PASTURES, INSECTS & MITES, AND MANAGEMENT.

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## Introduction

Insects and mites can reduce pasture productivity. The degree of damage they cause will vary, depending on season, management, and the type of pasture being grown. Pests are only one of many factors that determine pasture productivity. The value of lost production due to pests depends on the balance between all factors governing pasture production.

In this paper, I will examine the proposition that season and management are the main determinants of animal production from pastures, and that these two factors strongly influence the risk of losses due to pests.

*Season* sets the potential maximum plant yield for a soil-type.
***Management*** determines how much of that potential plant growth is achieved.

Above all, management governs the profitability of converting plant production into saleable animal products, and the long term stability of the pasture.

Insects and mites affect animal production indirectly, through their effects on plant growth. In turn, plant growth can affect insect population dynamics. The balance between how fast plants grow, and how fast they are eaten, has a large effect on potential pest numbers and damage caused.

## Factors in pasture production.

Pastures have two criteria for success -

(1) *Production* - dry matter grown each year.
(2) *Persistence* and pasture composition - sown species (eg subclover) are maintained at an optimum percentage of the pasture sward (ie less desirable species such as capeweed, erodium, 'poor' grasses and other weeds are not allowed to become dominant).

Whenever reasons are sought for declines in animal production from pastures, the following factors are commonly considered:-

(1) Season (variation in rainfall amount and distribution; temperature).

(2) False breaks (loss of early germinated clover).

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(3) Soil acidity (need for lime).

(4) Soil non-wetting and soil erosion by wind.

(5) Soil structure problems, particularly the development of hardpans.

(6) Waterlogging and/or salinity.

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(7) Reduced superphosphate "maintenance" dressings.

(8) Nutritional disorders, especially nitrogen, sulfur, potassium and trace element deficiencies.

(9) Diseases such as Kabatiella (clover scorch) and root rots.

(10) Insects, especially redlegged earthmite, lucerne flea and (more recently) blue green aphid.

(11) Unsuitable species or varieties of pasture legumes.

(12) Dominance of capeweed, barley and silver grass, and other weeds.

(13) Increased cropping, with poor clover regeneration.

(14) Flock structure changes.

(15) Stocking rate (overgrazing or undergrazing).

Further points could be added, but the list highlights that 'old land' pastures are subject to many factors that can act singly or in combination. Moreover, the importance of a single factor is likely to vary with different seasons and changes in management practices.

## OPTIMUM PASTURE MASS

For maximum production, a pasture sward must have an optimum plant density and leaf area. In terms of available 'Feed On Offer' (FOO), the optimum is probably between 1.0 - 2.5 Tonnes/ha of green dry matter (not green freshweight) (Table 1). The actual values will depend on pasture species and composition, and also on the stage of plant development ie. whether they are growing vegetatively, or are flowering and setting seed.

Leaf Area Index (LAI) is a measure of how much leaf material is present. Clover grows best when the leaf area index is greater than 4; that is, for every square metre of soil surface there are more than 4 square metres of clover leaf area. Approximately 1.3 - 1.4 tonnes per hectare of pasture is needed to provide an LAI of 4 for clover (Table 2).

In Table 1 it is proposed that the growing season can be divided into three phases; (1) establishment; (2) vegetative growth; (3) flowering and seed set. For each stage, upper and lower values for FOO (Kg dry matter/ha) are suggested for optimum pasture mass.

**TABLE 1: Suggested boundary values for optimum FOO at three pasture growth periods**

| | GROWTH STAGES | | |
|---|---|---|---|
| FOO OPTIMUM "BOUNDARY" VALUES | ESTABLISHMENT "Autumn" | VEGETATIVE "Winter" | FLOWER/SEEDFILL "Spring" |
| LOWER | 800 kg/ha | 1000 kg/ha | 1500 kg/ha |
| UPPER | | 2500 kg/ha | 3500 kg/ha |

The FOO "boundary values" represent the limits for optimum pasture and animal production. If FOO falls below the lower limit, or rises above the upper limit, changes occur in plant and pasture sward structure that decrease growth, or result in lost dry matter through scenescence and death of leaves. Plant growth continues outside these limits, but ***not at optimum productivity,*** particularly below the lower limit. The factors that come into play include the following:

LOWER BOUNDARY:
If FOO falls below the lower boundary, plant leaf area is decreased. Bare patches occur in the pasture, and these represent wasted light that is not being intercepted by plants. The lower the LAI, the more severely do low temperatures reduce growth. At a pasture mass of 400 kg/ha, the LAI is about 1, at which level low temperatures have a marked effect on slowing growth. At LAI values above 4, low temperatures have much less of an effect in slowing plant growth rate. During pasture establishment, it is important to allow plants to grow big enough to grow efficiently. Pasture deferment in autumn may be necessary to allow this to occur, especially if dry periods, or periods of cold and waterlogging, or pest attack reduce plant growth rates. Over-grazing can keep pasture mass down, and reduce the productivity of the pasture. Grazing tends to favour prostrate species, including clover.

UPPER BOUNDARY:
Grasses (typically rye grass) can carry a maximum of three green leaves on a tiller. Older leaves scenesce and die, and become wasted dry matter. As FOO increases above 2500 kg/ha, tiller numbers decrease as surviving tillers grow thicker and longer.

Clover plants show reduced branching of runners, and the distance between leaf nodes on runners increases. Leaf stems get longer, and leaves become larger as the plants compete for light. Older leaves below the canopy die and become wasted dry matter. More erect competitors such as grass and capeweed can overtop clover, especially in autumn and winter. The potential for seed set decreases as runners become less branched and rank. Flowers only arise from an axil between a runner and a leaf. Once flowering starts, clover plant branching stops. Plant numbers decrease as weaker plants of all species die in the competition for space and light. Lax grazing tends to favour upright species, such as grasses and capeweed.

The risk of loss from redlegged earthmite and aphids increases as FOO increases. Clover dominant spring pastures that are ungrazed can lose up to 80% of seedset, and 30% dry matter, from pest attack.

Within these limits, leaf area and plant density are optimum for maximum plant productivity. Dry matter losses due to leaf death is minimized. The structure of clovers, grasses and broadleaf weeds is such that eating the pasture down from the upper value to the lower value does not result in stripping of leaves that can severely retard growth. By contrast, hard grazing of rank pasture can result in such a loss of leaves, and exposure of pale thin stems, that recovery of growth is slow. Hay cutting can have the same effect.

