

Paper 7

INSECT PESTS OF LUCERNE IN NEW ZEALAND

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INTRODUCTION

An excellent review of invertebrate pests of New Zealand lucerne crops was presented by Pottinger and MacFarlane to the Lucerne Symposium held at Lincoln College in 1967. At that time, 49 pest species of lucerne were known to be present in New Zealand. Of these only the common grass grub (*Costelytra zealandica* White), white fringed weevil (*Graphognathus leucoloma* Boheman) and stem nematode (*Ditylenchus dipsaci* Kuhn) were considered to be of major importance. Pottinger and MacFarlane (1967) considered that "no pest constituted a limiting factor to lucerne-growing" and concluded that many important overseas pests such as spotted alfalfa aphid (SAA) (*Therioaphis maculata* Buckton), alfalfa weevil (*Hypera postica* Gyllenhal) or potato leafhopper (*Empoasca fabae* Harris) were not present in either Australia or New Zealand, because of the stringent quarantine procedures imposed by both countries. As grass grub is recognised as a pest of only young lucerne (Pottinger and MacFarlane, 1967; Wynn-Williams, Paper 2) and methods to control it are well documented (East and Kain, 1979) it is not covered in this review. Since 1967 blue-green aphid (BGA) (*Acyrtosiphon kondoi* Shinji), pea aphid (PA), (*A. pisum* Harris) and Sitona weevil (*Sitona* sp.) have become established in New Zealand and BGA, PA and SAA in Australia. BGA is a recent arrival in the western world and was first found in California in 1974 (Sharma *et al.*, 1975), in New Zealand in 1975 (Cox and Dale, 1977) and in Argentina and Australia in 1976 (Nielson and Lehman, 1980). The pest is of Asian origin and native to the countries of the Far East (Nielson and Lehman, 1980). Although PA is a recent arrival in Australasia and was first recorded in New Zealand in 1974 (R.D. Archibald, pers. comm.) it is a common pest of mid-latitude countries of the Northern Hemisphere, where its biology has been well documented (e.g. Cooke, 1963). The origin of the initial introduction(s) of Sitona weevil into New Zealand is almost certainly Australian (Chadwick, 1960; Allen, 1971) where it is a major problem of lucerne in South Australia.

In view of the known trans-Tasman movement of insects onto New Zealand (Fox, 1978) and the propensity of aphids to disperse intercontinentally, in wind currents (Johnson, 1967) the recent establishment of SAA in Australia (Walters, 1978) poses a potential threat to the New Zealand lucerne crop. In combination with BGA it has been estimated that this pest reduced Australian lucerne production in 1977 by 33%; a loss valued at \$150 million (Waterhouse, 1980).

These recent pest problems and the spread of stem nematode and particularly white-fringed weevil (Schofield, 1979) combined with an increased incidence of several important diseases, most notably bacterial wilt (*Corynebacterium insidiosum* McCull.) (Close and Mulcock, 1974) have had a major impact on lucerne agronomy. Over the last five years the area of lucerne has declined rapidly. This decline has been precipitated by a succession of wet summers, which have markedly reduced the large cost-benefit advantage lucerne normally enjoys over traditional pastures in drought-prone areas. In turn this has high-lighted problems caused by new and established pests, which under these circumstances have eroded farmer confidence in the crop.

The purpose of this paper is to review the biology, status and control of the major invertebrate pests of forage lucerne, and to discuss strategies which are necessary to ensure the protection of the crop from future outbreaks of overseas pests in this country.

LUCERNE APHIDS

Following the establishment of BGA and PA in New Zealand it soon became evident that the local cultivar Wairau, the most commonly-grown lucerne at that time, was highly susceptible to both pests. In the southern North Island region autumn production from two lucerne meal factories fell by 60% largely as a result of damage caused by BGA (Kain *et al.*, 1978).

Because of their pest status in USA and the early losses that these pests caused, a multi-disciplinary research programme was initiated to rapidly develop methods to control them. This involved DSIR, MAF and Lincoln College. Its major objective was to economically protect existing lucerne crops from aphid damage, until stands were replaced by suitable multiple aphid resistant cultivars (Nielson *et al.*, 1976). The studies focussed on the rapid acquisition of information on the population growth patterns of both aphids, under controlled conditions and from a wide range of environments. The pest status of each aphid on different stages of lucerne regrowth was studied, and the worth of existing natural control agents evaluated (Cameron *et al.*, 1980). In a comparatively short time, crude but simple guidelines for successful integrated pest management of lucerne aphids were formulated. These were based on pest densities, times at which control methods should be implemented and the best method to use under different conditions (Kain *et al.*, 1978, 1979b). Concurrently a plant breeding programme was mounted by Crop Research Division, DSIR to develop multiple aphid resistant cultivars (Dunbier *et al.*, 1980).

