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Progress towards pest and disease management in Australian olive production

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Abstract: With the rapid expansion of the Australian olive industry during the past decade, plantings have been made in many parts of Australia including both temperate and sub-tropical regions, where summer–dominant rainfall may present production problems. Australia appears to be free of many cosmopolitan olive pests and diseases such as olive moth (*Prays oleae*), olive fly (*Bactrocera oleae*) and olive knot (*Pseudomonas savastanoi*), although some species such as black scale (*Saissetia oleae*) and peacock spot (*Spilocea oleaginea*) are widely distributed. Australia also has several native pests of cultivated olive, including olive lace bug, *Froggattia olivinia* and Queensland fruit fly, *Bactrocera tryoni*. The industry has identified sustainable pest and disease management as a key priority, and a national project has been funded by the Australian Government through the Rural Industries Research and Development Corporation.

1. Introduction

Over the past decade, the Australian olive industry has rapidly expanded. It is now the fastest growing horticultural industry in this country, with more than 7 million trees planted and predictions for this to increase by 10% within the next 5 years. Significant plantings have been made in all states except the Northern Territory. In Australia, more than 80% of production is for oil, with most trees yet to bear fruit. Grove size varies from several hundred to >700,000 trees. Australia lies approximately between latitudes 10° and 45°S, with its northern third in the tropics and almost another third with summer dominant rainfall. While the majority of groves in Australia are planted in localities with a typical Mediterranean climate, a significant minority are in areas with summer dominant rainfall (Sweeney and Davies, 1997). Most groves receive supplementary irrigation.

Although Australia appears to be free of many cosmopolitan olive pests, the recent industry expansion has led to increased problems with pests and diseases, some of which had not been previously encountered. In addition, many (especially smaller) growers do not have a background in horticulture, and therefore lack a detailed understanding of pests and diseases. Hence, the apparent appearance of a pest, disease or damage has sometimes resulted in a "knee-jerk response", which most commonly is the use of synthetic pesticides. There are currently no pesticides

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registered in Australia for use on olives, but the Australian Olive Association (AOA) has been granted permits by the National Registration Authority (NRA) for use of a limited number of insecticides, fungicides and herbicides until end 2003.

Australia also has a well established network of commercial biological control producers who have formed an association, Australasian Biological Control Inc., which operates a members' website (www.goodbugs.org.au) and publishes a book on biological control agents and their use, The Good Bug Book (Llewellyn, 2002).

2. Materials and Methods

The industry, through its official body the AOA, has identified sustainable pest and disease management as a key industry priority. A three-year national project on olive pests and diseases has been funded by the Australian Government through the Rural Industries Research and Development Corporation (RIRDC). This project, which commenced in 2001, comprises a team of entomologists, plant pathologists and industry development officers from five states. It aims to provide a clear picture of the pest and disease complex in Australian olive agro-ecosystems, and an increased understanding in growers of sustainable approaches to their control. This is the first systematic investigation of the olive pest and disease complex in Australia, whereas previously *ad hoc* responses had been made for specific pest problems.

The project comprises three major activities: i) Surveying districts throughout Australia for incidence and severity of olive pests and diseases and their impact on production; ii) Developing and undertaking field monitoring systems for key pests and diseases, as well as biological control agents; iii) Conducting workshops on pest, disease and beneficial organism recognition, monitoring and sustainable management.

To date, a national written survey of olive producers has been undertaken, and twelve workshops have been conducted in five Australian states. The workshops emphasise grove ecology, sustainable pest and disease management, recognition of pests, diseases and beneficial organisms and field monitoring. They comprise both formal presentations and field activities in groves. In addition, a web site has been set up, to provide information on the project, the theory and practice of ecological pest and disease management, and images of key pests and diseases.