PASTURE MASS, LAI, AND PLANT GROWTH

**Table 2. Approximate relationship between LAI and FOO, for a subclover based pasture. Precise values depend on pasture composition.**

| LAI | FOO (kg/ha) | Comments |
|---|---|---|
| 1 | 350 | |
| 2 | 700 | |
| 3 | 1050 | |
| 4 | 1400 | Optimum growth threshold for Sub clover |
| 5 | 1750 | |
| 6 | 2100 | |

Above an LAI of 4, pasture has the capacity to grow at its maximum rate. That means it ***has the potential to produce the maximum amount of dry matter per day.*** Whether or not it meets this potential will be governed by -

| | |
|---|---|
| water | [seasonal factor] |
| plant nutrients (fertilizer) | [management factor] |
| light and temperature | [seasonal factor] |
| insects and diseases | [management factor] |

Total annual productivity will depend on how quickly a pasture gets to optimum LAI in autumn, the length of growing season, and the supply of water and nutrients. In poor seasons, plant growth may be so restricted that FOO never reaches 1400 kg/ha; in this case, productivity will always be below optimum.

It is important to realize that even if growth is slowed by a shortfall in one or more or these factors, the best possible growth will be achieved only if the LAI is maintained at greater than 4; that is, at a pasture mass (FOO) of greater than 1300 - 1400 kg/ha. In practice, under set stocking, if pasture growth rate slows down, animal demand results in grazing down to below the optimum growth threshold FOO, thereby reducing even more the capacity of the pasture to grow.

## GRAZING PRESSURE VERSES STOCKING RATE

To maintain pasture FOO within optimim limits, management of stock grazing pressure is essential, as is the ability to assess FOO.

There is an important difference between stocking rate and grazing pressure. Each can be defined as follows:

***Stocking rate*** is simply the number of animals per unit area; for example, 5 wethers per hectare, or 2 steers per hectare, and so on. Each animal has a demand for food that it gets by eating pasture plants.

***Grazing pressure*** is the balance between how much the animals eat, and how fast the pasture is growing. For example, comparing a paddock in winter stocked with 20 DSE/ha to the same paddock in spring also stocked with 20 DSE/ha, it is clear that the grazing pressure in winter is higher (because the pasture is growing slowly), while in spring the grazing pressure is lower (because the pasture is growing faster). In each case the ***stocking rate*** is the ***same*** (20 DSE/ha), but the ***grazing pressure*** is ***different.*** In winter, 20 DSE/ha can eat pasture faster than it is growing, so there is an overall decrease in paddock feed, while in spring, pasture can grow faster than 20 DSE/ha can eat, so there is an overall increase in paddock feed.

These definitions may seem obvious, but it is important to be clear about the difference. Grazing pressure is a better yardstick than stocking rate for grazing management, because it takes into account how well a pasture is growing. Every farmer knows that pasture growth varies with season, soiltype, and where a farm happens to be.

Technically it is very difficult to measure precisely how fast pasture is growing if it is already eaten, or to measure how much an animal has eaten because it is inside the animal.

***The simplest way of assessing grazing pressure, is to estimate FOO in front of the animal, and to weigh and body condition score the animals.***

## THE 'SPRING FLUSH'

In a 'normal' season, pasture growth in spring is faster than can be eaten by sheep in a set-stocked system, resulting in excess feed being available, with FOO values between 3 - 8 Tonnes/ha, well in excess of the optimum FOO values given in Table 1. Large amounts of unused pasture at the end of spring can result in grass dominance, reduced clover seed set, and even reduced clover germination in the following autumn. Stock have access to unlimited feed.

## SET STOCKING IN RELATION TO PASTURE GROWTH

Set stocking (leaving a fixed number of animals to graze a fixed area of pasture throughout the season) has been the standard grazing management proceedure for 40 years. The stocking rate is arrived at by experience, and district averages over many seasons for numbers of stock per hectare are used as a yardstick for the carrying capacity of paddocks. It stands in contrast to intensive grazing management methods, such as ration grazing, strip grazing, and intensive spring grazing, in which stock are moved between grazing areas after regular assessments of available feed (variously called pasture mass; feed on offer; pasture on offer). The aim is to match grazing pressure to pasture growth rate. Dairy farms are the best local example of 'tactical grazing'.

Compared to more intensive grazing management, set stocking is generally characterized by three points:-

1) Conservative - biased to poor seasons of low potential productivity.
2) Early season - overgrazing risk with low LAI values.
3) Spring - undergrazing with low grazing pressures and *ad lib.* feed.

The question posed is "Can set stocking be modified with tactical management to improve productivity and quality of pasture and animals?" Tactics include -

- Autumn deferment of grazing in late break seasons
- Nitrogen on grassy pastures in late autumn or winter
- Intensive spring grazing of selected paddocks
- Strip grazing (ration grazing)
- Fodder conservation (silage, hay,'hayfreezing'dry feed, topping pasture)
- Insect and mite control in autumn and spring on selected paddocks.

The need for and value of insect control will depend on pasture management decisions made each season, for the reasons outlined above.

## PESTS IN PASTURES

Pests commonly found on pastures in Western Australia are listed in Table 3. The most important are redlegged earth mite (RLEM), lucerne flea (LF) and bluegreen aphid (BGA). Examples of how pests affect pastures will be restricted to these three pests.

**TABLE 3: Pests commonly found in pastures, with the main pests highlighted, and the plants attacked listed by numbers in brackets.**

| PASTURE SPECIES | PESTS |
|---|---|
| 1 Subclover | <u>Mites</u> |
| 2 Annual medics | ***redlegged earth mite*** (1,2,3,4,8) |
| 3 Serradella | blue oat mite (1,8) |
| 4 Capeweed | bryobia mite (1,2,8) |
| 5 Erodium (geranium) | <u>Springtails</u> |
| 6 Grasses - Annual | ***lucerne flea*** (1,2,4,8) |
| 7 Grasses - Perenial | <u>Aphids</u> |
| 8 Lucerne | ***bluegreen aphid*** (1,2,8) |
| | cowpea aphid (1,2,8) |
| | spotted alfalfa aphid (1,2,8) |
| | cereal aphids (6,7) |
| | <u>Caterpillars</u> |
| | webworm (6,7) |
| | cutworm (1,2,3,5,6,7,8) |
| | armyworm (6,7) |
| | native budworm (1,2,3,4,8) |
| | brown pasture looper (4,5) |
| | pasture day moth (4,5) |
| | <u>Weevils</u> |
| | vegetable weevil (4) |
| | sitona weevil (2,8) |
| | small lucerne weevil (8) |
| | desiantha weevil (4,6) |
| | <u>Beetles</u> |
| | African black beetle (6,7) |
| | cockchafers (various) (?) |
| | <u>Grasshoppers</u> |
| | wingless grasshopper. (7,8) |

Plants in an annual pasture have to do two things to be successful:-

(1) Produce useable dry matter over as much of the growing season as possible, and leave useable dry matter over the dry summer season.
(2) Produce enough germinable seed to regenerate pastures in following years.