Biology

Both species overwinter in lucerne and on other pasture legumes, in the parthenogenetic viviparous form (Kain *et al.*, 1979b). Sexual and egg stages of BGA are unknown (Kodet and Nielson, 1980). Although the PA forms sexual stages and overwinters as an egg in North

America (Cooke, 1963) these stages are unknown in New Zealand. In common with most aphids, both species have a high potential to increase rapidly and under favourable environmental conditions can, from very low levels, reach epidemic proportions in eight to 12 days (Richardson, 1977; Gaynor *et al.*, 1980; Kain *et al.*, 1979b).

The density and relative abundance of the two aphid species changes with the seasons. Usually BGA aphids are most abundant in spring and early summer and again in autumn. PA is the more numerous in summer (Kain *et al.*, 1979b; Rohitha, 1979). This generalised pattern of pest abundance however, is markedly influenced by short-term variations in weather and regional climatic patterns (Fig. 1) (Trought and Kain, 1977; Kain *et al.*, 1979b). In years or localities with cool wet summers, BGA are abundant in summer and autumn. Under warm dry summer conditions BGA numbers diminish rapidly, and PA becomes the dominant species. Under severe and prolonged drought PA numbers also collapse, but following these conditions this pest is usually the dominant species in the autumn and the following spring (Kain *et al.*, 1978). These changes in seasonal abundance can largely be explained by the different temperature responses of the two species. The favourable constant temperature range for BGA is 6.0°C to 20.5°C and its lower threshold for development is 2.6°C compared with 5.2°C for PA (Rohitha, 1979) which accounts for the dominance of BGA in winter. Above 25.5°C the reproductive rate and longevity of apterae BGA

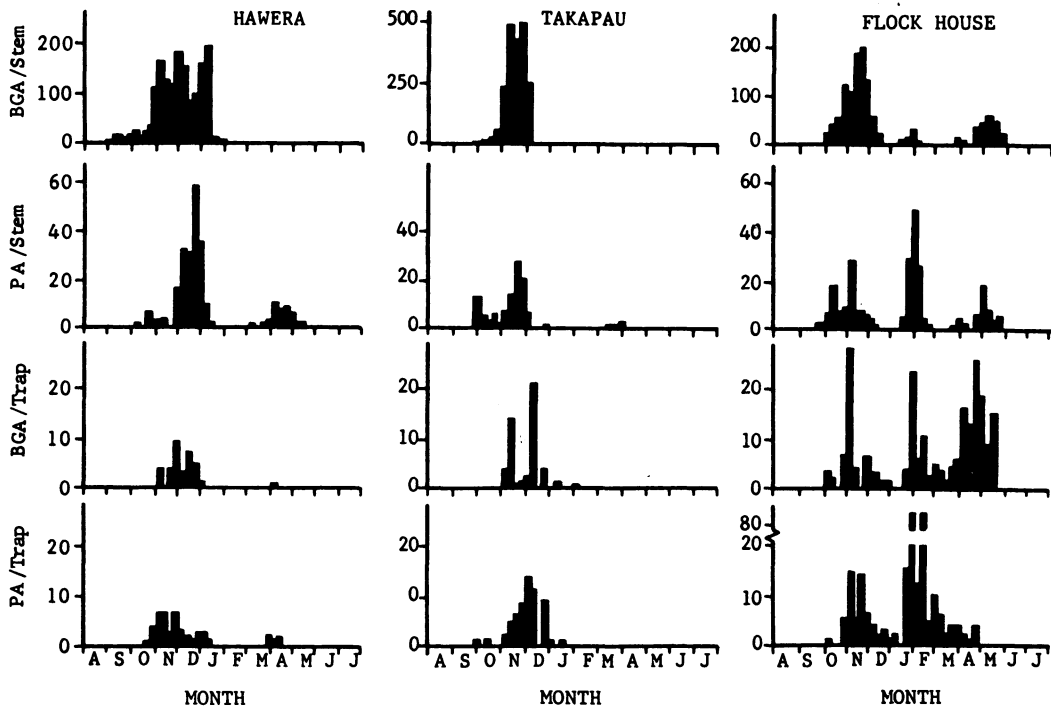


Figure 1: Blue-green (BGA) and pea aphid (PA) populations (nbr/stem) and flights (nbr/trap) at three sites in 1977/78.

declines rapidly and the pest is unable to survive above 30°C (Rohitha, 1979; Rohitha and Penman, 1981). In comparison PA can survive and reproduce at temperatures well in excess of this (Harrison and Barlow, 1973); hence its dominance in summer, and following severe summer droughts in autumn and spring.

