CULTURAL PRACTICES

1 INTRODUCTION

The ability of certain cultural practices to augment the action of natural enemies directly or indirectly, has been known for some time in citrus and other agricultural crops. Cultural practices that can have an influence can be divided into two groups, i.e., plant diversity and operational systems. Some of these practices, for example, the seasonal rotation of crops and the interplant system where different crops are grown on the same piece of ground, are of no importance to citrus growers. These approaches are aimed at decreasing plant conspicuousness (to decrease or prevent plant infestation by pest organisms), and also to prevent the build-up of chronic infestations. The perennial character of citrus eliminates the use of such systems. However, several cultural practices exist which are already in deliberate or accidental use by citrus growers and can be further promoted. There is still much to be learnt about cultural control practices but in the meantime it is recommended that growers adopt as many of the different techniques as possible because few disadvantages are known. As most cultural control advantages are associated with natural enemies they can be beneficial only where IPM is practised.

2 PLANT DIVERSITY

2.1 Ground Covers or Cover Crops

The presence of flowering plants (weeds) between rows of citrus has been shown to be beneficial by CRI entomologists. This can largely be attributed to the pollen and/or nectar being utilised as food by natural enemies. For example, it is known that nectar of the Umbelliferae is much sought after by hymenopterous parasitoids of the Braconidae, Aphelinidae, Ichneumonidae and Tiphiidae. The egg parasitoid *Trichogramma minutum* (Hymenoptera: Trichogrammatidae) lives for approximately 4 days without food. When supplied with honey, it can survive and stay fertile for up to 26 days. Nectar will probably have a similar beneficial effect.

Pollen serves as an alternate food source for *Euseius* predatory mites, amongst others. Rhodes grass “Katambora” is commonly planted as a ground cover between rows of citrus in Queensland, Australia, because it is considered beneficial to the local *Euseius* sp. However, overseas research has demonstrated that the pollen of dicotyledons is generally more suitable. For example, a plant visited freely by a wide range of natural enemies including *Orius* spp. (Anthocoridae), is prostrate knotweed *Polygonum aviculare* (Polygonaceae) which is common in South Africa.

Ground cover can also play an important role in hosting alternative prey for generalist predators such as lacewings, ladybird beetles and predatory mites. Most of these prey species are not citrus pests.

A system whereby natural plant growth is allowed between rows of citrus trees is becoming the norm for citrus growers. This is mainly meant to bind loose soil and prevent erosion by wind. It also serves to stabilize orchard temperatures and increase relative humidity. Usually this ground cover is mowed frequently during the wet season, partially nullifying the benefit of flowering plants. By leaving an unmown strip of approximately 1 m wide down the middle of the interrow the benefits of the flowering plants can be maximized while maintaining easy access to the citrus trees and reducing root competition. Deliberate or systematic attempts to introduce any plant growth other than citrus trees are largely neglected. Climate obviously plays an important role in the survival of such plants. In general, uncultivated plants will survive during the summer in the summer rainfall areas without irrigation, while in the winter rainfall areas broad-leafed plants in particular will only survive on incidental irrigation. As available water resources become fully utilized, it can be expected that increased use will be made of irrigation systems such as drip irrigation, which is not conducive to natural or cultivated plants between citrus tree rows. Fortunately it seems that continuous ground cover over a whole orchard is not necessary to promote natural enemies. Therefore, it should be possible and practical to modify the irrigation in certain rows, e.g. every fifth row, so as to obtain full surface wetting. This will enable the planting of desirable ground cover plants in those rows.

Whether specific cover crops are more advantageous than natural mixed ground cover requires further research. Attention will also have to be given to possible disadvantages of ground covers such as effects on fertilizer requirements and the possible harbouring of pests.

2.2 Windbreaks

In general the influence of windbreak trees on citrus pests is relatively unobtrusive. A single row of windbreak trees is usually planted to break the force of the wind and prevent damage to fruit and citrus trees. Trees that are quite suitable for this purpose are beefwood *Casuarina cunninghamiana* (Casuarinaceae) (declared a category 2 invader), Chinese poplar *Populus simonii* (Salicaceae), the Dutch alder *Alnus cordatus* (Betulaceae) in the Western Cape and *Corymbia torelliana* (Myrtaceae) in the hotter regions.

Several other tree types such as the common pine *Pinus radiata* (Pinaceae) (declared a category 2 invader) and the silky oak *Grevillea robusta* (Proteaceae) (declared a category 3 invader) are also used, but they are less effective as windbreaks. Observations have shown that *G. robusta*, once a popular windbreak tree in the Eastern Cape, is a host for citrus thrips. Increased thrips damage is often caused on citrus trees next to *G. robusta.* These trees are not regarded as suitable windbreaks and should therefore either not be planted at all or removed where they are already present. None of the other tree types are utilized by citrus thrips.

