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Development of guidelines for improved control of gout fly *(Chlorops pumilionis)* in winter wheat

by

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Contents

1.0 Abstract

Gout fly (*Chlorops pumilionis*) is becoming an increasingly serious pest of winter wheat due to earlier sowing of crops, generally milder autumns and winters and the toxic effect of BYDV vector sprays on beneficial gout fly parasitoids. Traditionally a pest of southern England, gout fly has now been recorded on farms over a large part of the UK.

This project was commissioned by HGCA to:

1) establish treatment thresholds and effective spray application windows for gout fly control,
2) determine effects of seed rate and drilling date on gout fly numbers and % plant infestation,
3) identify economic treatments based on cost and crop losses,
4) examine the extent to which gout fly has become a UK-wide problem and
5) monitor the occurrence of gout fly parasitoids in field situations.

Experiments were carried out over two seasons (2002/03 and 2003/04) on two Velcourt commercial farms with a history of gout fly and in fields known to be most at risk, i.e. in sheltered areas with nearby woodlands. Working solely on the autumn generation of gout fly, two main types of experiments were carried out using commercially available insecticide products. Experiment 1 aimed to establish an economic threshold and treatment window for gout fly control and experiment 2 to evaluate crops most at risk in terms of plant population, variety and management practice. The geographic spread of gout fly and the two parasitoid wasp species (*Stenomalina micans* and *Coelinus niger*) were investigated through field surveys and questionnaires to the HGCA Agronomists' Alliance.

Early-sown (early Sept.) crops were found to be most at risk with some later-sown crops (October onwards) often free from pest attack. Insecticide seed treatments such as imidacloprid gave a significant level of gout fly control but only when populations were below 40% plants infested. The application of foliar insecticides significantly reduced the percentage of plants infested but application timing was found to be crucial. Spray applications were optimal at GS11-12. Applications after this were not effective and product choice was less important than timing. Despite high levels of gout fly in some cases (50-60%) there was no significant reduction in yield attributable to the infestation. This was even the case in low seed rate, thinner crops and those stressed due to reduced early nitrogen. There was no relationship between the percentage of plants infested ($R^2 = 0.40$) and yield (t/ha). It is likely that in the majority of cases the crop can compensate for the early loss of tillers due to the autumn generation.

The geographical survey results showed that gout fly is now widespread throughout England but that the levels of parasitoids are still very low and do not have a significant impact on gout fly populations.

2.0 Summary

2.1 Introduction

Gout fly (*Chlorops pumilionis*) has two generations per year, both of which attack cereal crops. Incidence varies from year to year with the autumn generation causing most damage on early-sown crops in mild autumns and the spring generation most damage to spring-sown cereal crops in wet springs when sowing is delayed. The nature of the damage caused by the two generations differs as the crops are at different growth stages at the time of pest attack. Adult flies are on the wing during May and June and from August to October. They generally lay their eggs singly on the leaves of cereal plants. Larvae hatch from the egg after about a week and crawl down between the leaf sheaths to feed. Attack in the autumn/winter results in swelling of the affected shoot (dead hearts) and other shoots on the plant senescing. In severe cases the whole plant may be lost. Attack in the spring is mainly focused on the stem below the ear. Larvae feed on the extending stem causing a distinctive groove. Stem extension is restricted and the ear often remains partially within the flag leaf sheath.

September-sown wheat crops are at much greater risk than later sowings and tend to be the crops where the most severe problems have been recorded in the past few years. The earliest crop to emerge in an area also tends to attract most of the flies with sheltered fields more prone to attack. April-sown spring cereals are more prone to attack by the spring phase of the gout fly generation than earlier-sown crops. Gout fly has traditionally been a problem in the south of England but over the past few years there have been an increasing number of reports of high levels throughout England. There are several reasons why gout fly is becoming more of a problem and these are summarised below:-

1. The use of BYDV vector sprays and seed treatments over the past decade has encouraged earlier sowing of crops.
2. Mild autumns and winters are favourable to this pest; it could be that gout fly is an early beneficiary of the effects of climate change.
3. Historically gout fly suffered from a high level of natural parasitism in the field. The observation that pyrethroid sprays applied after mid-October tended to reduce their natural mortality (and therefore increase damage), suggests that the pyrethroid killed off many of the beneficial parasitoids. This may also be the case with BYDV vector sprays.
4. Gout fly is most effectively controlled before larvae hatch from the eggs. This only allows for a 10-day spray window after identifying the eggs.

Until recently gout fly has not been considered to be an important pest and as such the level of research that has been carried out on it has been limited. It is often difficult to determine at what point a pest such as gout fly warrants further investigation. From widespread discussions with farm managers and agronomists it has become apparent that gout fly has a far greater geographic spread than it once had. Many farmers are finding it difficult to control; this is probably because they did not realise they had a problem until it was too late to treat and were not aware that their crop was at risk. Limited evidence has suggested that treatment is economic in winter crops if eggs are found on more than 50% of plants at GS12 (Pest Management in Cereals and Oilseed rape – a guide, HGCA). However, further work is required to establish reliable treatment thresholds and to establish at what levels of gout fly treatment is economic.

2.2 Aims

- To establish treatment thresholds and effective spray application windows for gout fly control.
- To determine the effects of seed rate and drilling date on gout fly numbers and % plant infestation.
- To identify economic treatments based on cost and crop losses.
- To examine the extent to which gout fly has become a UK-wide problem.
- To monitor the occurrence of gout fly parasitoids in field situations.

2.3 Methods

The experiments were carried out over two seasons, 2002-03 and 2003-04, on two sites with a history of gout fly infestations. Fields sites were chosen on the basis that conditions were likely to be conducive to gout fly attack, i.e. sheltered fields near woodlands. The two sites were on commercially run Velcourt farms at Rougham Estates. Rougham, Bury-St Edmunds. Suffolk. (managed by Mr Andrew Hunt) and Cornbury Park Farm**,** Charlbury, Oxon. (managed by Mr Richard Fanshawe). All field experiments were managed according to Good Farm Practise (GFP) and PSD standards (PSD registration no. ORETO 117) and were set up in a fully randomised block design with four replicate plots per treatment. Factorial data analysis and additional statistical analysis were carried out using Genstat. Two sets of experiments were carried out over the two seasons, as well as geographic surveys of the levels of gout fly and parasitoids in commercial field situations.

2.3.1 Experiment 1. *To establish an economic threshold and treatment window for the control of gout fly using commercially available products*.