Insects can attack this system at three critical points:
(1) Kill seedlings and reduce plant density.
(2) Lower dry matter production through the growing season.
(3) Reduce seed set at the end of the year.

Research since 1940 has shown that RLEM and LF can kill subclover seedlings, thereby reducing plant density and growth rate, resulting in season-long loss of pasture production (Norris 1944, 1948). Seed production of subclover was also reduced.

Wallace and Mahon (1963) concluded that " *It has been estimated that control of severe RLEM and LF could allow stocking rates to be increased by from 0.8 to 1.6 sheep per hectare. Even so, the ecoconomic importance of these pests has been exagerated in the past because, in general, existing pastures are understocked.*"

The conclusion drawn by Wallace and Mahon is significant for two reasons; firstly, the '*biological*' loss of dry matter production does not necessarily mean an *economic* loss, unless grazing management on the farm is capable of using the extra plant production and converting it into saleable animal production. Secondly, it is necessary to know the conditions of season and grazing management that result in pests causing economic loss of pasture dry matter or seed yield.

In 1979 bluegreen aphid arrived in Western Australia, and developed into a significant pest of subclover, annual medics and lucerne. Serradella is not much affected. For annual pasture legumes, BGA is most likely to be a pest in spring, though in years with ealy breaks, autumn infestations can cause losses, especially in irrigated pastures. In spring, BGA can occur with RLEM and LF; attempts to compare the relative damage caused by these pests has proven of little value. They can cause significant damage alone or in combination. The sward conditions that are most at risk are similar for BGA and RLEM.

Trials at Esperance (from 1982 to 1988) looked at the effects of mites and aphids on patures that were ungrazed (experiment 1), or kept at optimum FOO (1300 -1500 kg/ha) (experiment 2). Combinations of phosphate and potassium fertilizer were used to see if the effect of pests was changed by fertilizer status.

## THE EFFECT OF RLEM AND BGA ON UNGRAZED SUBCLOVER

(Summary of experiment 1, Brennan and Grimm)

The dry matter production (DMP) and seed yield of subterranean clover (*Trifolium subterraneum* L. cv. Daliak) were reduced by infestations of redlegged earth mite (RLEM)(*Halotydeus destructor* Tucker) and bluegreen aphid (BGA)(*Acyrthosiphon kondoi* Shinji) during spring growth, flowering and burr burial. The dominance of BGA and RLEM (hereafter referred to as the pests) varied with seasons. Spraying with insecticides to control the pests changed the DMP and seed yield responses to superphosphate (SP) and potassium chloride (KCL) fertilizers. Responses to SP were described by Mitscherlich functions for each of three levels of KCl, except for seed yields with pest sprays.

At optimum levels of SP and KCl, pests reduced DMP by up to 34% (from 6.52 t/ha to 4.37 t/ha) (Fig.1). Spraying to control pests where nil KCl was applied increased DMP to more than was grown on unsprayed plots fertilized with KCL, for all levels of SP. The maximum DMP response to SP was achieved with the application of 15-20 kg P/ha. With optimum SP, the value for DMP depended on the combination of spraying for pests and amount of KCl applied, generating a series of Mitscherlich response curves for SP application, with differing maximum yields. With optimum SP applied, the least DMP recorded within a season was 3.47 t/ha (pests not sprayed; nil KCL), and the most was 6.52 t/ha (pests sprayed; 120 kg/ha KCl), a difference of 47%.

Seed yield was affected like DMP, but losses from pests were more marked (Fig.2). At optimum levels of SP and KCl, pests reduced seed yield by up to 80% (from 1100 kg/ha to 290 kg/ha). With optimum SP, seed yield within a season ranged from 1100 kg/ha (pests sprayed, 120 kg KCl/ha) to 210 kg/ha (pests not sprayed; nil KCl). With pests sprayed, seed yield declined with SP applications greater than 20 kg P/ha; the relationship was best described by a quadratic function. With pests not sprayed, seed yield did not decline with increasing amounts of SP, and the relationship fitted a Mitscherlich function.