The physiological condition of the host-plant is known to markedly affect certain aphid species (Tingey and Singh, 1980). Rohitha (1979) suggested that the lower end of the favourable temperature range for BGA is probably below the growth threshold of lucerne, and at these temperatures the host may not be able to meet the nutritional requirements for aphid growth. Probably as a result of this, winter-active cultivars support higher winter populations of BGA than winter-dormant cultivars, and therefore a move to more winter active cultivars, unless resistant to BGA, would aggravate the problems caused by this pest (Kain *et al.*, 1978, 1979b; Gaynor *et al.*, 1980).

Opinions differ as to why BGA populations rapidly diminish in early summer, in the absence of natural enemies and under temperatures which appear to favour their reproduction and survival. Collapses in local populations of both aphid species seem to be largely attributable to a rapid production and dispersal of alate (Kain *et al.*, 1979b; Gaynor *et al.*, 1980). This phenomenon may be precipitated by a deterioration in the quality of the host-plant associated with growth stage, moisture stress and aphid damage (Kain *et al.*, 1979b; Gaynor *et al.*, 1980). Gaynor *et al.*, (1980) noted, that under favourable conditions BGA increased at an exponential rate during the most rapid growth period in the lucerne regrowth curve, but declined rapidly between the point of inflection and the asymptote.

PA flights occur throughout spring, summer and occasionally in late autumn whereas BGA flights are confined to late spring, and early summer and autumn, and follow immediately the occurrence of peak aphid populations in the crop. Although winged BGA are present in winter, flights do not occur at this time of year (Kain *et al.*, 1979a).

Fungal pathogens belonging to the genus *Entomophthora* cause unpredictable and catastrophic mortalities in BGA and PA populations under humid conditions (Rohitha, 1979; Kain, 1979b; Gaynor *et al.*, 1980; Henderson, 1980). Generally however, the existing natural invertebrate predators of lucerne aphids are not diverse and are usually restricted to six commonly-occurring species; eleven-spot lady bird (*Coccinella undecimpunctata* L.), brown lacewing (*Micromus tasmaniae* Walker), small syrphid fly (*Melanostoma fasciatum* MacQuart) (Thomas, 1977; Cameron *et al.*, 1979; Henderson, 1980), large syrphid *Melangyna novae-zealandiae* (Somerfield and Burnett, 1976), *Nabis maoricus* Walker (Henderson, 1980) and *Nabis capsiformis* Germar (Thomas, 1977).

Cameron *et al.*, (1980) noted that the major factor limiting the effectiveness of aphid predators against BGA is their lack of synchrony with aphid populations in early spring. In the case of the brown lacewing this probably results from the species' higher temperature threshold for

development (Syrett and Penman, 1981) than for BGA (Rohitha and Penman, 1981) and for the eleven-spot ladybird emigration from the field prior to aphid build-up (Cameron *et al.*, 1980). Nevertheless the eleven spot-ladybird and brown lacewing can significantly influence PA and BGA levels (Cameron *et al.*, 1980). Unfortunately coccinellid-aphid relationships are intrinsically unstable and being such mobile predators, unpredictable (Gilbert and Frazer, 1967).

Although an *Aphelinus* sp. has been collected from BGA (Thomas 1977; Cameron *et al.*, 1980) native parasites seldom attack lucerne aphids. Five aphid parasites were introduced into New Zealand to reinforce the natural enemy complex of PA and BGA of these *Aphidius ervi*, *A. aedyi*, *A. urticae* and *Ephedrus plagiator* have established on PA but not BGA. Fear exists that this selective parasitism of PA may change the dynamics of aphid interactions in such a way that BGA may become the numerically dominant species (Cameron *et al.*, 1980, 1981). Hyperparasitism of these parasites by native species can be high and in certain areas may reduce their effectiveness (Walker and Cameron, 1981).