These experiments investigated the use of seed treatments with and without insecticides to control gout fly, as well as additional foliar applied insecticide treatments. In year 1 two experiments were carried out, one at each site. They compared the use of Sibutol (a.i. bitertanol + fuberidazole, Bayer CropScience) and Sibutol Secur (a.i. bitertanol + fuberidazole + imidacloprid, Bayer CropScience) seed treatments, as well as four commercially available foliar applied insecticides at three timings (D1 (GS 11-12) and 10 and 20 days after treatment D1) with an untreated control. The insecticide products were:- Fernpath Banjo (a.i. cypermethrin, Agriguard Ltd.), Mavrick (a.i. tau-fluvalinate, Makhteshim Ltd.), Danadim (a.i. dimethoate, Cheminova Ltd.) and Cyren (a.i. chlorpyrifos, Headland Ltd.).

In year 2, two further experiments were carried out. These were rationalised from year 1 to take account of the loss of some products and the introduction of new ones. At the Oxford site Sibutol and Sibutol Secur seed treatments were again compared with an additional treatment of Sibutol plus a new product from Syngenta TMX (a.i. bitertanol + fuberidazole + thiamethoxam, Bayer CropScience + Syngenta). In this experiment the foliar insecticides Fernpath Banjo and Mavrick were applied at two timings (D1 (GS11-12) and 10 days after D1) and compared with an untreated control. In addition, an experiment funded by Syngenta was also included within this project. This experiment was at the Bury St Edmunds site and compared the seed treatments Beret Gold (a.i. fludioxonil, Syngenta), Beret Gold + TMX (a.i. fludioxonil + thiamethoxam, Syngenta) and Sibutol Secur. The foliar applied pyrethroid Hallmark (a.i. lambda-cyhalothrin, Syngenta) was applied at two timings.

2.3.2 Experiment 2. *Evaluation of crops most at risk from gout fly including the effect of a) plant population and b) variety and management practice*

In year 1, at the Bury St Edmunds site, Experiment 2a was set up to investigate the effect of drilling date, seed rate and foliar insecticide timing on the control of gout fly. Plots were drilled at three drilling dates, Early Sept., Mid Sept. and Early Oct., at two seed rates, high (350 seeds/m^2) and low (150 seeds/m^2). A pyrethroid insecticide (Fernpath Banjo) treatment was then applied at one of two timings (D1 (GS11-12) and 10 days after D1) and compared with an untreated control.

In year 2, at both sites, Experiment 2b was set up to investigate whether some crops were more at risk than others from the effects of gout fly infestation. Two varieties were selected with high tillering (Consort) and low tillering (Napier) habits. These were sown at two seed rates, low (150 seeds/m^2) and high, (350 seeds/m^2), with 0, 60 or 120 kg N/ha early (final total N was equal in all treatments, i.e. 200kgN/ha). Plots were left untreated for gout fly. In order to compare with equivalent treated plots, Napier and Consort plots in an adjacent experiment at the same two seed rates were compared at harvest. These plots received the same total nitrogen and also a well-timed pyrethroid application at GS11.

2.3.3 Assessments

The same assessments were carried out on all experiments at both sites.

Gout fly and parasitoid numbers

Yellow sticky traps were placed in the crop to trap both gout flies and parasitoids. Traps were set up in the field on metal stands to a height of approximately 0.5m surrounded by a wire netting cage to prevent animal damage. Traps were placed in the experimental area (4 traps per area) after crop emergence until the end of October with traps replaced every 7-10 days. The traps were then examined with a dissecting microscope to identify the number of gout fly (*Chlorops pumilionis)* and parasitoids (*Stenomalina micans* & *Coelinus niger*) trapped.

Plant establishment and gout fly egg counts

The number of plants/m^2 and the number of gout fly eggs per plant and per m^2 were determined at GS11-12. Plant numbers were calculated by counting the number of plants in 4 x 0.5m rows selected at random in each plot. The number of gout fly eggs present on these plants was also recorded and expressed as gout fly eggs/m^2 and gout fly eggs/plant.

Plant infestation and parasitised larval numbers

The number of plants infected with gout fly larvae was assessed at GS25 by taking 3 x 0.1m quadrat samples at random from each plot. The whole plants were removed from within the quadrat and where necessary the plants were washed before assessment. In the laboratory, the number of plants with one or more infected tillers was counted and expressed as a percentage of plants infected. In most cases the presence of a gout fly larva within a tiller was easy to identify based on the "spring onion like" swelling of the base of the tiller. In cases where infestation with gout fly larvae was uncertain the tiller was dissected in order to establish whether a larva was present. In some situations where severe levels of infestation had occurred the number of plants with more than one tiller infected was also recorded.

In year 1 of the project, infected plants from all the treated plots in all experiments were also assessed to determine the number of parasitised larvae. In year 2, following the experiences of year 1, only the untreated control plots were examined in the first instance. Depending on the level of parasitised larvae found in these samples, further samples would or would not be examined, i.e. if very few parasitised larvae were found in control plots the samples from other treatment plots would not be examined. Parasitised larvae were identified by excising the gout fly larvae and then crushing them on a microscope slide. The presence of parasitoid pupae was then determined under a dissecting microscope. The number of parasitised larvae was recorded.

Leaf Area Index

At GS39-55 the leaf area index (LAI) of all the treatment plots was determined using a Delta-T Sunscan (Delta-T Devices, Cambs.). For each plot 5 LAI measurements were made across the rows from random positions within the plot.

BYDV assessments

In experiments where BYDV patches were apparent a full assessment of BYDV patches was made.

Harvest parameters

In order to determine harvest parameters a 0.25m^2 quadrat sample was taken from each plot in all experiments in each season prior to harvest. In areas where BYDV patches had occurred care was taken to avoid these in order to get a measure of the likely impact of the gout fly infestation. The total dry weight of the samples, harvest index, number of ears/m^2, thousand grain weights and number of grains per ear were also determined where necessary. All plots were combined with a Sampo plot combine with a 2m cutter width. Grain moisture was determined and yield corrected to 15% moisture. Specific weight was also determined for all grain samples.

2.3.4 Geographic spread of gout fly

The geographic spread of gout fly and its parasitoids was determined by surveying fields at a range of sites and sending out questionnaires to members of the Agronomists' Alliance.