3. Results and Discussion

Major identified olive pests and diseases in Australia

The following is a summary of the major olive pests and diseases recorded in Australia, compiled from data gathered from the national survey, project workshops and specimens submitted for identification (Page 2000; Hall, 2001). While Australia appears to be free of some major cosmopolitan olive pests and diseases such as olive fly (*Bactrocera oleae*), olive moth (*Prays oleae*) and olive knot (*Pseudomonas savastanoi*), some species such as black scale (*Saissetia oleae*) and peacock spot (*Spilocea oleaginea)* are widely distributed. Australia also has several native pests of cultivated olive, including olive lace bug *Froggattia olivinia* and Queensland fruit fly *Bactrocera tryoni,* as well as region-specific pests (including vertebrates).

Olive lace bug, Froggattia olivinia *(Hemiptera: Tingidae)*

Olive lace bug is an Australian native species first described feeding on the native olive *Notelaea longifolia* in New South Wales (Froggatt, 1901), and has also been recorded in Queensland and Tasmania. Froggatt also reported lace bug severely attacking European olive, and remarked "..if the olive is ever largely cultivated in Australia this might become a very serious pest" (Froggatt, 1901). This prediction has now occurred, with lace bug being recorded as a serious pest in many parts of eastern Australia (Hely *et al.*, 1982). It is now spreading, probably with movement of plant material, and was reported for the first time in South Australia in December 1999 (Spooner-Hart, unpublished data), followed by a confirmed infestation in Western Australia in April 2002 (Learmonth, personal communication).

Adult lace bugs are mottled brown, 3 mm in length, with large clubbed antennae and a highly punctured upper body surface (Fig. 1A). Eggs are laid on the underside of leaves in clusters close to the midvein and are commonly covered with tar-like excrement. Highly spined nymphs emerge in spring, piercing the leaf surface and feeding on cell contents (Fig. 1B, C). This results in yellow spotting on leaves, which become highly chlorotic and abscise in heavy infestations. Twig dieback may occur in severe infestations (Fig. 1D). There are 5 nymphal instars which can complete their life cycle in as little as 5-6 weeks, depending on climatic conditions (Spooner-Hart, unpublished data). In many parts of Australia, there appears to be 4 or 5 generations per season. Adults feed in a similar manner to nymphs.

Limited information is available on natural enemies of *F. olivinia*. There are anecdotal reports of predation by ants, an as yet unidentified assassin bug (Family Reduviidae) and small insectivorous birds, but none of these have been observed to exhibit significant impacts on lace bug infestations. Current recommendations (permits) for control have been given for the organophosphorus insecticides dimethoate and fenthion, although a permitted organic alternative is insecticidal potassium soap (Natrasoap®). It also appears there may be resistance/tolerance to lace bug in different olive varieties and in different tree culturing systems. Identification of effective control strategies for lace bug will be central to achieving sustainable olive production in many regions.