Damage

Lucerne severely damaged by BGA is stunted and exhibits chlorosis, shortened internodes, and small misshapen leaves (Sharma *et al.*, 1975; Kain *et al.*, 1977 and Kain *et al.*, 1979a). Sharma *et al.*, (1975) considered that these growth malformations are caused by a toxin(s) injected into the plant by the feeding aphid. PA also causes stunting, leaf-yellowing and leaf-drop, but apart from cupped leaves (Evans and Gyrisco, 1956) damaged plants are not usually misshapen or twisted as they are following BGA attack.

BGA can severely damage and kill seedling lucerne (Palmer, 1977; Wynn-Williams and Burnett, 1977). Losses in production of mature crops following BGA attack of up to 62, 30 and 71% have been recorded in spring, summer and autumn respectively whereas losses caused by PA in summer are less severe (< 42%) (Nielson and Kodet, 1975; Kain *et al.*, 1979a; Rohitha, 1979). Kain *et al.*, (1979a) observed severe carry-over effects of BGA damage following autumn damage, which caused reductions in winter and spring production of 50% and 33% respectively. In rapidly-growing lucerne, losses in herbage production from either aphid does not occur below 30 per stem (Kain *et al.*, 1979a; Gaynor *et al.*, 1980) except in very young regrowth (Kain *et al.*, 1979a, Sharma and Stern, 1980). When growth slows in autumn and the plant is at its most susceptible to aphid damage, control is necessary when the number exceeds 10 per stem, even when regrowth is 15 cm high (Kain *et al.*, 1979b).

Plant densities can be reduced by up to 20% during autumn and late winter, in lucerne badly and persistently damaged by BGA (Kain *et al.*, 1977, 1979a).

Long-term reductions in herbage production, caused by BGA damage, have been found to be correlated with reduced reserves of non-structural carbohydrate in the roots (Kain *et al.*, 1979a).

Although levels of carotene and xanthophyll may be depressed by aphid damage, the feed value of lucerne is not greatly affected (Kain *et al.*, 1979a). However, increased coumestan levels found in aphid-damaged lucerne herbage, can be high enough to cause appreciable reductions in the ovulation rate of ewes fed this herbage at mating (Kain and Biggs, 1980; Jagusch, Paper 9).

Aphid-damaged crops of lucerne are also prone to weed-invasion, which generally requires herbicidal treatments to retain stand-purity and production (Kain *et al.*, 1977 and 1979a).

Control

A locally-developed cultivar, Rere, with BGA and PA resistance, became available in 1979 (M.W. Dunbier, pers. comm.) and is the only BGA resistant cultivar available in New Zealand. A number of bacterial wilt resistant cultivars with PA resistance had been imported prior to the arrival of this pest, as a suitable replacement for Wairau in areas where wilt was a problem (Dunbier *et al.*, 1980). More recently, other exotic lucerne cultivars with resistance to both PA and bacterial wilt as well as to SAA, have been sown throughout the country (Dunbier and Easton, Paper 19).

BGA and PA are susceptible to a wide range of insecticides applied to the foliage at very low rates (e.g. Kain *et al.*, 1976; Pottinger *et al.*, 1978; Syrett and Penman, 1980) and young seedlings can be protected with granular systemic insecticides sown with the seed (Palmer, 1977). Of the foliar-applied aphicides, pirimicarb is the least toxic to beneficial fauna (Davies *et al.*, 1978; Franzmann, 1978; Syrett and Penman, 1980). Bartlett (1958) noted that the use of aphicides with short residual lives, ensured that adult aphidiids emerging from mummies, were exposed to toxic residues for a much shorter period than following applications of persistent aphicides.

Grazing and harvesting of lucerne can cause sudden collapses in populations of lucerne aphids (Kain and Atkinson, 1977; Kain *et al.*, 1979a; Rohitha, 1979) but under certain conditions, harvesting may concentrate BGA on susceptible young regrowth and cause severe crop damage (Kain *et al.*, 1979b). Grazing, or the use of

insecticides after autumn flights have ceased, can so reduce aphid densities that damaging levels are not reached until paddocks are reinfested by flights in spring (Kain and Atkinson, 1977; Kain *et al.*, 1979b; Penman *et al.*, 1979; Rohitha, 1979). The judicious use of grazing or harvesting, is capable of confining aphid densities below damaging levels until the summer decline of BGA occurs (Penman *et al.*, 1979).

Kain *et al.*, (1978, 1979b) and Kain and Atkinson (1981) considered that the choice and implementation of control methods for lucerne aphids should be guided not only by the density of the pests concerned, but also by the stage of lucerne regrowth, season, intended crop use and previous management or condition of the crop.