2.4 Results and discussion

Trapped gout fly and parasitoid numbers

The gout fly and parasitoid numbers trapped per day was broadly similar in year 1 (2002-03) of the study at both sites with 0.09, 0.06 and 0.08 (Oxford) and 0.06, 0.08 and 0.05 (Bury St Edmunds) mean number of individuals trapped/day (*C. pumilionis: S. micans: C. niger* respectively). In year 2 (2003-04) the gout fly numbers were higher at the Bury St Edmunds site than the Oxford site (no gout fly were trapped in Oxford) and parasitoid numbers were generally very low (<3 parasitoids in total). The time of trapping of the gout fly in relation to the parasitoids for year 1 is summarised in Figure 1. It can be seen that the gout fly are the first to increase in number through time until the appearance of the parasitoids 2-3 weeks later. As their numbers increase, so the numbers of gout fly decrease.

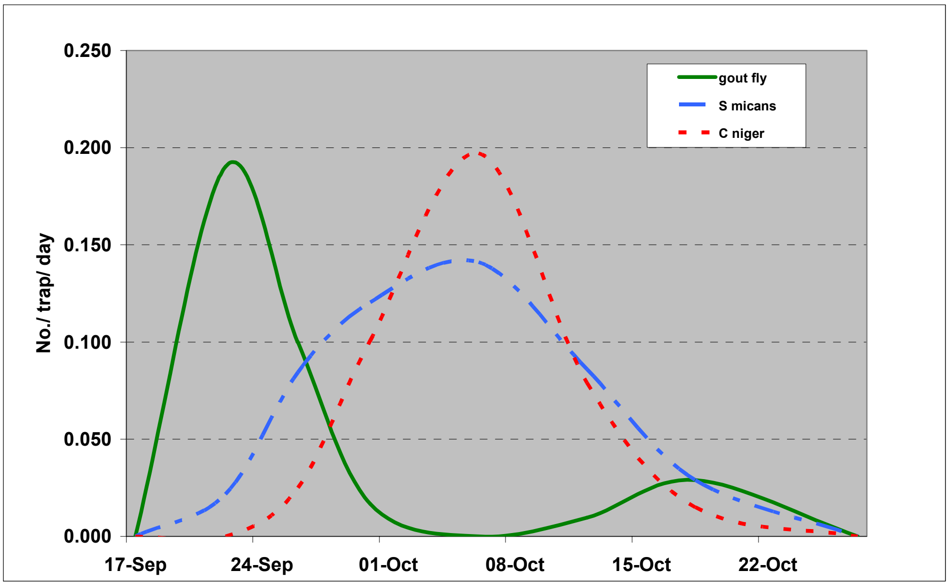


Figure 1. Population dynamics of gout fly (*C. pumilionis)* and the parasitoids *S. micans* and *C. niger* (Oxford and Bury St Edmunds data combined (2002)).

2.4.1 Experiment 1. *To establish an economic threshold and treatment window for the control of gout fly using commercially available products*.

Plant establishment

The effect of seed treatment on plant establishment was only significant at the Oxford site in 2002-03 where Sibutol Secur significantly ($P<0.01$) increased the number of plants/m^2 compared with the Sibutol seed treatment, with 240 and 208 plants/m^2 respectively. This was believed to be as a result of controlling slug damage.

Gout fly egg counts

In 2002-03 the number of gout fly eggs/m^2 and eggs/plant were significantly reduced ($P<0.001$ and <0.01 respectively) with the addition of Secur to the Sibutol seed treatment at the Bury St Edmunds site (Figure 2). In contrast, at the Oxford site there was a significant increase in the number of gout fly eggs/m^2 in the Sibutol Secur treatment compared with the Sibutol alone treatment. This was as a result of the increase in plant establishment rather than a seed treatment effect. This is supported by the fact that the number of gout fly eggs/plant was not significantly different between treatments. In 2003-04 gout fly numbers were very low at the Bury St Edmunds site and no differences in gout fly egg numbers either per m^2 or per plant were observed. At the Oxford site, where gout fly numbers were higher, Sibutol Secur and Beret Gold + TMX treatments both significantly reduced the number of eggs/m^2 and eggs/plant ($p<0.001$) in comparison with Beret Gold alone.

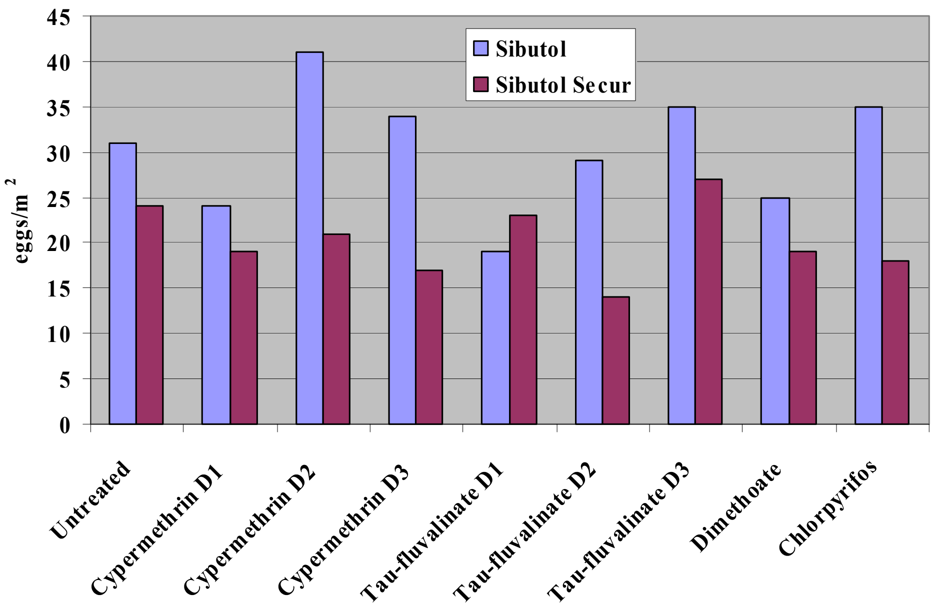


Figure 2. Gout fly eggs/m^2 at Bury St Edmunds in Experiment 1, 2002-‘03 (5% LSD = 12).

Percentage plant infestation

In 2002-03 the % plants infested with gout fly larvae was significantly reduced ($p<0.001$) in the Sibutol Secur treatment as compared with the Secur alone at Bury St Edmunds with and without foliar insecticide treatment (Figure 3). In contrast, no differences in the % infested plants were found between seed treatments at the Oxford site; this may have been a result of the higher gout fly population at that site (Figure 3). The effect of spray timing at both sites in 2002-03 had a large effect on the % plants infested with the D1 timing (GS11-12) significantly reducing ($P<0.001$) the % of plants infested compared with the two other timings (D2 10DAT1 & D3 20DAT1). The choice of pyrethroid did not have a significant effect on % plant infestation and the use of both Danadim (a.i. dimethoate) and Cyren (a..i. chlorpyrifos) at the D3 timing gave no better control of gout fly than either pyrethroid applied at the same timing.