RLEM are known to cause DMP losses in clover. Norris (1948) showed that

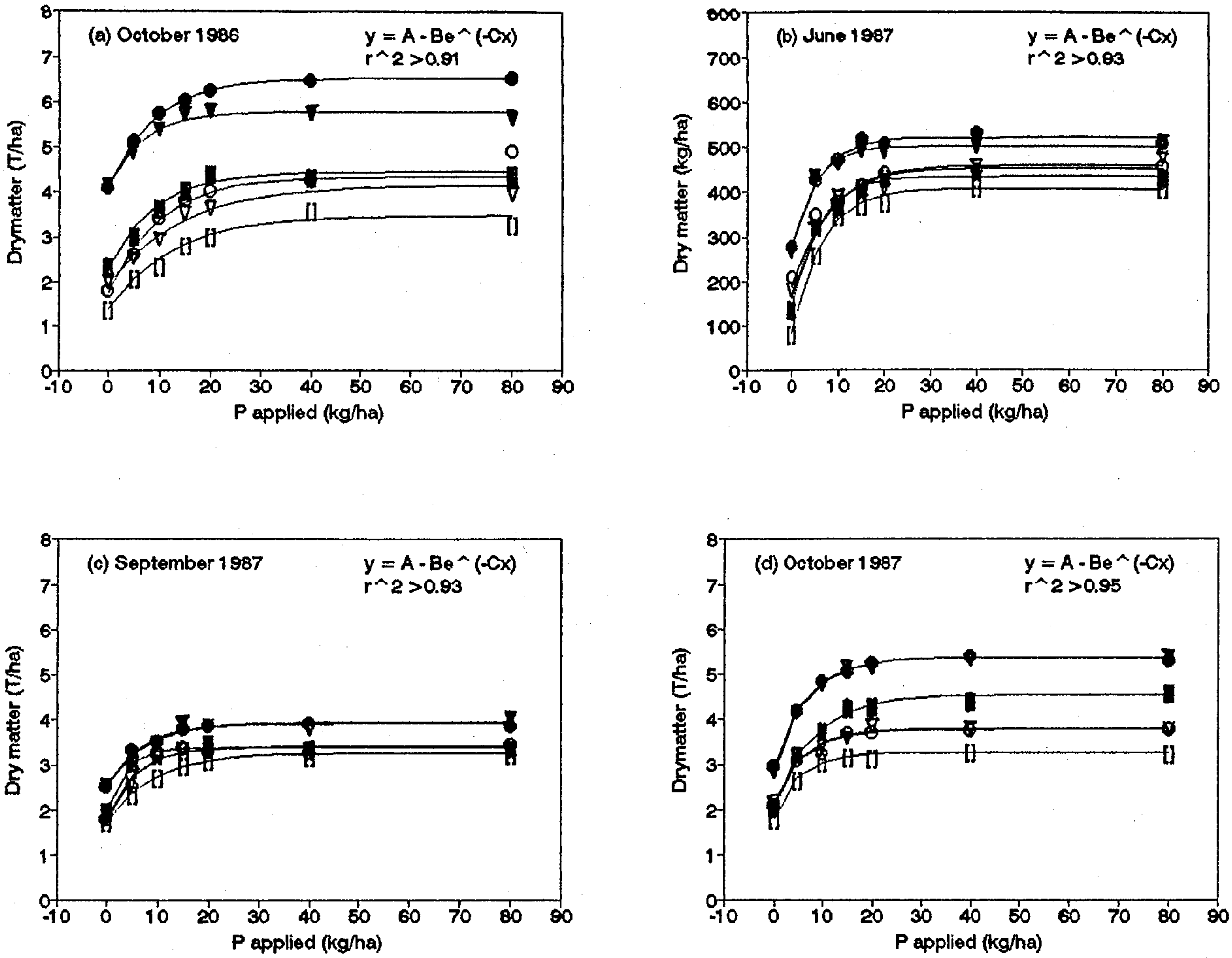



Fig.1 Dry matter production of subclover for 7 levels of applied P, at 3 levels of applied K, with and without control of RLEM and BGA. (a) October 1986; (b) June 1987; (c) September 1987; (d) October 1987 (a,c,d = T/ha; b = kg/ha)
Insects controlled: K0 ■---■; K30 ▼---▼; K60 ●---●; Insects uncontrolled K0 []---[]; K30 V---V; K60 O---O.

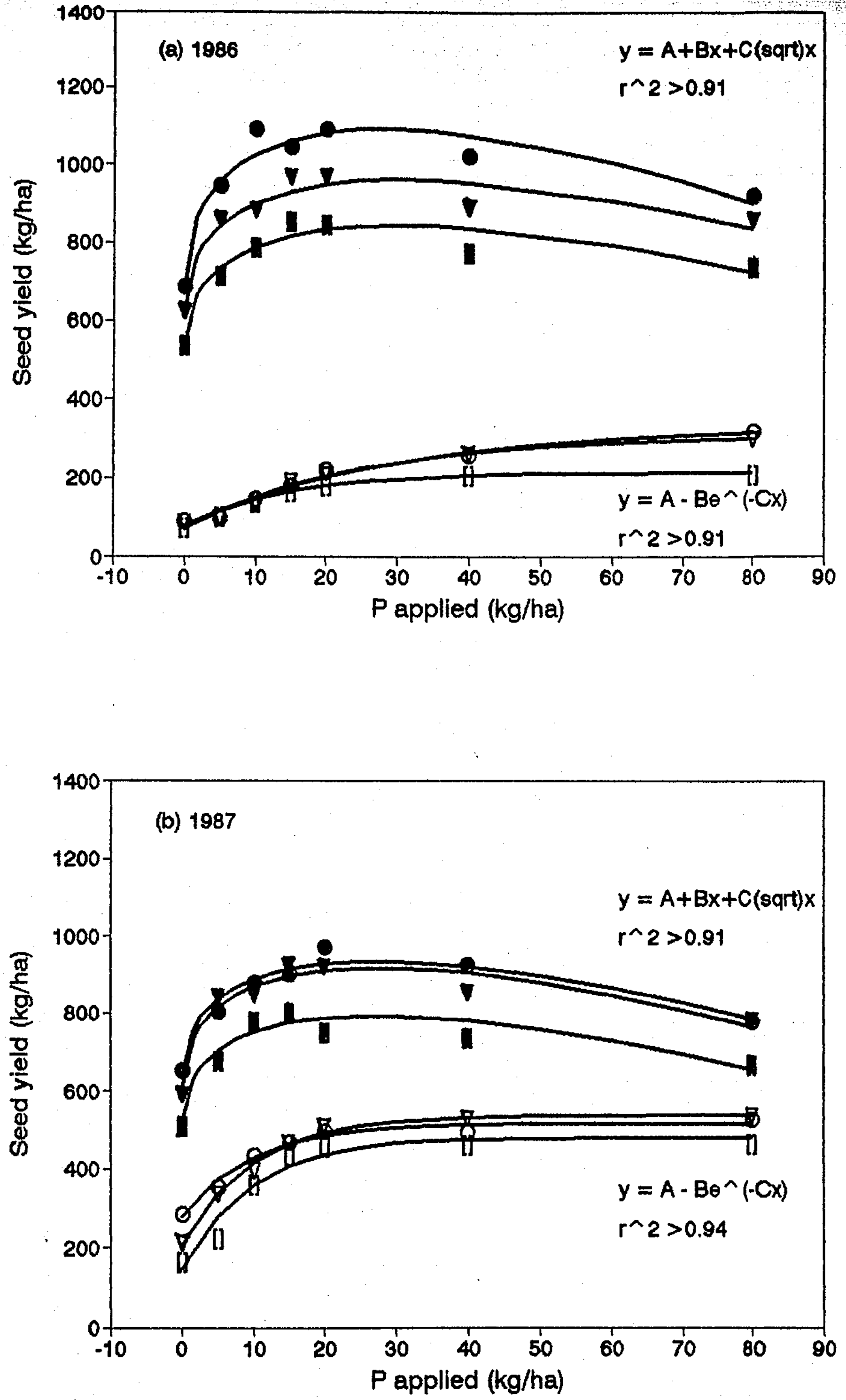



Fig.2 Seed production (kg/ha) of subclover for 7 levels of applied P, at 3 levels of applied K, with and without control of RLEM and BGA. (a) 1986; (b) 1987
Insects controlled: K0 ▮----▮; K30 ▼----▼; K60 ●----●; Insects not controlled: K0 []----[]; K30 V----V; K60 O----O.