Recent studies have shown that the management of BGA-damaged lucerne should be aimed at increasing root reserves depleted by aphid damage quickly, by allowing the crop to reach an advanced stage of growth before harvest or grazing (Stiefel, unpubl. data). As a consequence of this, insecticidal protection from aphid damage is required over this period. Most of the variables which influence aphid control have been discussed above, and based on this information a simple decision chart for aphid control (Table 1) embodying most of these has been drawn up, and will be refined as further data comes to hand. Although BGA is more damaging than PA (Nielson and Kodet, 1975; Kain *et al.*, 1979b) for practical purposes no effort has been made to distinguish between the two pests. However, because of the differences in the seasonal occurrence of the two species, this has been taken into account in the recommendations.

Given the speed with which aphids can build up to pest proportions, and that damage is both a function of pest-density and the time that aphids are present on the crop (Kain *et al.*, 1977; Rohitha, 1979) weekly crop inspections are necessary, except in winter, to prevent aphid damage. Rohitha (1979) has shown the possibilities of developing a model based on a physiological time-scale (day degrees above the development threshold temperature) for predicting the time at which BGA flights occur and flight

TABLE 1: Decision chart for aphid control on lucerne based on aphid abundance, season and height.

Aphid Abundance	Season	Lucerne height (cm)		
		1—10	11—25	>25
None — few	autumn	*re-examine	no action	no action
Aphids easily found clustering on the terminals	early spring	spray	re-examine	graze,
	late spring	spray	re-examine	harvest
	summer	spray	re-examine	or spray
	autumn	spray	spray	
Aphids heavily clustered on terminals and stems	all	spray	spray	graze, harvest or spray

* re-examine in three days.

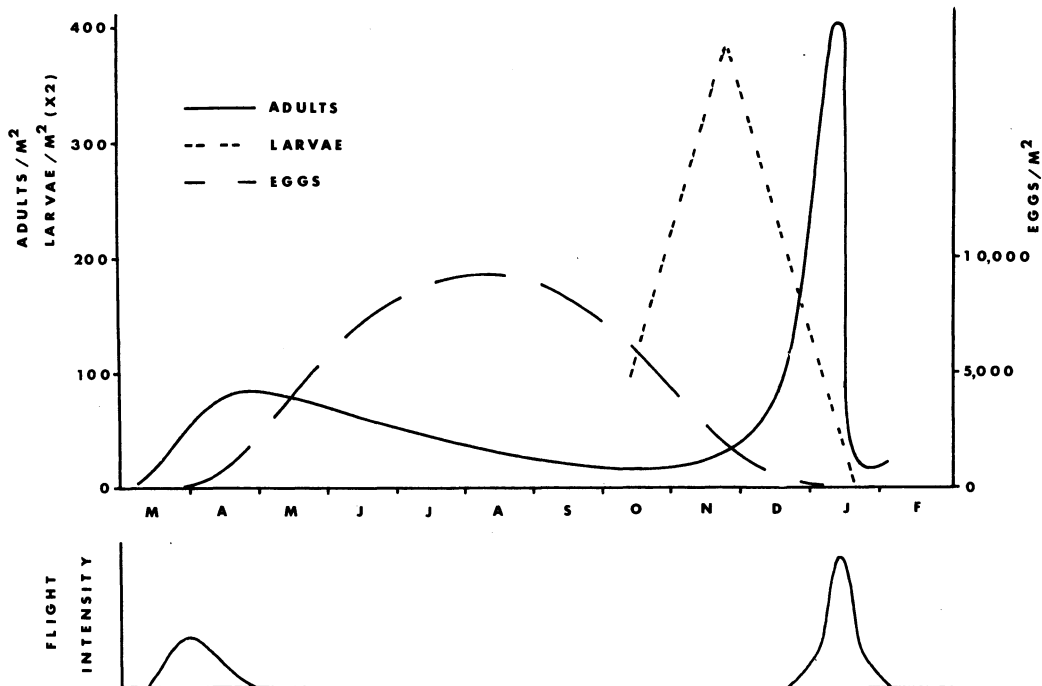


Figure 2: Seasonal distribution *Sitona* populations in a first year lucerne stand (1980/81).

duration (Rohitha, 1979). The use of this model could assist in the timing of BGA control programmes, by defining the time over which pest surveillance should be conducted.