In 2003-04, gout fly numbers were very low at the Oxford site and no significant results were obtained. However, at the Bury St Edmunds site where gout fly numbers were higher, the % plants infested was significantly reduced ($P<0.001$) as a result of the addition of both TMX to the Beret Gold and the use of Secur with Sibutol.

BYDV

The occurrence of BYDV patches was found to be significantly higher ($p<0.001$) in treatments with the Sibutol seed treatments as compared with those treated with Sibutol Secur alone at both sites. In year 2 no differences in the levels of BYDV were found between seed treatments on either site.

Leaf Area Index

In all the experiments carried out there was no significant difference in LAI at either site.

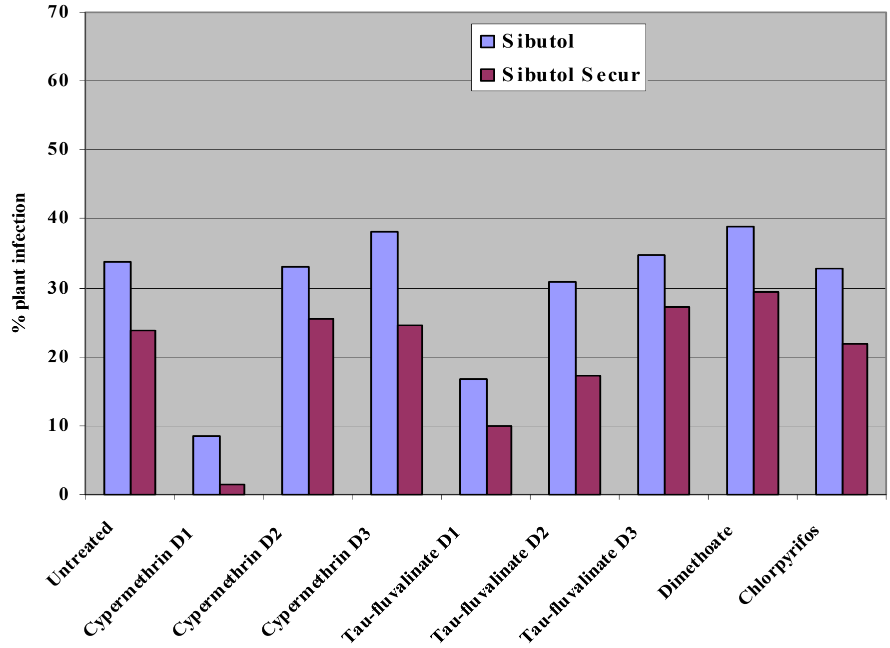


Figure 3. Percentage plant infestation at Bury St Edmunds site, 2002-03. (5% LSD = 10.03).

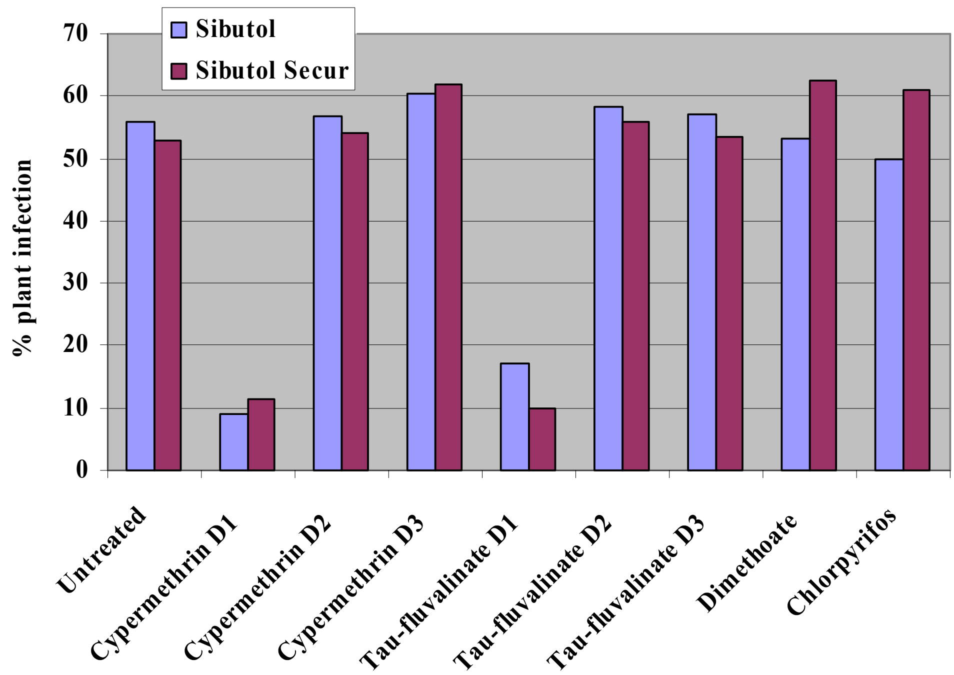


Figure 4. Percentage plant infestation at Oxford site, 2002-03. (5% LSD = 14.90).

Yield

Factorial analysis of yield data in 2002-03 showed significant differences between seed treatment yields at the Bury St Edmunds site ($P<0.01$). This was as a result of differences between the untreated yields with and without Secur (Figure 5). Comparison of harvest parameters (from non-BYDV areas) gave no significant differences. The BYDV data suggested that the differences between the untreated yields with and without Secur were as a result of BYDV, rather than gout fly. This is supported by the fact that, despite significant differences in the % plants infested between D1 and D2 and D3 treatments (Figure 3 & 4), no yield differences were found. In spite of the high levels of % plants infested at the Oxford site (max. 60%), no significant differences in yield were found.

In 2003-04, it was not surprising to find no differences in harvest yield data or harvest parameters at the Oxford site as no differences in eggs/plant or % infested plants was seen. However, despite a significant reduction in % infected plants in the Syngenta seed treatment experiment, no differences in yield or harvest parameters were found.

