control strategies. *Fruits* 42 (3), 149-162.
- AUBERT B., 1988.
 Towards an integrated management of the citrus greening disease. In: *Proceedings of the tenth Conference of the International Organisation of Citrus Virologists, 17-21 November 1986*, Valencia, Spain. California (USA): University of California Press, L.W. Timmer, S.M. Garnsey and L. Navarro (Editors), 226-230.

- BEDFORD E.C.G., 1985.
Die koste van spuitmiddels en spuitprogramme vir sitrusplae. *Information Bulletin, Citrus and Subtropical Fruit Research Institute*, Nelspruit, South Africa, 30, 17-21.
- BUITENDAG C.H., 1986.
Vergroeningsiekte van sitrus: verskeie beheermetodes van die vektor Trioza erytrae (Del Guercio) met Azodrin (monokrotofos) en 'n ondersoek na onderdrukking van vergroeningsiekte-vrugsimptome met staminspuitings. Pietermaritzburg (South Africa): University of Natal, Ph.D. (Agric.) thesis, 265 p.
- BUITENDAG C.H., BRONKHORST G.J., 1984.
Chemiese beheer van die sitrusbladvlooi, *Trioza erytrae*, met spesiale verwysing na die stamaanwending van insekdoders. In: *Proceedings of the Symposium on Citrus Greening*, 26-28 November 1984, Nelspruit, South Africa, CSFRI, 148-153.
- BUITENDAG C.H., BRONKHORST G.J., 1986.
Further aspects of trunk treatment of citrus with insecticides: phytotoxicity, side effects on incidental pests, and development of application apparatus. *Citrus and Subtropical Fruit Journal*, 604, 7-10.
- CATLING H.D., 1969a.
The bionomics of the South African citrus psylla, *Trioza erytrae* (Del Guercio) (Homoptera: Psyllidae) 1. The influence of the flushing rhythm of citrus and factors which regulate flushing. *Journal of the Entomological Society of Southern Africa*, 32, 191-208.
- CATLING H.D., 1969b.
The bionomics of the South African citrus psylla, *Trioza erytrae* (Del Guercio) (Homoptera: Psyllidae) 2. The influence of parasites and notes on the main species involved. *Journal of the Entomological Society of Southern Africa*, 32, 209-223.
- CATLING H.D., 1969c.
The control of citrus psylla *Trioza erytrae* (Del Guercio) (Homoptera: Psyllidae). *South African Citrus Journal*, 426, 9-16.
- CATLING H.D., 1970.
The bionomics of the South African citrus psylla, *Trioza erytrae* (Del Guercio) (Homoptera: Psyllidae) 4. The influence of predators. *Journal of the Entomological Society of South Africa*, 33, 341-348.
- DE LANGE J.H., VINCENT A.P., NEL M., 1984.
Breeding for resistance to greening disease in citrus. *Citrus and Subtropical Fruit Journal*, 614, 6-9.
- GREEN G.C., SCHWARZ R.E., 1970.
Greening a menace to our citrus industry. *South African Citrus Journal*, 437, 3-7.
- KOTZE J.M., 1982.
Vergroening by sitrus - Tyd vir 'n oplossing word min. *Citrus and Subtropical Fruit Journal*, 585, 8.
- KOTZE J.M., 1985.
Control of citrus greening: An epidemiological approach. *Citrus and Subtropical Fruit Journal*, 617, 10-11.
- LOUNSBURY C.P., 1897.
Psyllidae or jumping plant lice. In: *Report of the Government Entomologist for the year 1896, Cape of Good Hope, South Africa*, Unpublished report, 115-118.
- McCLEAN A.P.D., OBERHOLZER P.C.J., 1965.
Citrus psylla, a vector of the greening disease of sweet orange. *South African Journal of Agricultural Science*, 8, 297-298.
- MORAN V.C., 1968.
The development of the citrus psylla, *Trioza erytrae* (Del Guercio) (Homoptera: Psyllidae), on *Citrus limon* and four indigenous host plants. *Journal of the Entomological Society of Southern Africa*, 31, 391-402.
- MORAN V.C., BLOWERS J.R., 1967.
On the biology of the South African citrus psylla, *Trioza erytrae* (Del Guercio) (Homoptera: Psyllidae). *Journal of the Entomological Society of Southern Africa*, 30, 96-106.
- ÔTAKE A., 1990.
Bibliography of citrus greening disease and its vectors attached with indices, and a critical review on the ecology of the vectors and their control. Japan International Cooperative Agency, 7, 161 p.
- SAMWAYS M.J., TATE B.A., MURDOCH E., 1986.
Monitoring the citrus thrips and psylla using fluorescent yellow sticky traps - a practical guide. *Citrus and Subtropical Fruit Journal*, 629, 9-15.
- SCHWARZ R.E., 1967.
Results of a greening survey of sweet orange in the major citrus-growing areas of the Republic of South Africa. *South African Journal of Agricultural Science*, 10, 471-476.