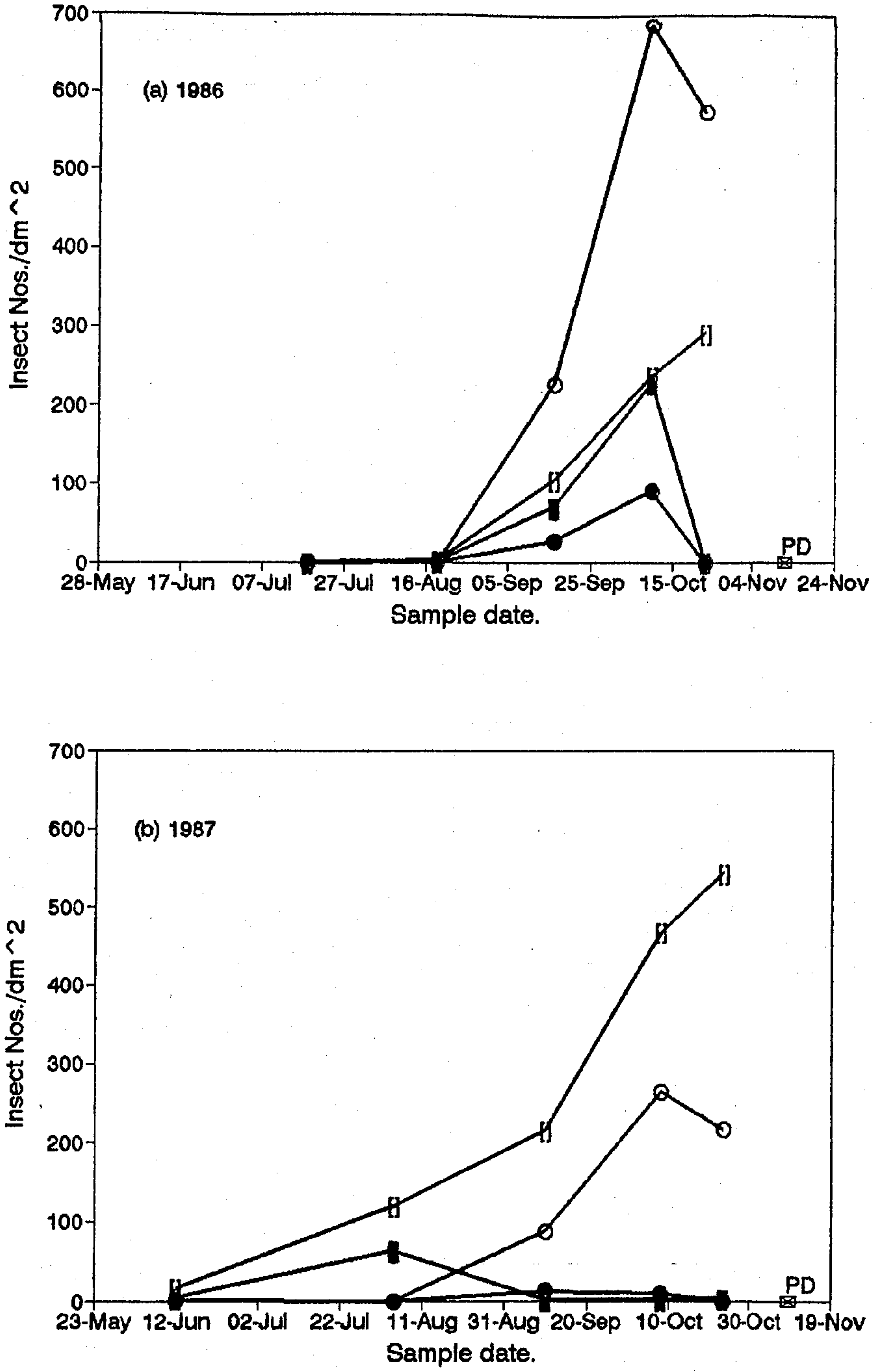
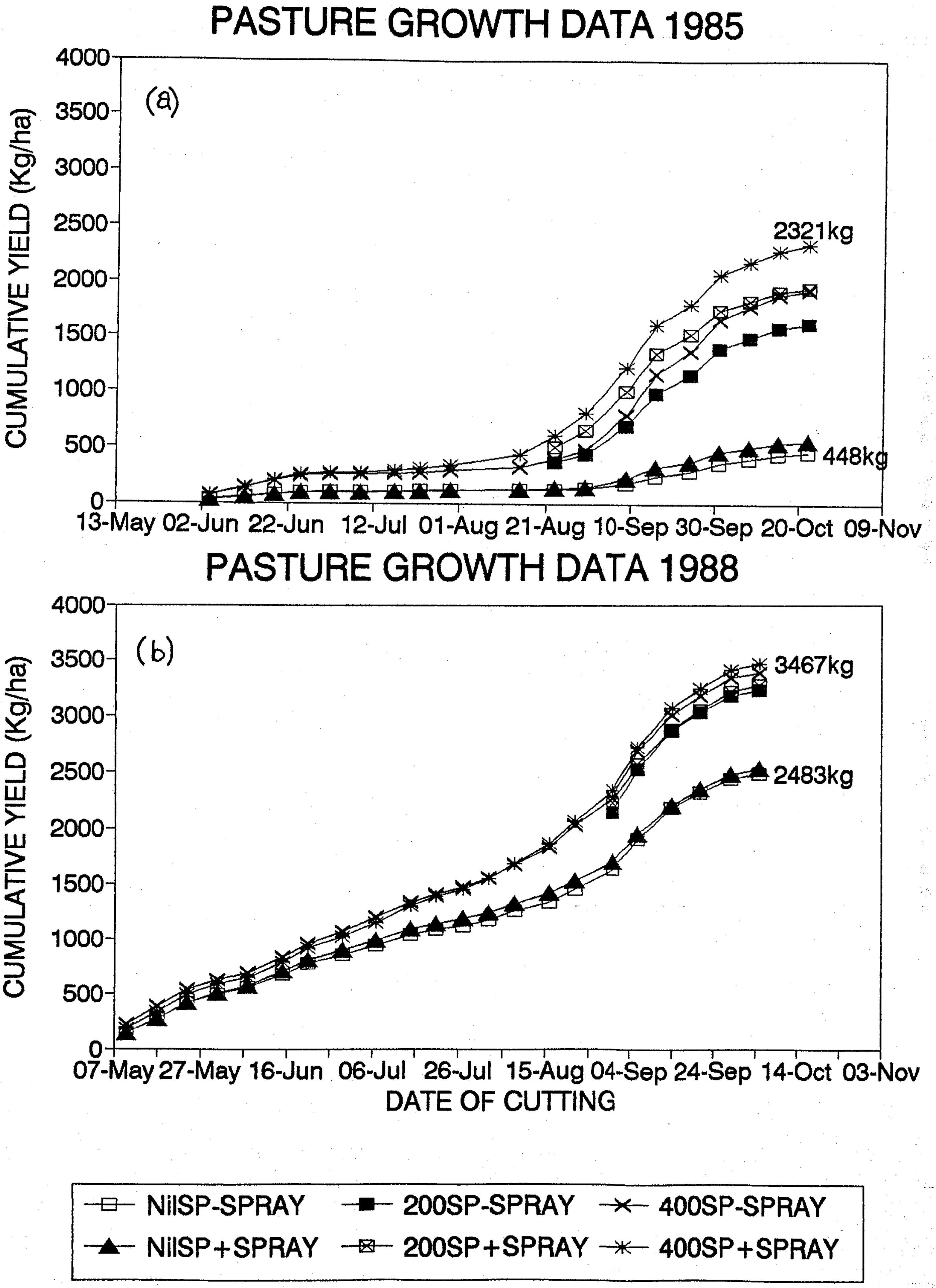