SITONA WEEVIL

Sitona weevil (previously thought to be *Sitona humeralis* Stephens but now confirmed as *S. discoideus* Gylh.) was first recorded in 1974 in a narrow coastal strip near Napier damaging bur medic (*Medicago polymorpha*) but at that time, was not found on lucerne (Esson, 1975). In early 1976, the adults were first recorded defoliating lucerne on Banks Peninsula (Somerfield and Burnett, 1976) but there is little doubt that the pest was widespread in parts of Canterbury before this (Wood, 1980). *Sitona* can now be found in most parts of New Zealand, wherever lucerne is grown or annual medics occur. Concern about the defoliation the adult causes to lucerne is frequently reported from the central areas of the South Island and parts of the southern North Island.

Biology

Wightman (1980) and Wood (1980) considered the species to be bivoltine. On the basis of studies on its reproductive physiology Kwong Sue *et al.*, (1980a) concluded that *Sitona* was univoltine, and this ties in with

J.P. Aeschlimann's (pers. comm.) observation that aestivation is an essential pre-requisite for egg-laying. Recent field studies confirm that the species is univoltine (Goldson, unpubl. data).

Adult *Sitona* weevils have a normal life-span in captivity of 9-11 months (Wood, 1980). Under field conditions females are capable of laying eggs throughout the year, except when aestivating in January and February (Wightman, 1980; Kwong Sue *et al.*, 1980a).

The pest has two main flight periods (Fig. 2). The first through December and January, when most weevils emigrate from the lucerne paddock they originated in, to aestivate in sheltered sites outside the crop. The second or infestation flights occur in autumn through March and April, when weevils fly to previously infested or uninfested crops. Summer dispersal and autumn infestation flights cause populations in lucerne to suddenly collapse and increase respectively (Barratt and Goldson, unpubl. data).

Egg-laying by female weevils begins in March, at the end of the aestivation period, and may continue through until December (Fig 2.). Eggs are scattered over the soil surface, and one female can lay up to 1,000 eggs (Wightman, 1980). The incubation time of eggs is markedly influenced by temperature (Allen, 1971). At 10°C, eggs take over two months to hatch, but at 22°C this is reduced

to 14 days. Two active periods of egg-laying were defined by Kwong Sue *et al.*, (1980b). The first occurred in autumn and the second in spring during September to October. Recent observations suggest that peak egg densities occur on the soil surface in July (Goldson, unpubl. data).

Larvae are present in the soil of lucerne paddocks from August through to December (Wightman, 1980) and peak numbers, occur in mid November (Fig. 2). Although larvae do not occur in Canterbury before August, they may occur earlier than this in the more northerly areas, where winter soil temperatures are higher. The development time from egg to adult is also strongly related to temperature, and varies from 99 days at 15 °C to 55 days at 20 °C (Kwong Sue *et al.*, 1980b). This strong temperature dependence may explain why, in spite of a spread oviposition period, peak numbers of larvae occur in Canterbury over a relatively limited period, from mid-October to mid-December, when they cause most damage.

Natural regulatory factors affecting *Sitona* weevil in New Zealand are little understood. Studies by Wood (1980) in Canterbury have shown that the adults are readily eaten by starlings and infected by a protozoan pathogen (*Pleistophora* sp). Between March and October, easily identified protozoan infections can be as high as 20% (Wood, 1980). Wightman (1980) observed that an unidentified pathogen "appeared to decimate *Sitona* populations in Canterbury".

Damage

Adult weevil damage can cause near-complete defoliation of lucerne (Greenup, 1967; Hopkins, 1979) and is characterised by notching of the leaf margins (Hopkins, 1979). No measure of the effect of adult damage on lucerne-yield in New Zealand as been published, and would be difficult to ascertain, since big populations in the field are usually associated with a previous history of larval damage.

The period over which adult damage occurs is very short, starting when peak numbers emerge from pupae, and ending when they fly away to aestivation sites. In the South Island this generally occurs in December or early January, and is most noticeable when lucerne is short or during periods of slow growth. Substantial losses of leaf can occur at this time in Hawkes Bay (Kain, unpubl. data) but only small losses have been observed in Canterbury (Trought, unpubl. data).

High densities of *Sitona* weevil larvae have been recorded in South Australia as destroying nearly all the nodules of annual medics (Allen, 1971) and in central Asia most of the nodules of lucerne (Yakhontov, 1935). Numerous reports exist on yield losses in lucerne caused by larval destruction of nodules (e.g. El-Dessouki, 1971). J.P. Aeschlimann (pers. comm.) has stated that larvae will also feed on root hairs of lucerne, a habit which may be of greater significance to early larval survival than to yield losses. Estimated herbage losses in excess of 30% have been measured from trials in Canterbury over one growing season (Trought, unpubl. data). However, the effect of continued debilitation of lucerne by *Sitona* damage on the

crop's susceptibility to disease, weed ingress and persistence may be more severe than these short term yield losses indicate.