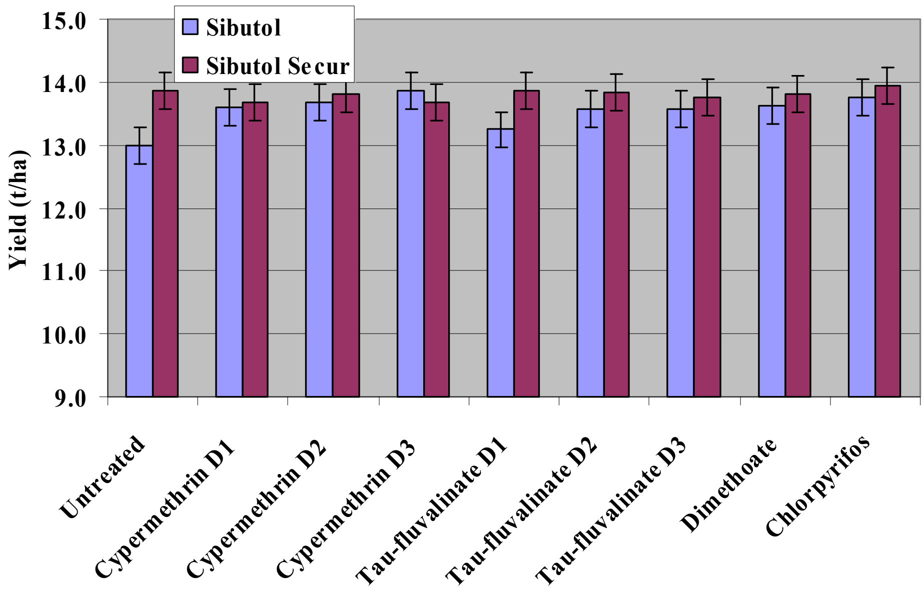


Figure. 5 Yield (t/ha) at the Bury St Edmund site, 2002-’03 (5% LSD = 0.29).

2.4.2 Experiment 2a. *Evaluation of crops most at risk from gout fly:- effect of plant population.*

Percentage plants infected

In Experiment 2a, at Bury St Edmunds, the early-drilled, low seed rate plots were found to be most at risk from attack by gout fly. In the early-drilled, low seed rate treatment, over 50% of plants were infested. Levels of gout fly were significantly lower in both the Mid. Sept. and Early Oct. drilled plots, with no plants infected in the latter. The higher seed rate (in untreated plots) had 20% less plants infested. This experiment also demonstrated the importance of insecticide timing. In both the high and low seed rates the D1 insecticide timing significantly reduced the % plants infested. The D2 treatment did reduce the % of plants infested but not significantly.

Yield

Comparison of the untreated yields in both the high and low seed rates with the respective D1 and D2 treatments at each sowing date demonstrated that in no case did gout fly significantly reduce yields (Figure 6). Not surprisingly, there were significant difference between drilling date and seed rate but this was a physiological response, rather than as a result of gout fly.

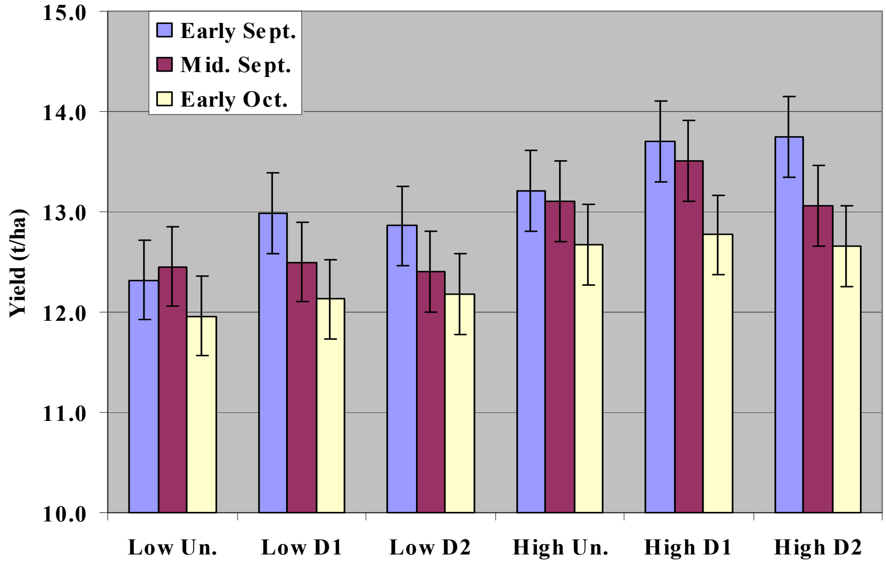


Figure 6. Yield (t/ha) at the Bury St Edmunds site comparing drilling date, seed rate and spray timing.

2.4.3 *Experiment 2b* *Evaluation of crops most at risk from gout fly:- effect of variety and management practice.*

Gout fly egg counts and % plant infestation

At the Bury St Edmunds site there were significant differences (P = <0.01) in the number of gout fly eggs/m^2 between seed rates and between varieties. In the Napier treatments low seed rates had 129 eggs/m^2 compared with the high rate with 173 eggs/m^2. In the Consort treatments the low seed rate had 178 eggs/m^2 compared with the high seed rate with 207 eggs/m^2. However, these differences did not seem to be translated into differences in % plant infestation as there was no significant difference between treatments: % plant infestation was 37% (low seed rate – Napier), 37 % (high seed rate – Napier, 46% (low seed rate – Consort), 38 % (high seed rate- Consort). At the Oxford site, there were low levels of gout fly. In none of the treatments were there any significant differences in either the number of gout fly eggs/m^2 (max. 5 eggs/m^2) or the % of plants infected (maximum 25%).

Yield

Although both LAI and yield were significantly different (P<0.001) between varieties and seed rates, there were no significant differences between nitrogen application timings. Yields at the Oxford site (in the absence of a significant level of gout fly) gave the expected range of yields, i.e. Consort gave higher yields than Napier and the higher seed rate higher yields than the low seed rate. Differences in the early N regime did not result in any significant yield differences. Yields at the Bury St Edmunds site followed a similar patter to those at the Oxford site. Again, there were no differences between early N regimes suggesting that the crop was able to compensate at a later stage. From comparison of yield data in this experiment with neighbouring, equivalent pyrethroid treated plots the levels of gout fly at the Bury St Edmunds site were either not high enough to result in a significant yield loss or the plant stands were able to compensate. Yield differences that were observed were most likely to be attributable to physiological differences between varieties and seed rate and not as a result of gout fly.

2.5 Geographic spread

Gout fly were found to be widespread throughout England from as far north as Northumberland and Yorkshire, in the west in Worcestershire and in the east in Lincolnshire. There were no reports of gout fly in Scotland, Wales or Northern Ireland. The levels of parasitoids seemed to be variable and were generally higher in areas where gout fly had been identified for some time. It may be that as gout fly move up the country the parasitoid numbers take some time to build up. Although parasitoids were found at both experimental sites, despite sampling several hundred gout fly larvae, only two were found to be parasitised over the length of this study. This suggests that parasitoid numbers need to increase significantly if they are to have an impact on reducing gout fly numbers in the field.