- VAN DEN BERG M.A., 1982.
Hoe om die sitrusvlooi te beperk. *Information Bulletin, Citrus and Subtropical Fruit Research Institute*, Nelspruit, South Africa, 120, 6-7.

- VAN DEN BERG M.A., 1984.
Introduction of natural enemies against citrus psylla, *Trioza erytreae* (Del Guercio) (Hemiptera: Triozidae). *Citrus and Subtropical Fruit Journal*, 612, 8-11.
- VAN DEN BERG M.A., 1986.
Effects of citrus cultivars and reduced irrigation on availability of new growth for citrus psylla breeding. *Fruits*, 41 (10), 597-604.
- VAN DEN BERG M.A., 1987.
Hoe om sitrusbladvlou te beperk. *Information Bulletin, Citrus and Subtropical Fruit Research Institute, Nelspruit, South Africa*, 184, 5.
- VAN DEN BERG M.A., 1990a.
The citrus psylla, *Trioza erytreae* (Del Guercio) (Hemiptera: Triozidae): A review. *Agriculture, Ecosystems and Environment*, 30, 171-194.
- VAN DEN BERG M.A., 1990b.
Citrus psylla. *Farming in South Africa*. Citrus series H.1, 4 p.
- VAN DEN BERG M.A., ANDERSON S.H., DEACON V.E., 1991a.
Population studies of the citrus psylla, *Trioza erytreae*: Factors influencing population size. *Phytoparasitica*, 19, 183-193.
- VAN DEN BERG M.A., DEACON V.E., 1988.
Dispersal of the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae), in the absence of its host plants. *Phytophylactica*, 20, 361-368.
- VAN DEN BERG M.A., DEACON V.E., 1989.
Flight activities of the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae). *Phytophylactica*, 21, 391-395.
- VAN DEN BERG M.A., DEACON V.E., FOURIE C.J., ANDERSON S.H., 1987a.
Predators of the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae), in the Lowveld and Rustenburg areas of Transvaal. *Phytophylactica*, 19, 285-289.
- VAN DEN BERG M.A., DEACON V.E., DE JAGER K., 1990.
Ecology of the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae). 1. Daily activities and habits of adults. *Phytophylactica*, 22, 323-328.
- VAN DEN BERG M.A., DEACON V.E., STEENEKAMP P.J., 1991b.
Dispersal within and between citrus orchards and native hosts, and nymphal mortality of citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae). *Agriculture, Ecosystems and Environment*, 31, 297-309.
- VAN DEN BERG M.A., DEACON V.E., THOMAS C.D., 1991c.
Ecology of the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae). 3. Mating, fertility and oviposition. *Phytophylactica*, 23, 195-200.
- VAN DEN BERG M.A., NEL M., 1981.
A review of research work on the citrus psylla, *Trioza erytreae* (Del Guercio). *Subtropica*, 2 (6), 11-15.
- VAN DEN BERG M.A., VERCUEIL S.W., 1985.
Neglected and dry-land navel trees as a source for the breeding of citrus psylla, *Trioza erytreae* (Del Guercio) (Hemiptera: Triozidae). *Subtropica*, 6 (12), 12-15.
- VAN DEN BERG M.A., DE VILLIERS E.A., MÜLLER P.J., 1983.
Bespuitingsprogramme vir die beheer van sitrusbladvlou, sitrusblaaspootjie en Amerikaanse bolwurm op sitrus. *Subtropica*, 4 (5), 9-11.
- VAN DEN BERG M.A., VAN VUUREN S.P., DEACON V.E., 1987b.
Cross-breeding and greening disease transmission of different populations of the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae). *Phytophylactica*, 19, 353-354.
- VAN DEN BERG M.A., VAN VUUREN S.P., DEACON V.E., 1992.
Studies on greening disease transmission by the citrus psylla, *Trioza erytreae* (Hemiptera: Triozidae). *Israel Journal of Entomology*, 25 and 26, 51-56.
- VAN DER KOOIJ M.D.H., MINNAAR M.W., BEGEMANN G.J., 1986.
Sitrusplaagverkenning op Zebediela. *Citrus and Subtropical Fruit Journal*, 628, 5-7.
- VAN DER MERWE C.P., 1923.
The citrus psylla (*Trioza merwei*, Petzey). *Reprint No. 41. Department of Agriculture. Union of South Africa*, 8 p. [R.A.E., A11: 494-495].
- VAN DER MERWE C.P., 1941.
The citrus psylla (*Spanioza erytreae*, del Guercio). *Science Bulletin, Department of Agriculture and Forestry, Union of South Africa*, 233, 12 p. [R.A.E., A30, p. 563]
- VAN VUUREN S.P., 1983.
Uitsny van vergroeningstakke. *Citrus and Subtropical Fruit Research Institute, Information Bulletin*, 132, 5.