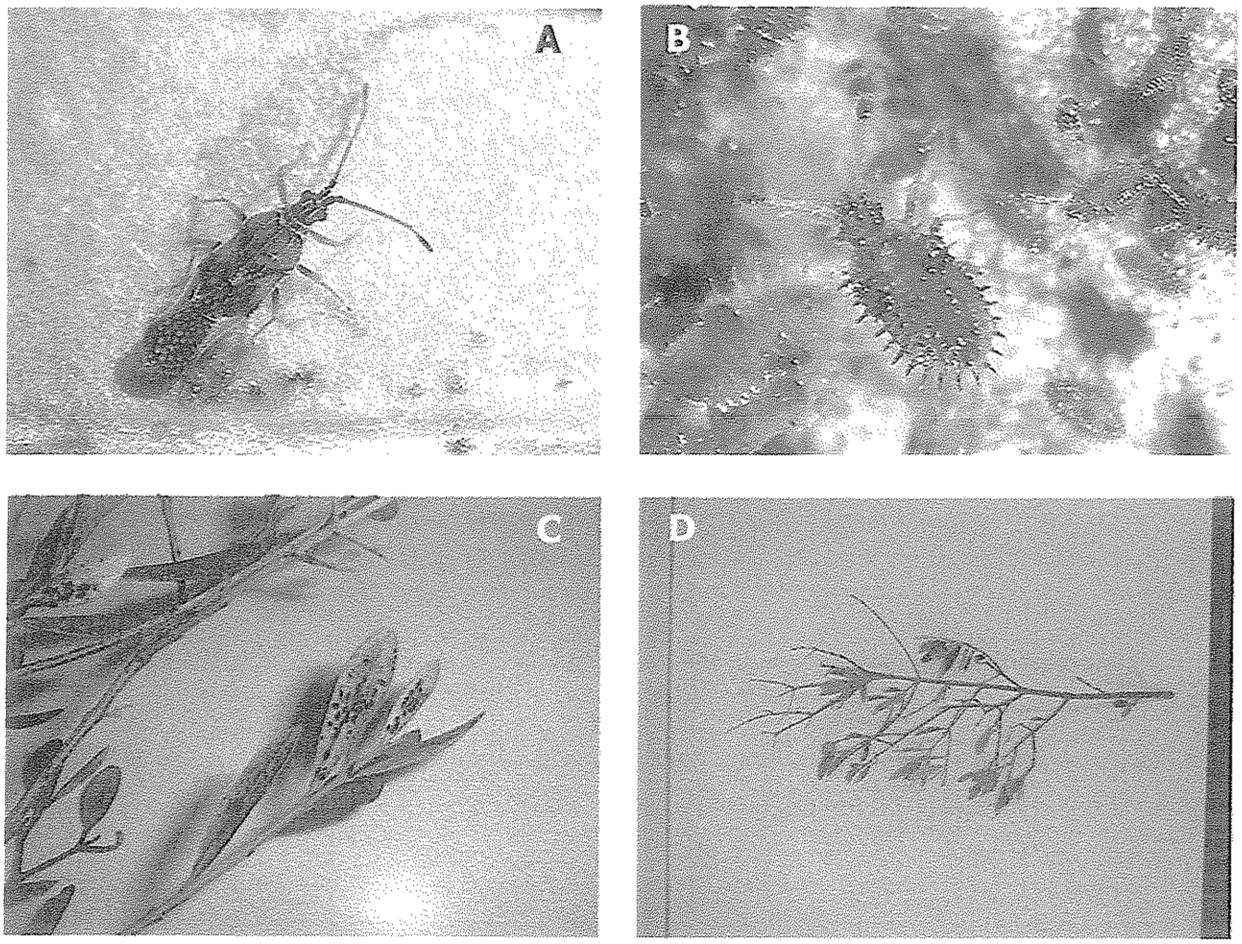

Fig. 1 - Olive lace bug, *F. olivinia*. A= Adult; B= Nymphs; C= Infestation on leaves; D= Dieback of olive branch caused by severe lace bug infestation.

Black scale, Saissetia oleae *(Hemiptera: Coccidae)*

This cosmopolitan species is widely distributed in Australian olive production areas, and can cause severe problems in some groves resulting in leaf drop, reduced tree vigour and twig dieback in heavy infestations. The presence of ants and sooty mould associated with the honeydew produced by the scale can also compound problems of tree health and management. In Australia, there are between 2 and 4 scale generations per year, with first generation nymphal hatching in spring or early summer.

Natural enemies of black scale include the parasitoids *Metaphycus* spp., of which the imported *M. bartletti is* being considered for commercial rearing and release (Smith *et al.,* 1997; Altman, personal communication), and *Scutellista caerulea,* which is also an egg predator. Field parasitism by the latter species can be very high, with >80% parasitism of adult scales recorded in some olive groves (Spooner-Hart, unpublished data). Unfortunately, it is highly prey density-dependent and only reaches such high levels late in the season. Predators include several species of ladybird beetles (Coleoptera: Coccinellidae), lacewing larvae (Neuroptera: families Chrysopidae and Hemerobiidae) and the scale-eating caterpillar *Catoblemma dubia* (Lepidoptera: Noctuidae).

The use of horticultural spray oils has been strongly encouraged for scale control in olives and citrus crops. While this has been primarily application of narrow-range petroleum oils with high efficacy and low phytotoxicity, there is also strong interest, particularly by organic growers, in a canola oil spray formulated with extract from the Australian native tea tree, *Melaleuca alternifolia.* However, correct timing of applications to coincide with scale crawler emergence and ensuring adequate tree coverage are both critical factors in the success of all oil sprays. There is also a permit for methidathion, although this is generally only recommended for severe infestations.