C. cunninghamiana is regarded as a very good windbreak type. Male trees produce large quantities of pollen that are preferred by *Euseius addoensis* (an important predator of citrus thrips) above that produced by other prolific pollen producers such as the Himalayan cypress *Cupressus torulosa* and *P. radiata.* *C. cunninghamiana* has little horticultural disadvantages, provided it is irrigated sufficiently.

C. torelliana is beneficial for predatory mites because the leaves are pubescent and form an ideal habitat for these natural enemies. These trees therefore serve as a reservoir of predatory mites, which can recolonise orchards following the spray application of detrimental products.

Little is known about other relationships between windbreak trees and citrus pests, although the following observations have been made:

- FCM females often prefer protected parts of orchards in the vicinity of large natural or cultivated trees for egg laying. The absence of such protection, however, does not prevent infestation by this pest.

- Chinese poplars can be infested by red scale. Few cases of infested citrus trees adjoining the poplars have been found. This red scale can therefore be of benefit to biological control in the citrus orchard by serving as hosts for natural enemies without the hazard of red scale infestation from the windbreak trees. If the scale infestation becomes deleterious to the windbreak trees, they can be sprayed in winter when leafless with horticultural mineral oil at 1.4%.

- In the USA, signs of less soft brown scale and more positive parasitism have been noticed in citrus trees adjoining windbreak trees.

2.3 Other Plants

Other vegetation outside of citrus orchards can support pest insects and natural enemies, for example:

- Giant bamboo *Dendrocalamus giganteus* clumps are often infested with the armoured scale *Asterolecanium miliaris*, which does not occur on citrus. This scale is preyed upon by the ladybird beetles *Chilocorus cacti* and *C. nigritus*, predators of red scale on citrus. This alternative prey can help to stabilise populations of *Chilocorus* and form a base from which red scale can be attacked. The cultivation of bamboo in the vicinity of citrus orchards can therefore be advantageous.

- Oak trees are an alternative host for FCM. The nuts are not ideal food for the larvae and their development can be retarded for up to eight months in this food source. The larvae are therefore relatively protected against adverse circumstances throughout the winter. Their life cycle is completed in spring when a new citrus crop becomes available for infestation. By destroying the nuts, population numbers can be limited.

- In subtropical areas, the garden shrub *Poinciana pulcherrima* ("Pride of Barbados"), which acts as a host for citrus thrips, was commonly used in hedgerows. As in the case of *G. robusta*, more severe infestations of citrus thrips also occurred on citrus in the vicinity of these plants.

- Flowers of coral trees (*Erythrina* spp.), wild pear (*Dombeya rotundifolia*) and KwaZulu-Natal mahogany (*Trichilia emetica*) harbour large numbers of the citrus thrips predator *Orius thripoborus* between June and October. They may therefore be beneficial in contributing towards the suppression of citrus thrips in nearby citrus during spring.

2.4 Relative susceptibility of citrus cultivars

There are many differences in the relative susceptibility of different cultivars to pest organisms. The reasons for this are mainly unknown. For example, different species of thrips in Argentina and Australia severely damage the soft citrus cultivar Murcott before causing damage to other citrus cultivars. This also seems to apply to the Kyomi and Thoro Temple cultivars. It is also significant that false codling moth (FCM) more often damages certain cultivars – an apparent preference that cannot be correlated to the degree of fruit maturity or time of season. Observations show that a Satsuma mandarin orchard can have an influence on the FCM infestation in an adjoining Clementine orchard. Moth activity in both cultivars can exceed the trap threshold value for commercial damage from early in the season. The Satsumas can be heavily infested, while infested Clementines are seldom noticed during the same period. There are indications that the Clementines are infested only after the Satsumas have been harvested, which shows that the females prefer Satsumas as long as fruit is available. Differences in the degree of FCM infestation have also been noticed where different navel cultivars such as Navelina, Robyn and Bahianina are planted close together.

3 OPERATIONAL SYSTEMS

A range of operational systems can be used to eliminate or suppress pests on agricultural crops. Some of these, such as planting times, plant spacing and soil tilling, are not applicable to citrus. However, several others can be exploited to reduce pest infestation and/or promote natural enemy activity.

3.1 Irrigation/fertilization

It is generally accepted that a physiologically healthy tree can resist damage by pest organisms better and recover faster than trees subject to water or nutritional stress. Research in California has shown that the economic threshold for red mite on citrus trees can be raised from a mean of two to approximately eight mites per leaf, **if water stress in the infested trees can be prevented.** This can allow natural enemies more time to suppress the mite infestation and, in doing so, perhaps obviate the need for chemical control.

3.2 Orchard sanitation

The collection and destruction of dropped fruit is an important and integral part of pest and disease control in a citrus orchard. For example, fruit fly maggots seldom leave the fruit before it has fallen. Similarly, the opportunity exists to pick up and destroy FCM-infested dropped fruit before the immature stages emerge. Orchard sanitation of a cultivar such as Valencia, which under normal circumstances is not particularly susceptible to FCM attack, should not be neglected. Surveys have shown that approximately 70% of all ripe in-season fruit that drops at the end of winter, is infested with FCM. This also applies to out of season and late hanging fruit of other cultivars. A large number of fruit is not necessarily lost in this way, but can still contribute to the faster re-establishment of FCM populations in spring.