Control

Adult *Sitona* weevil may be controlled by a number of wide-spectrum insecticides at relatively low rates of application (Trought and Stringer, 1976). Application of soil insecticides for larval control have been unsuccessful (Trought, unpubl. data) but timing may be critical. Studies on the biology of *Sitona* have indicated that spray applications of insecticide against adults in autumn, after the last flights have occurred but before egg-laying is far advanced, may substantially reduce egg-laying and subsequent larval damage (S.L. Goldson, pers. comm.)

Chemical treatment of adults is recommended only in relatively high-value situations where the pest is abundant, such as lucerne seed crops or to protect seedlings. Local studies on the behaviour of *Sitona*, have shown that seedlings are only at risk if sown in autumn. Adult control with insecticide may give temporary relief, but in general by the time adult numbers are high enough to be of concern, populations will usually be emigrating to aestivation sites.

Neither haymaking nor rotational grazing appear to markedly affect *Sitona* weevil populations, but mob-stocking in autumn and winter may reduce adult weevils. Since yield reduction is caused by the destruction of nodules, the possibility, through the judicious use of nitrogenous fertiliser, to compensate for this and rehabilitate the crop, requires investigation. Furthermore recent preliminary studies have shown that the establishment and survival of larvae tends to be particularly high in the shallow root systems of young stands. As the roots develop and become deeper their remoteness from the surface - laid eggs leads to reduced levels of attack and indications are that larval damage may be confined to the first 2 or 3 years of a stand's existence (Goldson, unpubl. data).

WHITE-FRINGED WEEVIL

White-fringed weevil and stem nematode are similar, in that they are largely dependent for dispersal on the movement of infected plant material in the form of hay (R. East, pers. comm.; Wood, 1972) and in the case of stem nematode poorly-dressed seed (Wood and Close, 1974). Stem nematode can also be spread in irrigation water and run-off (Thorne, 1961). The biology of both pests in New Zealand is well documented (Wood, 1972; East, 1978).

Damage

White-fringed weevil is now a major problem of seedling and established lucerne in the North Island, particularly on the lighter and sandy soils of the Manawatu-Wanganui district (Morton and Roberts, 1978) and on the friable soils of southern and central Hawkes Bay. In these areas it has severely restricted and reduced the use of lucerne (W. Stiefel, pers. comm.) and a similar problem exists in the northern areas of the North Island (G.I.B.

Cumberland, pers. comm.). The pest appears to be spreading in Blenheim (Somerfield and Burnett, 1976) and has been found in mid-Canterbury (McGregor and Somerfield, 1978).

The root-feeding larvae of white-fringed weevil kill seedling lucerne, and in areas with summer droughts, reduce the production and persistence of young (Morton and Roberts, 1978) and mature crops (East and Parr, 1977b).

Control

Larval stages of the pest are tolerant to insecticides (Todd, 1969) applied at economic rates, but a range of granular insecticides sown with the seed can protect seedling lucerne (East and Parr, 1977b). Although adult weevils are susceptible to most insecticides (Todd, 1969) the period over which they emerge was considered too long to maintain an economic and effective spray cover on the crop (East *et al.*, 1975). Recent studies however, have demonstrated the possibilities of controlling the pest with three to four applications of insecticide over the main part of the adult season (East and Parr, 1977b).

The fecundity of white-fringed weevil is spectacularly reduced when the adult weevils are subjected to grass rather than legume foliage (East, 1977). As a consequence of this, the growing of sudax (*Sorghum bicolor* x *S. sudanese*) can reduce weevil populations up to 94%. Intensive cultivation with a rotary hoe in late spring and summer, or clean fallow over this period, are also effective methods of controlling white-fringed weevil (East and Parr, 1977a).

STEM NEMATODE

Stem nematode has a severe effect on the productivity and persistence of lucerne (Dunbier *et al.*, 1980) and is a serious pest in Canterbury and North Otago (Burnett *et al.*, 1979). Although nematicides are available which can control this pest (Rae, 1975; Grandison, 1976) in practice their use may be either impractical or uneconomic. In uninfested areas, the use of clean seed and the feeding-out of hay from uninfested areas may preserve this state for a considerable period of time. In areas already infested, the use of nematode resistant cultivars will alleviate this problem (Dunbier, *et al.*, 1979).