Armoured scales: (Hemiptera: Diaspididae)

Several species of armoured scales have been reported causing economic damage in Australian olive groves (Hely *et al.*, 1982; Page, unpublished data; Spooner-Hart, unpublished data). These include red scale *Aonidiella aurantii*, parlatoria scale *Parlatoria oleae* and oleander scale *Aspidiotus nerii*. Damage is primarily to leaves and twigs, although occasional fruit infestations have been observed.

Natural enemies of armoured scales are commonly parasitoids including *Aphytis melinus*, and *A. lingnanensis* both of which are mass reared and commonly released into citrus orchards, *Comperiella bifasciata* and several *Encarsia* spp. (Smith *et al.*, 1997). However, predators can play an important role in scale control, particularly the ladybirds *Rhizobius lophanthae*, *Chilocorus circumdatus* and *Halmus chalbeus*, and to a lesser extent some species of lacewings and predatory mites.

Oil sprays, as discussed previously for black scale, are also encouraged for use against armoured scales as a component of ecological pest management in olive groves, although methidathion also has permitted use.

Fruit flies (Diptera: Tephritidae)

Two fruit fly species, Queensland fruit fly, *Bactrocera tryoni*, and Mediterranean fruit fly, *Ceratitis capitata*, have been reported damaging olive fruit in Australia, although to date this has not been widespread. *B. tryoni* (Fig. 2) is endemic to Queensland and the coastal parts of New South Wales.

Fig. 2 - Adult Queensland fruit fly, *B. tryoni*.

Most of inland New South Wales, together with the states of Victoria and South Australia, are free of *B. tryoni*. *C. capitata* only occurs in Western Australia. With both species, fruit are damaged by oviposition, which can prematurely ripen fruits or cause them to fall. This damage also predisposes fruit to fungal rots.

While natural enemies of Queensland fruit fly have been recorded, primarily braconid parasitoids (Hymenoptera: Braconidae), the assassin bug *Pristhesancus plagipennis* (Hemiptera: Reduviidae) and birds, these rarely achieve economic control (Smith *et al.*, 1997) Although attempts at biological control of Medfly have been tried, these have been unsuccessful. Sterile insect technique (SIT), however, has been used with some success against both species. Current permitted insecticides for fruit fly control in olives are dimethoate and fenthion.

Cuelure and trimedlure are used to monitor for presence of adult male flies of Queensland fruit fly and Medfly respectively in many crops. Baiting with yeast autolysate mixed with an insecticide is recommended in areas of high fruit fly activity in other tree crops, although it is not currently recommended for olives. There is evidence that oil spray deposits may protect fruit from damage by inhibiting oviposition (Beattie, personal communication).

Weevils (Coleoptera: Cucurlionidae)

Curculio beetle (= apple weevil), *Otiorhynchus cribricollis*, damages olive leaves in inland NSW, South Australia and Western Australia, whereas garden weevil, *Phlyctinus callosus*, has only been reported as a pest in Western Australia. In both species, adults are nocturnal and emerge from soil, leaf litter and weed stubble to feed, climb the olive trees and chew the outer leaf margins. Minor damage results in ragged leaves, but heavy infestations can severely damage growing tips and may remove leaves entirely, especially in young trees. The soil-dwelling larvae may also damage tree roots. A permit for butt spraying of non-bearing olive trees with α-cypermethrin is current. No natural enemies of weevils have been identified, although free-range poultry have been used for weevil control in apple orchards. An effective alternative to insecticide application to butts of trees is the application of either a sticky or a fibrous barrier to the tree trunk. In the latter case, weevils become enmeshed in the fibres.

Caterpillars (Lepidoptera)

There are a number of caterpillar species recorded attacking olives in Australia. Of these, the most important is light brown apple moth *Epiphyas postvittana* (Tortricidae), a native species of leafroller. It primarily damages growing tips in olives, tying them together with silken threads to form a protected area within which it feeds (Fig. 3). Other caterpillars identified include native hawk moth (Sphingidae), heliothis and cutworms (Noctuidae). Most leaf-feeding larvae, including *E. postvittana*, are readily controlled by applications of *Bacillus thuringiensis*

An as yet unidentified species of *Cryptoblabes* (Family Pyralidae) has recently been recorded feeding on fruit in Queensland (Page, unpublished data).