In the lowveld, mummified fruit in the trees can serve as a source of coffee bean weevil which may damage fruit just before harvest.

Orchard sanitation also contributes to reducing the spore load of particularly green and blue mould in the orchard, which can reduce post harvest waste significantly.

3.3 Pruning

3.3.1 Internal

A pruning technique whereby the inside of the citrus tree is shaped by selective pruning to enhance light penetration and, therefore, stimulate fruiting, is generally recommended. No information exists on the influence of this practice on pest populations although it does make the trees easier to spray efficiently. Soft and armoured scales are generally positively phototropic. Several species exist throughout the tree, although their numbers are usually less on the inside branches than on the outside. It is not expected that selective pruning will materially change pest distribution in the tree, because relatively little direct sunlight is admitted. Enhanced light intensity will, however, probably lead to higher temperatures, which in turn can stimulate larger pest numbers. Direct effects on parasitoids and predators that normally take refuge within the tree are not known, but shelter from insecticides sprayed on the outside canopy is diminished.

The following methods of pruning can also have a significant effect on pest infestations.

3.3.2 Skirting

All low-hanging branches must be pruned so that tree access to crawling pests such as ants, weevils and snails is confined to the trunk. Weeds under the skirt of the tree must also be controlled to eliminate alternative access routes. Access via the trunk should be limited by insecticide treatment, or one of several types of trunk barriers (see ANTS in Chapter 3).

The main object of the skirting and trunk barrier technique is to keep ants out of the trees where they can interfere with the activity of natural enemies and reduce the effectiveness of the biological control of scale insects. The ants are not eliminated in the orchard and this allows them, as insects of prey, to make a potential contribution to the destruction of, for example, citrus thrips, fruit fly or FCM pupae in the soil.

3.3.3 Removal of dead branches

Because of the dense foliage canopy of citrus trees, inside twigs tend to lose their leaves and die. Dead, hard plant material is formed which can damage fruit. The plant mass that must be wetted during a spraying operation, is simultaneously increased. It also interferes with the movement of droplets during spraying and impedes thorough wetting of the target areas, i.e., the pest organisms and the parts of the tree that support them. Full cover sprays are achieved at substantially lower volumes when the trees are pruned. All dead branches must therefore be removed to enhance spray efficiency and save costs.

3.4 Dust

Of all citrus pests, red scale is most often associated with trees chronically covered with dust. This phenomenon can be ascribed to the partial or complete absence of natural enemies on such trees. This is probably the result of the abrasive action of dust on the intersegmental membranes of the actively moving natural enemies.

Loamy and clay-containing soils are easily turned into a fine dust by excessive vehicle movement and this quickly forms a layer on adjoining trees. Certain types of soil, such as sand, are sometimes regarded as coarse enough to prevent dust, but even in such cases there is often room for improvement. This problem can be addressed in several ways with a systematic dust suppression programme.

3.4.1 Planning of dust roads

When new orchards are planned, access roads to farm buildings, etc. which are often visited, must be located as far away as possible. In the case of existing orchards and adjoining roads, attempts must be made to re-route such roads. Dust roads between orchards must only be used by vehicles servicing those orchards.

A dust-limiting upper layer of gravel can be spread over dust roads. Limestone can also be worked into the top layer of dust roads containing a high clay content. Lime has the ability to bind to clay to form flakes which do not break up into dust with traffic. Several chemical products are available which can be applied to the roads to bind the upper layer. A byproduct of coal, i.e. carbon oxyhumates, can be applied to dust roads as a liquid. It is also available as a solid which can be applied as a suspension in water. Although the treated surface deteriorates due to traffic, binding reoccurs when wetted. Used lubricating oil can also be used to limit dust. Although this method works fairly well, it is not environment-friendly.

3.4.2 Windbreaks as dustbreaks

The use of windbreaks to protect orchards from wind damage, can also double up as a barrier against excessive dust from outside the orchard. Care must be taken to ensure that this barrier is placed between the road and the orchard.

3.5 Integrating pest management in citrus and adjoining crops

In the Western Cape, citrus orchards are often planted on farms where deciduous fruit and vineyards are cultivated. For organisational reasons, utilisation of common resources, availability of ground, etc., new citrus orchards usually adjoin existing fruit orchards and/or vineyards. In citrus orchards such as these, mealybug, red scale, red mite, and waxy scale often attain pest status that necessitates corrective control with insecticides. Even the control of fruit fly often needs to be adapted to successfully control larger fly populations occurring in these orchards.

Existing pest control programmes in deciduous orchards and vineyards include the frequent and regular use of long-residual insecticides. Applied with mist blowers, the spray drift of these materials invades citrus orchards and adjoining natural vegetation where natural enemy populations are suppressed. It is difficult to adapt such control programmes to be more environmentally friendly. However, the use of harmful programmes must be limited as far as possible.