DISCUSSION

Lynch (1967) noted that unless lucerne cultivars more suited to grazing than Wairau were developed, new cultivars were unlikely to influence the use of lucerne in New Zealand. Ten lucerne cultivars are now in common use in this country. These have been developed or were imported initially because of their resistance to disease and, more recently, to both disease and invertebrate pests. In the absence of pests none are outstandingly better than Wairau. None have resistance to white-fringed or Sitona weevil or to both BGA and PA and stem nematode (Dunbier and Easton, Paper 19). Hence the correct selection of a cultivar

for a particular district is dependent on the farmer's knowledge of the pest problems that exist, or are likely to be encountered.

The potential threat that the establishment of SAA in Australia posed to lucerne growing in New Zealand in 1977, has now been offset to some extent by the introduction, development and use of lucerne cultivars resistant to it. The concept of developing local cultivars resistant to major pests that are likely to become established in New Zealand, is an appealing one and could overcome the loss in confidence suffered by growers by the recently encountered pest and disease problems.

Of the 16 key pests of lucerne in the world there are only four for which resistant germ-plasm is not available (Nielsen and Lehman, 1980). Although the development of cultivars resistant to anticipated pest problems from overseas is feasible, it is not without problems, as biotypes exist and develop which fail to recognise the resistance of a particular cultivar (Nielsen and Lehman, 1980). For this reason, the incorporation of resistance which has not been tested against a wide range of biotypes throughout the world can lead to obvious problems. For example Gladiator, a lucerne cultivar described as resistant to stem nematode overseas, is susceptible to the biotype found in Canterbury (Burnett *et al.*, 1979; Dunbier *et al.*, 1979).

The widespread sowing of resistant cultivars can create such a strong selection pressure on the pest, that biotypes can quickly develop and cause problems especially where the control of pests, particularly nematodes (Dunbier *et al.*, 1979) and aphids (Nielsen and Don, 1974), is reliant on host plant resistance. In these situations the monitoring of the performance of resistant cultivars is necessary, in order to warn farmers and plant breeders of impending problems.

Lucerne is a relatively low value crop in New Zealand, and for this reason some of the more sophisticated technology associated with lucerne pest control in USA is not economically viable in this country. It is in these situations, and where the pest is continuously present, that the host plant resistance has significant advantages over other methods of control (Ortman and Peter, 1980). In its absence, the control of invertebrate pests of lucerne in New Zealand must be effective, simple and cheap and take into account essential agronomic practices. This has been accomplished for lucerne aphid control.

As sowings of lucerne cultivars with multiple aphid resistance, including SAA resistance, increase, the present and anticipated lucerne aphid problems will lessen. In the meantime efforts to introduce parasites which attack BGA as well as PA should continue. If SAA becomes established in New Zealand this should extend to *Trioxys complanatus* Quilis, a parasite which has been successfully introduced into Australia for the control of this pest (C.G. Wilson, pers. comm.).

The most pressing invertebrate pest problem facing lucerne growing in New Zealand is the control of white-fringed weevil and Sitona. Species from the genera that these two pests represent are considered only minor pests of

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DISCUSSION

- Wall: What is the long term effect of the BGA toxin(s)?
- Kain: We have measured yield reductions from autumn infestations, which continue through into the early summer, but this may be a root reserve effect rather than a toxin effect.
- Q: Does a heavy aphid infestation affect palatability to sheep?
- Kain: Reports suggest this. Especially with the pea aphid. A smut develops on the honey dew (sticky exudate) they produce, and it is thought that this has some effect on palatability. Chemical analysis has not shown any large differences between damaged and undamaged plants, but phyto-oestrogens build-up in response to aphid attack and reach levels which could impair ewe fertility.
- Davidson: What is the distribution of *Sitona* weevil?
- Trought: Everywhere lucerne is grown in New Zealand but it is worse in some areas than others.
- Davidson: Lewthwaite had a *Sitona* problem and did not winter graze, Brosnan had no such problem but does winter graze — is there a connection?
- Trought: Late autumn-winter grazing helps aphid control, but we do not know the effect of *Sitona*.
- Elliott: Do frosts have an effect on winter survival?
- Trought: It does not seem so, as *Sitona* has been bad at Tara Hills which has very harsh winters.
- Wynn-Williams: I would make a plea that *Sitona* be kept in perspective. The insect is present in Australia but not as a pest of lucerne. Adult defoliation occurs only sporadically, and only then at a time when there is little growth anyway. Also the insect has been here long enough now to have established itself as a major problem, if it was going to be one.