Fig.3 Redlegged earthmite and bluegreen aphid populations (numbers per square decimetre) sampled on sprayed and unsprayed plots. (a) 1986 (b) 1987. PD = plants dried off. Insecticide applied: BGA ●---●; RLEM ▮---▮; No insecticide: BGA O---O; RLEM []---[].



PASTURE GROWTH DATA 1985
(a)
CUMULATIVE YIELD (Kg/ha)
4000
3500
3000
2500
2000
1500
1000
500
0
13-May 02-Jun 22-Jun 12-Jul 01-Aug 21-Aug 10-Sep 30-Sep 20-Oct 09-Nov
2321kg
448kg
PASTURE GROWTH DATA 1988
(b)
CUMULATIVE YIELD (Kg/ha)
4000
3500
3000
2500
2000
1500
1000
500
0
07-May 27-May 16-Jun 06-Jul 26-Jul 15-Aug 04-Sep 24-Sep 14-Oct 03-Nov
DATE OF CUTTING
3467kg
2483kg
NilSP-SPRAY
200SP-SPRAY
400SP-SPRAY
NilSP+SPRAY
200SP+SPRAY
400SP+SPRAY


FIG. 4

RLEM attack during seedling emergence had a marked effect on dry matter production, whereas later attacks had little effect. Most of the loss was attributed to seedling mortality. In our work, swards were established before RLEM hatched in autumn, so seedling mortality was not a factor in DMP or seed losses. Norris (1948) did not quantify RLEM populations in his experiments, so comparisons with our work on a population basis are not possible. Damaging populations of RLEM reported by Wallace (1954, 1959) and Wallace and Mahon (1963) are typically 200-800 per square link (50-200 per $dm^2$). Wallace (1956) considered that 1,000 RLEM per square link (250 per $dm^2$) represented a very large population. In our work, RLEM populations peaked at 200 per $dm^2$ in 1986 and 550 per $dm^2$ in 1987 (Fig.3 a,b). Such high populations in spring are consistent with the DMP and seed yield reductions recorded in our work, without any significant plant damage having been recorded in autumn or winter. In 1987, RLEM numbers increased from June onwards, whereas in 1986, they did not increase until August. The increased numbers of RLEM on sprayed plots in 1986 followed the use of pirimicarb, which killed only BGA; later sprays with dimethoate controlled BGA and RLEM. BGA in combination. In our work, it is likely that RLEM caused proportionally more damage than BGA in 1987 when they exceeded BGA in numbers during spring. In 1987, extensive leaf silvering of clover in unsprayed plots was observed in October, the symptoms being consistent with severe RLEM attack (Norris 1944). However, in 1986, there was much less leaf silvering, whereas symptoms of BGA infestation were evident. It is likely that BGA infestation caused proportionally more of the DMP and seed losses measured in 1986, when they exceeded RLEM numbers during spring. We did not control RLEM and BGA separately so it was not possible to compare losses caused by RLEM relative to BGA, or to draw conclusions on any interactive effects between them.

*Seed yield*

BGA and RLEM reduced seed yield more than DMP. Controlling pests changed the relationship describing the response curve to applied P, being better described by a quadratic function (Fig.2). Seed yield decreased at levels of P greater than $P_{15}$ or $P_{20}$, for all levels of K, in both years; dry matter yields maintained a plateau value throughout this range. Donald (1954) obtained a similar result in response to increasing plant density, where total DMP maintained a plateau value at plant densities greater than about 60 plants per square link (15 plants per $dm^2$), but seed yield decreased. Donald discounted water stress as a factor in his result, and offers no suggestion as to the mechanism of the seed yield decrease. Donald and Neal Smith (1937), and Rossiter (1959) showed declining seed yield as functions of maturity grading of strains of subterranean clover, where later flowering cultivars encountered increasing water stress, and thus decreased seed yield. Andrews *et. al.* (1977) showed that withholding water during flowering reduced seed yield of clover. In our work, there is no reason to believe that water stress ('self droughting' due to large plant biomass) could explain the fall off in seed yield with increasing level of applied P.