Fig. 3 - Damage caused by light brown apple moth, *E. postvittana*

Olive bud mite Oxycenus maxwelli

Olive bud mite was first detected in NSW Australia in 2000 (Knihinicki, 2000), but had possibly been present in this country for some time. This small (0.1 to 0.2 mm) mite preferentially feeds on developing buds, shoots and leaves. While this species does not generally cause major damage, it is most severe in young trees in favourable conditions (warm temperature and high humidity).

Other sucking bugs (Hemiptera)

Generally, these are of minor importance, although they may be prevalent in some districts in favourable seasons. These include lygaeid bugs (Lygaeidae), particularly Rutherglen bug *Nysius vinitor*, which can be a serious pest on new plantings in South Australia and the wheatbelt areas of Western Australia (Hardie, personal communication), green vegetable bug *Nezara viridula*, and cicadas (Cicadidae).

Grasshoppers (Orthoptera: Acrididae)

There are four major species of grasshopper (or locust) that may attack olives in Australia, the plague locust *Chortoicetes terminifera*, the spur-throated locust *Austacris guttulosa*, the migratory locust *Locusta migratoria* and the wingless grasshopper *Phaulacridium vittatum*. Of these, plague locust is the most devastating, although *P. vittatum* has been a serious pest in the wheat-belt regions of Western Australia (Hardie, personal communication) as well as other areas of southern Australia. In the non-gregarious phase, grasshoppers primarily feed on terminal leaf margins. However, in the locust phase, they devour most green plant material, stripping trees rapidly. Under these conditions, immediate action is essential. There are no permitted pesticides for controlling grasshoppers in olives, although several pesticides permitted for use in olives are registered for grasshopper control in other tree crops. Additional permits for pesticide use are usually made in locust plague outbreak years.

Snails (Gastropoda)

Snails, including the small brown snail, *Microxeromagna vestita*, and the white Italian snail, *Theba pisana*, are a problem in some areas of South and Western Australia. They appear to cause limited feeding damage, but they rest in trees, causing smothering of trunks and branches, and occasionally broken limbs from their sheer weight (Fig. 4). In South Australia, they move off trees in autumn and are not present during the critical harvest period where they could contaminate fruit.

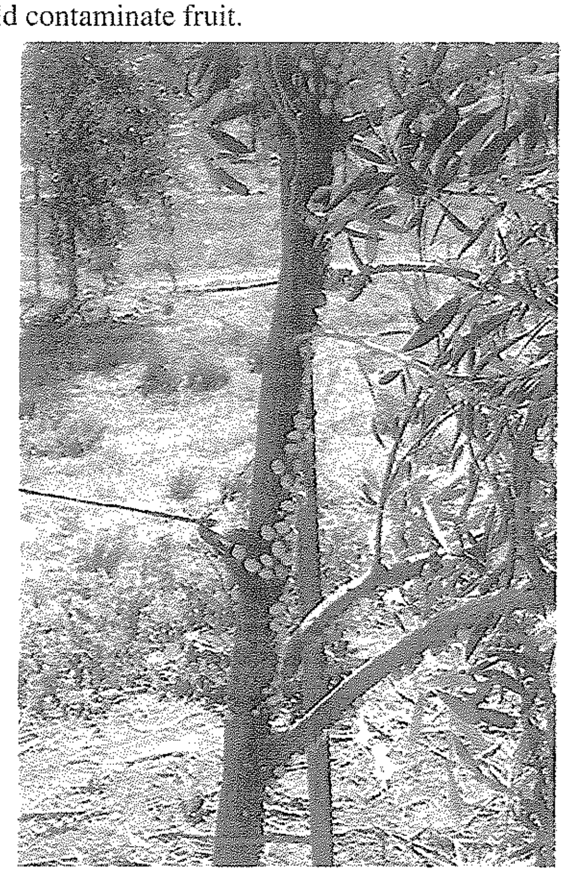

Fig. 4 - Snail infestation on olive tree, South Australia.