2.6 Implications for levy payers

1) Insecticide seed treatments, such as imidacloprid, can reduce gout fly egg numbers and the % of plants infested but only at low population levels.
2) Spray timing is important, with GS11-12 being optimal for control.
3) Product choice is less important than spray timing.
4) Early-drilled crops (early Sept.) in sheltered fields are most at risk from gout fly.
5) There is no relationship between yield and the % plants infested with gout fly.
6) Winter wheat seems to be able to compensate for attack by the autumn generation of gout fly even at levels >60% plants infested.
7) The use of an insecticide seed treatment would be a precautionary measure to reduce levels of gout fly but a foliar insecticide application would not be economic in the majority of cases.
8) Gout fly populations are now widespread throughout England and so potentially pose a threat.
9) Parasitoids occur sporadically and have yet to “catch up” with advancing gout fly populations.
10) Parasitoid levels do not seem to be sufficient to control gout fly populations naturally.
11) Whilst the recommendations based on this work would be not to treat autumn sown cereals to control gout fly, this could lead to a build up of problems on spring cereals where control is more difficult.

3.0 Technical Report

3.1 Introduction

Gout fly (*Chlorops pumilionis*) (Figure 7) has two generations per year, both of which attack cereal crops (Figure 8). Incidence varies from year to year with the autumn generation causing most damage on early sown crops in mild autumns and the spring generation most damage to spring-sown cereal crops in wet springs when sowing is delayed. The nature of the damage caused by the two generations differs as the crops are at different growth stages at the time of the pest attack. Adult flies are on the wing during May and June and from August to October. They generally lay their eggs singly on the leaves of cereal plants (Figure 9). Larvae hatch from the egg after about a week and crawl down between the leaf sheath to feed (Figure 10) (Derron & Goy, 1990; Lilly, 1947; Oakley *et al*., 1990). Attack in the autumn/winter results in swelling of the affected shoot (dead hearts) with the other shoots on the plant senescing, in severe cases the whole plant may be lost (Figure 11). Attack in the spring is mainly focused on the stem below the ear. Larvae feed on the extending stem causing a distinctive groove. Stem extension is restricted and the ear often remains partially within the flag leaf sheath. Grain size and number are both reduced, it has been estimated that the yield of infested tillers can be depressed by over 30%. It has been suggested that gout fly may favour crops and areas with lower plant populations which are less able to compensate for attack (J. Oakley, pers. comm.). Reducing seed rates to control tiller populations in early sown crops may therefore be contributing to the importance of this pest.

Figure 7. Adult gout fly (*Chlorops pumilionis*)

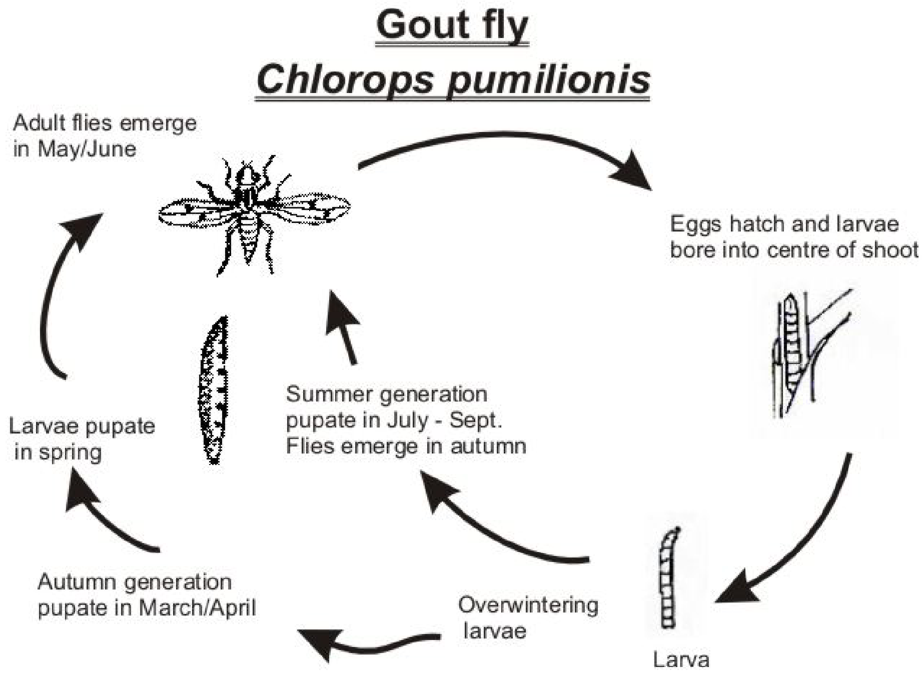


Figure 8. Life cycle of gout fly (*Chlorops pumilionis*).

Figure 9. Gout fly (*Chlorops pumilionis)* eggs on leaf sheaths.

Figure 10. Gout fly (*Chlorops pumilionis*) larvae within the stem base having crawled down the leaf sheath.

Figure 11. Symptom of "dead heart" in winter wheat from gout fly (*Chlorops pumilionis)* infestation.

Evidence suggests that September sown wheat crops are at much greater risk than later sowings and tend to be the crops where the most severe problems have been recorded in the past few years (Figure 12). The earliest crop to emerge in an area tends to attract most of the flies, with sheltered fields more prone to attack from large numbers of adults. Also, April sown spring cereals are more prone to attack by the spring phase of the gout fly generation than earlier sown crops (Figure 8). Although generally a less common problem, some crops did suffer a severe attack in spring when sown late due to the bad weather in the 2000/01 season.

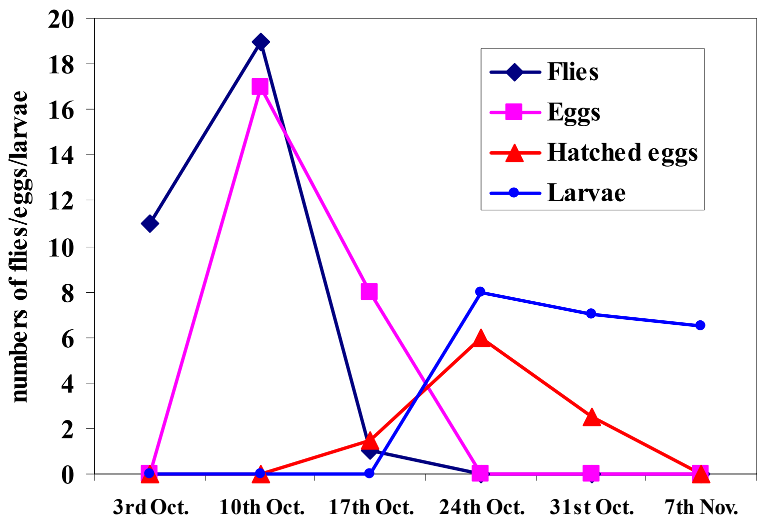


Figure 12. Phases of the autumn generation gout fly (*Chlorops pumilionis)* life cycle (J. Oakley unpublished data).