Our work illustrated that high numbers of BGA and RLEM during spring (flowering and burr formation), in ungrazed clover pastures, resulted in marked declines (50-90%) in seed production of clover. In order to maintain adequate seed reserves for satisfactory clover plant densities in following seasons, it may be necessary to control these pests. Harvesting clover seed on farms can suffer substantial losses if RLEM and BGA infestations are not detected and controlled. Our work also showed that BGA and RLEM reduced clover dry matter production by up to 34% (Fig.1). Wallace and Mahon (1963) and Wallace (1970) concluded that losses of clover dry matter in spring were only economically significant if animal grazing pressure was intensified to make use of extra feed gained by controlling pests. Dry matter losses in spring may be important where pastures are left ungrazed prior to silage or hay production, or where large reserves of standing dry matter are required to provide dry feed for stock over the summer-autumn period.

## THE EFFECT OF BGA AND RLEM ON PASTURE MAINTAINED AT 1200-1500 kg/ha

(Summary of experiment 2, Grimm).

The effect of pests on pastures maintained at FOO values in the optimum range (Table 1) was measured by using a mower weekly to harvest the dry matter production from plots that were sprayed and not sprayed to control pests. In addition, superphosphate treatments of nil, 200 kg/ha and 400 kg/ha were applied. The experiment was on a site adjacent to experiment 1, and was conducted from 1983 to 1988; the results from 1985 and 1988 are shown in figure 4 a,b. They represent the most extreme effect of season on dry matter production. Results from the other years of the experiment fit between these extremes.

In each year, pastures were allowed to grow to approximately 1000 kg/ha dry matter before weekly mowing commenced. The cutting height was set at 30 mm at all times. Weekly harvests were dried and weighed, and the yields for each treatment recorded as a running total (cumulative production). This technique allowed comparison of dry matter production between years, since the pasture mass was maintained at an LAI of about 4 (1200 - 1500 kg/ha) each year, and only growth above those values was removed. The cumulative growth curves for each treatment and season show the pasture growth over time, to give a seasonal pasture growth curve.

For all years except 1985 (Figure 4 a), there was no response of dry matter production to pest control. In each year, the pastures germinated and were established before RLEM had hatched. The results for 1988 (Figure 4b) are typical of the results for all other years. The main difference between seasons was the amount and distribution of rainfall. In 1985, a dry spell from early June to mid July resulted in almost no pasture growth, even though swards looked healthy and green. Plants remained alive, but did not grow. RLEM in this situation caused damage that showed progressively through spring as a decrease in DMP. There were similar responses to superphosphate application; in other seasons, there was minimal difference between 200 kg/ha and 400 kg/ha superphosphate (all other nutrients were supplied as basal fertilizer). In each year of the trial, the mown plots remained at about 80% Daliak subclover. By contrast, unmown plots became grass or capeweed dominant, with clover dropping to less than 15%. This happened within the first two years of the experiment. Insecticide application in unmown plots maintained the clover composition at about 60% throughout the experiment; however the proportion of Daliak changed from 99% to about 60%, with Seaton Park comprising 30%, and a mixture of other varieties the remaining 10%.

The main conclusions of this experiment are :-

1 Season has the greatest effect on pature production;
2 The effect of pests is markedly reduced by controlled 'grazing';
3 Pasture under stress are more at risk from pests;
4 Undefoliated pastures are most at risk from pests
5 Without defoliation, pasture composition is greatly affected by pests, fertilizer rate, and season.

## THE EFFECTS OF PESTS ON SEED YIELD

The results of experiment 1 show the marked effect of BGA and RLEM upon seed yield in ungrazed pastures (Fig. 2). From a different experiment grazed with sheep, it was found that grazing prevented seed yield losses following BGA infestation (Table 4). Clover in the spring-deferred plots was dead by the end of September, while pasture grazed in spring survived, with BGA and RLEM present but not causing plant mortality. The seed yield reduction of the autumn deferred treatment is mainly due to lower densities of subclover, and higher densities of capeweed and grasses; these species had 'overtopped' clover in early winter.

**TABLE 4. The effect of grazing management on seed yield in pasture attacked by BGA and RLEM**

| Grazing regime | Subclover seed yield (kg/ha) | FOO[a] (kg/ha) |
|---|---|---|
| Spring deferred (9 July - 29 Sept) | 200 (±90) | ≈ 4000[β] |
| Autumn deferred (March - 9 July) | 660 (±105) | ≈ 2000 |
| Continuous grazing (March - October) | 1020 (±115) | ≈ 2000 |

[a] Assessed 29 Sept.
[β] Subclover dead from BGA infestation; dry matter assessed 13 Sept.

In an experiment comparing the effects of controlling RLEM, clover scorch, broadleaf weeds and grasses on clover production, it was found that RLEM had the most significant effect on seed yield (Table 5).

**TABLE 5. The effect of controlling pests, clover scorch, broadleaf weeds, and grasses on the seed yield of subclover. Plots were grazed in common by cattle and sheep. Peak spring pasture mass was approximately 3000 kg/ha.**

| Treatment | Purpose | Seed yield (kg/ha) | p0.05[a] |
|---|---|---|---|
| Rogor | RLEM control | 750 | a |
| Rogor + Benlate | RLEM, Kabatiella control | 580 | b |
| Sprayseed | Grass, broad leaf weeds | 576 | bc |
| Sprayseed+Rogor+Benlate | RLEM, Kabatiella, weeds | 531 | bc |
| Benlate | Kabatiella | 446 | cd |
| NIL TREATMENT | | 423 | d |
| Gramoxone | Grasses | 390 | d |
| 2,4-D Amine | Broadleaf weeds | 366 | d |

[a] Different letters indicate significant differences at the p=0.05 level.

## CONCLUSIONS - PEST LOSS RISK FACTORS

The risk of pests causing economic loss of dry matter or seed production depend on season and management. The factors that increase or reduce that risk are summarised in Table 6. This is a guide, not a guarantee that losses will or will not happen. High pest numbers can develop and cause damage in low risk situations, particularly if a number of marginal factors combine.