Peacock spot Spilocaea oleagina

Peacock spot is widespread throughout eastern and central Australia and can cause severe problems, particularly in coastal and highland areas where conditions are most favourable (i.e. warm and humid). In some groves, significant leaf defoliation occurs, exposing the branches, trunk and fruit to environmental damage. Some cultivars appear to be more tolerant to this disease. Recommended fungicides are copper oxychloride and copper hydroxide, and hygienic practices such as removal of fallen infected leaves are encouraged.

Anthracnose Colletotrichum *spp.*

Anthracnose has been reported to cause ripe fruit rot in olives particularly in districts with summer rainfall (Fig. 5). It can affect fruit as they begin to ripen, particularly under wet conditions. Anthracnose and other fruit rots may be associated with fruit attack by insects, particularly fruit flies and environmental damage such as that caused by hail. Recommended fungicides are copper oxychloride and copper hydroxide, and application of these protectant compounds is recommended when prevailing weather conditions favour this disease.

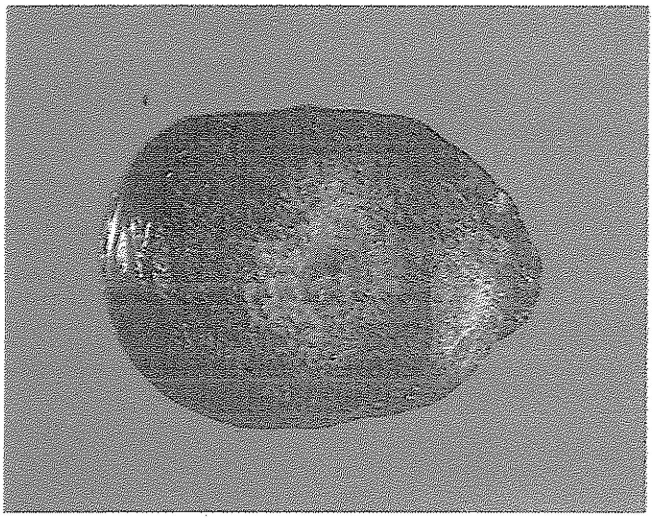

Fig. 5 - Anthracnose, *Colletotrichum* sp., on olive fruit.

Root and vascular diseases

Numerous cases of olive tree decline and death have been reported. Pathogenic fungi isolated from trees showing symptoms include *Phytophthora* spp., *Pythium* spp., *Rhizoctonia* spp. and occasionally *Verticillium dahliae*. These diseases are commonly associated with poor soil drainage. *V. dahliae* is most common on land which has previously grown susceptible crops such as tomatoes, potatoes or cotton. Use of well-composted organic matter and improved soil drainage are recommended cultural control strategies. The use of biocontrol fungi (e.g. *Trichoderma* spp.) has not yet been evaluated on olives in this country. There is a permit for use of the synthetic fungicide Metalaxyl M. to control *Phytophthora* spp. in nurseries.

Nematodes

The root knot nematode *Meloidogyne javanica* is widespread in Australia, particularly in sandy soils, and has been reported producing root galls on olives that reduce tree vigour and fruit size. A private permit for use of fenamiphos has been granted to a large olive producer in South Australia.

Opportunistic tissue-invading microorganisms

Many examples of localised trunk and stem die-back are not associated with known olive pathogens. It is suspected that tissue death is a result of entry of opportunistic fungi and bacteria through wounds such as pruning cuts and other mechanical injury. Occasional trunk and stem galls are also associated with opportunistic bacteria. Olive knot, *Pseudomonas savastanoi*, has not been recorded in Australia.