Gout fly has traditionally been a problem in the south of England but over the past few years there have been an increasing number of reports of high levels throughout England. There are several reasons why gout fly is becoming more of a problem and these are summarised below:-

1 The use of BYDV vector sprays and seed treatments over the last decade has encouraged earlier sowing of crops. Over the past few years early sowing of crops has resulted in a large numbers of cases of severe gout fly with reports from several members of the Agronomists' Alliance of fields with 100% plants affected. Unusually, in some cases, plants with more than one tiller affected have been recorded.

2 Mild autumns and winters are favourable to this pest, it could be that gout fly is an early beneficiary of the effects of climate change and its importance is likely to increase under the forecasted changes in climate. This is already evident by its increase in geographic distribution from the south to areas which have previously been free of the pest.

3 Gout fly suffers from a high level of natural parasitism in the field, the observation that pyrethroid sprays applied after mid-Oct, when the larvae were established, tended to reduce natural mortality (and therefore increase damage), suggests that the pyrethroid killed off many of the beneficial parasitoids. It is believed that this may also be the case with BYDV vector sprays.

4 Gout fly is most effectively controlled before larvae hatch from the eggs, this only allows for a 10 day spray window after identifying the eggs. Sprays applied after egg hatch tend to increase damage by the pest, again due to parasitoid toxicity. Timing of spray treatments is

crucial if effective control is to be achieved, identification of this spray window is essential to manage the work load during the autumn.

5 One of the most effective insecticides, Omethoate, has been withdrawn from the market; this now restricts choice to contact insecticides such as chlorpyrifos and cypermethrin. It is quite often assumed that seed treatments such as imidacloprid (Secur) give some level of gout fly control, although this has never been proven and is an objective in this project.

Until recently gout fly has not been considered to be an important pest and as such the level of research which has been carried out on it has been limited. Adult activity can be monitored with sticky traps and it is important to identify high risk fields. Identification of the early warning signs such as climate effects predisposing to attack and the appearance of eggs on cereal plants are essential if treatments are to be applied correctly. This is often difficult when other farm operations are a high priority. In 1989/90 a treatment threshold for gout fly was derived however this was from a single experiment in one season and at a time when gout fly levels were highly variable and generally low. The provisional guideline is that it is necessary to treat when 25% of plants are infested with eggs in winter (this level of infestation giving an approx. yield loss of 0.25 t/ha). However, with such a poor statistical relationship ($r^2 = 0.23$) from the experiment as shown below and very different conditions in the industry, i.e. lower grain prices, fewer chemicals, higher infestations etc. no realistic economic threshold for gout fly exists (Figure 13).

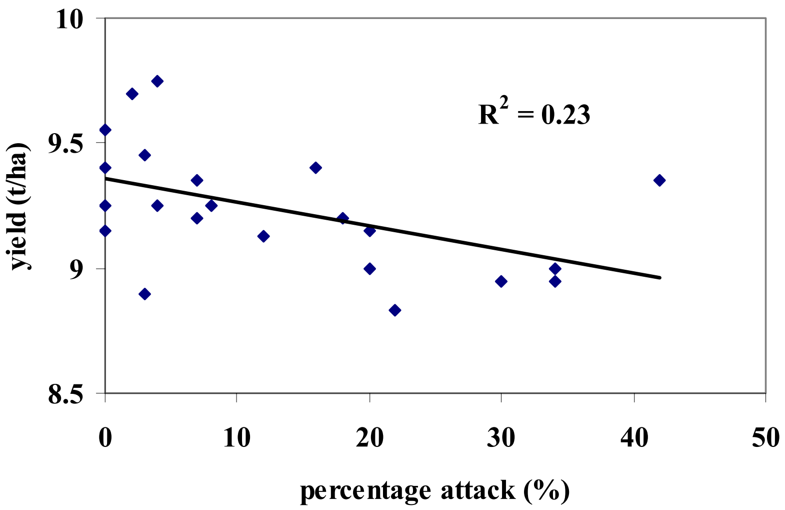


Figure 13. Regression analysis of the levels of gout fly (*Chlorops pumilionis)* attack per plant (%) with resulting yield (t/ha) (J. Oakley unpublished data)

It is often difficult to determine at what point a pest such as gout fly warrants further investigation. From widespread discussions with several farm managers and agronomists it has become increasingly apparent that gout fly has a far greater geographic spread than it once had. Many farmers are finding it difficult to control, this is probably because they did not realise they had a problem until it was too late to treat and were not aware that their crop was at risk. The choice of treatments available is limited and the two main active ingredients that can be used to treat gout fly are contact insecticides which means that timing is crucial. Seed treatments may afford some control but this is not well documented. Earlier sowing of cereal crops and more extensive use of BYDV vector treatments is putting crops at greater risk, a decrease in the natural parasitoid enemies of gout fly is also exacerbating the problem.

3.2 Materials and Methods.

3.2.1 Site selection and field details

The set of experiments were carried out over two seasons, 2002-03 and 2003-04 on two sites with a history of gout fly infestations. Fields sites were chosen on the basis that conditions were likely to be conducive to gout fly attack, i.e. sheltered fields near woodlands. The two sites were on commercially run Velcourt farms:-

Cornbury Park Farm, Nr. Chilson, Charlbury. Oxon. Managed by Mr Richard Fanshawe and **Rougham Estates**. Rougham, Bury-St Edmunds. Suffolk. Managed by Mr Andrew Hunt.

Field details are given in Appendix 1. Where standard field inputs were required these were applied to GFP in order to prevent the confounding effects of external factors such as weeds and foliar disease. Crop nutrients were applied as described in Appendix 1 except where these differed due to the experimental treatments required. All experimental treatments were applied according to Standard Operating Procedures to PSD standards (PSD registration no. ORETO 117).