**TABLE 6. Guide to risk factors for pest damage to pastures. Economic damage can occur in low risk situations. If more than 50% of leaves are showing damage, and pests are easily found, treatment may be worthwhile.**

| PERIOD | HIGH RISK (RLEM, LF)[a] | LOW RISK (RLEM, LF)[a] |
|---|---|---|
| Autumn | Germination with RLEM hatching<br>Germination after RLEM hatched<br>False breaks (late clover germ.)<br>Low clover density<br>- reseeding<br>- after crop<br>- after false breaks<br>- poor seed set previous spring<br>- heavier soils favour LF | Germination before RLEM hatch (moderate risk from BGA in early break years).<br>- sandy soils, low LF risk |
| Autumn & Winter | Retarded growth rate<br>- FOO <700 kg/ha (autumn)<br>- FOO <1200 kg/ha (winter)<br>- overgrazing<br>- cold<br>- waterlogging<br>- dry periods (> 3 weeks) | Good growth rates<br>- FOO >800 kg/ha (autumn)<br>- FOO >1200 kg/ha (winter)<br>- grazing pressure maintains FOO within optimum bounds |
| Spring | Undergrazing (FOO >2500 kg/ha)<br>Dry spell during flowering (?)<br>- hay paddocks<br>- silage paddocks<br>- seed paddocks<br>**BGA risk is high for all factors, especially in clover dominant pastures**<br>- capeweed + clover (RLEM) | Adequate grazing pressure (FOO <2500 kg/ha) |

[a] BGA risk noted in brackets where appropriate.

**"USE IT, OR LOSE IT"**
The results of various experiments suggest that good grazing management can reduce the risk of losses due to pests, especially in spring. Thus the conclusion of Wallace and Mahon that RLEM and LF are not worth treating because pastures are understocked may be extended to say that the risk of losses in well grazed pastures is low. The slogan "*use it or lose it*" sums this up. It also suggests that "*if you can't use it, you may have to protect it to keep it*".

**Seed yield losses.** There is some debate on the value of increased seed production. For seed harvesting operations, there is no doubt that seed production needs to be protected from pests. However, in established pastures, there is no clear cut information that defines an optimum level of seed in the soil. A pasture can be sown with 5 kg/ha seed, so what is the benefit of producing more than 1000 kg/ha seed by protecting flowering pastures from pests? Factors that may be important include -

- Burrs and seed as feed for stock over summer
- Maximum seed bank to ensure high clover plant densities in autumn.
- Large seed reserves to cope with false break seedling losses.
- Large seed reserves to carry clover through a cropping year.

## OPTIMUM GRAZING PRESSURE IN SPRING

Undergrazing in spring is mainly due to rapid pasture growth, and insufficient stock to eat the large amounts of dry matter produced. It is impractical to buy in stock to keep pastures grazed to optimum FOO values in spring. The most direct solution is to increase stocking rate on selected paddocks by moving animals from other paddocks. The de-stocked paddocks can be used for fodder conservation such as -

- Hay
- Silage
- Hay freeze
- Standing dry matter

In all these cases, the need to control RLEM, BGA, LF, clover scorch, grass seed set, capeweed, sorrel, dock etc. must be assessed.

In the following year, the paddock selection is reversed, so that the previously de-stocked paddocks are intensively grazed, and the previously intensively grazed paddocks are destocked. Research at Albany has looking at the benefits for wool production from intensive spring grazing; these include finer wool, stronger wool, and more wool per hectare. The idea of alternating stocking pressure between years was first suggested during the 1970's by Reg Roberts, a CSIRO entomologist in NSW as a means of controlling a range of pasture pests.

## PEST LIFE CYCLE AND CHEMICAL CONTROL

The use of insecticides to control RLEM, LF and BGA is easily done. Witha knowledge of the life cycles of RLEM and BGA, insecticides can be applied with the correct timing to break the life cycle for a season. This can reduce numbers hatching in the following season. The critical factor is that the insecticides don't kill the eggs, and don't persist long enough to kill mites as they hatch. The use of two sprays will overcome this problem.

BGA can fly into a pasture or crop. They are all females, don't mate, and don't lay eggs. Each winged aphid gives birth to live young, which develop into wingless females that in turn give birth to more live young. In this way colonies of aphids can rapidly develop into very large infestations. Once the plants are seriously affected, or weather conditions become adverse, the wingless aphids produce winged aphids which can fly away to other pastures or crops. The symptoms of BGA attack are usually not apparent until numbers are high, and damage has occurred.

At germination, checking for pests requires observation of plants on hands and knees. Once the pasture mass (FOO) is above 1000 kg/ha an ice-cream container can be used to scoop through the pasture. Pests are easily seen in the bottom of the container, and if more than 30 are found in each scoop, closer examination is needed to decide if treatment is necessary.

TABLE 7. The life cycle of RLEM and the timing of sprays to control them are summarised. Notes on other pests are given as appropriate.

| Period | Life stages | Control |
|---|---|---|
| SPRING | Pastures maturing and drying<br>Female mites produce drought proof 'summer eggs'.<br>BGA may be present. | 2 sprays at 14-20 day interval.<br><u>OR</u><br>1 spray late to stop summer egg production.<br>USE higher rates of insecticide. |
| SUMMER | Summer eggs in dust, and in bodies of dead females. | |
| AUTUMN | Climatic cues for summer eggs to hatch:<br>- moisture (rainfall)<br>- cold (6 days <20°C)<br>Hatching occurs over 3 weeks.<br>New mites 5-6 weeks to lay winter eggs.<br>Winter eggs hatch within a week | 1 spray 3-4 weeks after summer egg hatching commences;<br><u>OR</u><br>2 sprays at 14-20 interval.<br>SPRAYS DON'T KILL EGGS.<br><br>BGA may be present in early break years. |
| WINTER | Mites lay winter eggs and die.<br>Winter eggs hatch; more mites, more eggs. | 2 sprays at 14-20 day interval should break life cycle. |

| INSECTICIDE | AUTUMN/WINTER | SPRING[a] |
|---|---|---|
| Systemic insecticides | | |
| dimethoate 40% | 50 - 100 ml/ha | 300 ml/ha |
| omethoate 58% | 50 ml/ha | |
| Contact insecticides | | |
| phosmet 15% | 350 ml/ha | |
| chlorpyriphos 50% | 140 ml/ha | |
| maldison ULV 118% | 200 ml/ha | |

[a] Higher rates of insecticide are needed to kill pests in spring, because of the greater amount of plant material. The rates of insecticide needed to kill aphids in spring will also kill RLEM and LF.

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