Non-pathogenic diseases

A number of samples of damaged or misshapen fruit have no apparent pathogenic cause (Fig. 6A, B, C). It

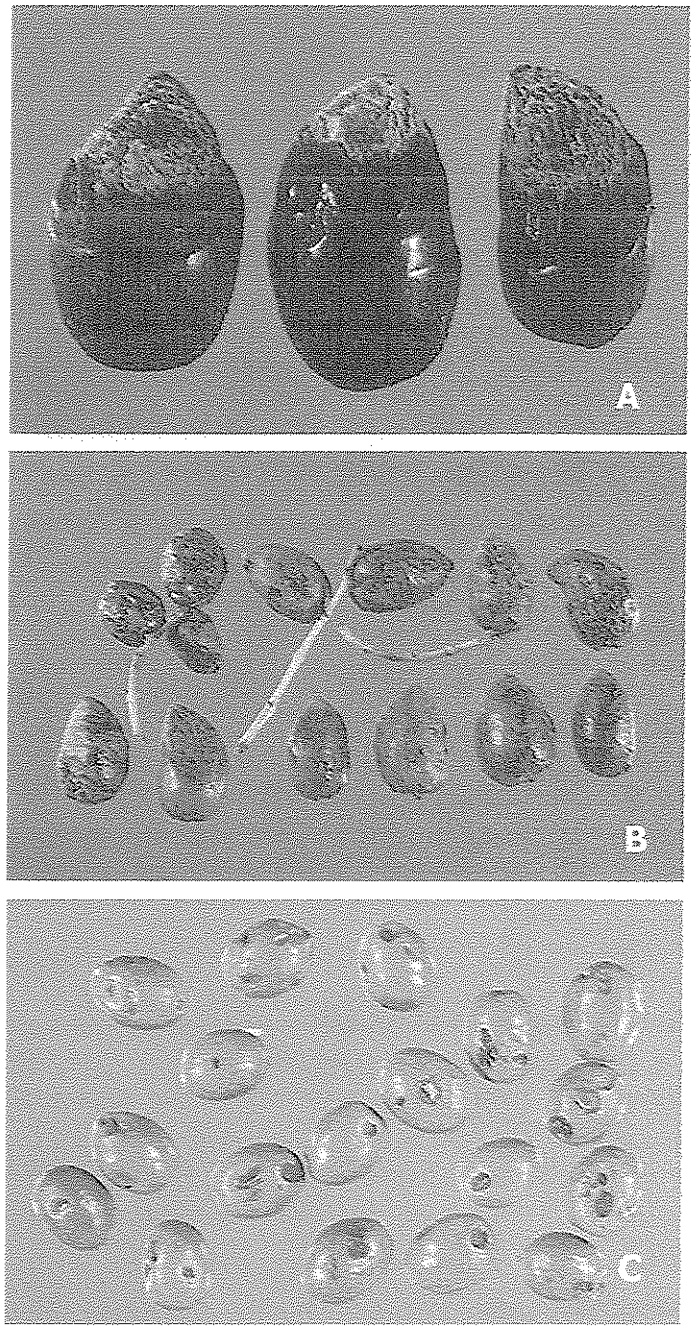

Fig. 6 - Symptoms of fruit damage believed to be from non-pathogenic causes. A= Blossom end rot: calcium/boron imbalance; B= Fruit marking, probably physiological; C= Fruit marking from hail damage.

appears the symptoms are a result of nutrient imbalance (particularly boron and calcium), or from irregular or over watering, or after a period of high temperature. As the Australian olive industry matures, increased local knowledge of appropriate irrigation and plant nutrition practices should reduce incidence of these problems.

Vertebrate pests

Several vertebrate pests, particularly rabbits and kangaroos, have been reported damaging young trees, primarily through bark stripping. Most trees are planted with protective tree guards, and groves are commonly fenced to prevent entry of potential vertebrate pests. Birds have also been reported attacking ripening olive fruit. Feral olives spread by birds have become a problem in several Australian districts, particularly in South Australia.

4. Conclusions

The national project described here will provide a detailed account of key olive pests and diseases in Australia and their distribution and seasonal occurrence, together with assistance in identifying them and their damage. Advice on sustainable and organic management of these pests and diseases, and identification of beneficial organisms in groves will be a further outcome.

It is envisaged that future developments in the Australian olive industry, particularly access to both IPM-friendly and organically acceptable pesticides together with the development of effective biological control options will complement cultural methods, resulting in increased adoption of sustainable production methods.

Acknowledgements

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