All experiments were set up in a fully randomised block design with four replicate plots per treatment, full experimental plot layouts are given in Appendices 2 & 3. Plots were drilled using a Suffolk coulter plot drill. Spray treatments were applied using a compressed air sprayer at a water volume of 100 l/ha at 2.0 bar with Flat fan 110^{o} nozzles. Fertiliser applications were applied by hand as ammonium nitrate. Over the two years of the project two main types of field experiments were carried out as described below. In addition, a geographic assessment of the spread of gout fly was also made by trapping in fields at risk, consulting with the industry and through the Agronomists' Alliance.

3.2.2 Experiment 1. *To establish an economic threshold and treatment window for the control of the autumn generation of gout fly using commercially available products***.**

Treatments and experiment design (also see Appendix 1)

Year 1 (2002-03) – Experiment 1 was carried out at both Bury St Edmunds and Oxford sites.

The aim of these experiments was a) To investigate whether the use of seed treatments affords some control of gout fly by comparing two seed treatments, Sibutol (a.i. bitertanol + fuberidazole, Bayer Crop Science) and Sibutol Secur (a.i. bitertanol + fuberidazole + imidacloprid, Bayer Crop Science) and b) To investigate the effect of insecticide timing and product choice on the control of gout fly infestations. The full treatment layout is given in Appendix 2 and summarised in Tables 1 & 2.

Table 1. Experiment 1 treatments applied at Bury St Edmunds and Oxford sites, 2002-03.

Trt No.	Seed Trt	D1: GS 11-12	D2: 10 DAT1	D3: 20 DAT1
1	[a]Sibutol			
2	Sibutol	[c]Fernpath Banjo 0.25		
3	Sibutol		Fernpath Banjo 0.25	
4	Sibutol			Fernpath Banjo 0.25
5	Sibutol	[d]Mavrick 0.1		
6	Sibutol		Mavrick 0.1	
7	Sibutol			Mavrick 0.1
8	Sibutol			[e]Danadim 0.85
9	Sibutol			[f]Cyren 1.0
10	[b]Sibutol Secur			
11	Sibutol Secur	Fernpath banjo 0.25		
12	Sibutol Secur		Fernpath Banjo 0.25	
13	Sibutol Secur			Fernpath Banjo 0.25
14	Sibutol Secur	Mavrick 0.1		
15	Sibutol Secur		Mavrick 0.1	
16	Sibutol Secur			Mavrick 0.1
17	Sibutol Secur			Danadim 0.85
18	Sibutol Secur			Cyren 1.0

[a] Sibutol - a.i. bitertanol + fuberidazole (Bayer Crop Science)
[b] Sibutol Secur – a.i. bitertanol + fuberidazole + imidacloprid (Bayer Crop Science)
[c] Fernpath Banjo – a.i. cypermethrin (Agriguard Ltd.)
[d] Mavrick - a.i. tau-fluvalinate (Makhteshim Ltd.)
[e] Danadim - a.i. dimethoate (Cheminova Ltd.)
[f] Cyren – a.i. chlorpyrifos (Headland Ltd.)
DAT1 = days after Treatment 1 (D1).

Table 2. Experiment 1 drilling dates and treatment timings at Bury St Edmunds and Oxford, 2002-03.

Site	Drilling date	D1: GS 11-12	D2: 10 DAT1	D3: 20 DAT1
Bury St Edmunds	04/09/02	24/09/02	07/10/02	17/10/02
Oxford	03/09/02	26/09/02	07/10/02	24/10/02

Year 2 (2003-04). Experiment 1 was carried out at the Oxford site only.

Following consultation with members of the Agronomists' Alliance (HGCA), project partners and visitors to Cereals 2003 some amendments were made to the treatments for experiment 1. Although the seed treatments Sibutol (a.i. bitertanol + fuberidazole, Bayer Crop Science) and Sibutol Secur (a.i. bitertanol + fuberidazole + imidacloprid, Bayer Crop science) were still included a further seed treatment Sibutol + TMX (a.i. bitertanol + fuberidazole + thiamethoxam) was added. TMX at the time of writing does not have a commercial product name but is produced by Syngenta and contains the active ingredient thiamethoxam. Due to the addition of a further seed treatment it was decided to rationalise the insecticide applications in order to limited the scale of the experiment. In the light of both the results from year 1 of this experiment, as well as the future registration concerns of both dimethoate and chlorpyrifos, it was decided not to include these two products. Similarly, in the light of the year 1 data, only two spray timings were considered necessary. The full experimental layout of the treatments is given in Appendix 3 and summarised in Table 3.

Additional experiment **(**funded by Syngenta**)**

Following a request from Syngenta a further experiment was carried out alongside Experiment 1 of this project at the Oxford site. Although the treatment layout was decided by Syngenta it was felt that the details of this experiment would be relevant to this project report. Syngenta have kindly agreed to allow their data to be included and the cost of experimentation was paid for by them. The experiment sets out to compare early gout fly levels following a seed treatment without an insecticide; Beret Gold (a.i. fludioxonil, Syngenta), an existing seed treatment with an insecticide included; Sibutol Secur (a.i. bitertanol + fuberidazole + imidacloprid, Bayer Crop Science) and a new seed treatment from Syngenta; Beret Gold + TMX (a.i. fludioxonil + thiamethoxam, Bayer Crop Science + Syngenta)). Pyrethroid applications were made at three timings D1 (GS21) and D2 and D3 (Table 4) using Hallmark (a.i. lambda-cyhalothrin, Syngenta) although these were designed to target BYDV vectors rather than gout fly . The full experimental layout is given in Appendix 3 and summarised in Table 4.

Table 3. Experiment 1 treatments at the Oxford site with drilling dates and treatment application timings. 2003-04.

	Seed Treatment Drilling Date:	**Insecticide Regime D1 GS11-12**	**D2 10 DAT1**
Trt No.	**05/09/2003**	**13/10/2003**	**24/10/2003**
1	[a]Sibutol		
2	Sibutol	[d]Fernpath Banjo 0.25	
3	Sibutol		Fernpath Banjo 0.25
4	Sibutol	[e]Mavrick 0.1	
5	Sibutol		Mavrick 0.1
6	[b]Sibutol Secur		
7	Sibutol Secur	Fernpath Banjo 0.25	
8	Sibutol Secur		Fernpath Banjo 0.25
9	Sibutol Secur	Mavrick 0.1	
10	Sibutol Secur		Mavrick 0.1
11	[c]Sibutol + TMX		
12	Sibutol + TMX	Fernpath Banjo 0.25	
13	Sibutol + TMX		Fernpath Banjo 0.25
14	Sibutol + TMX	Mavrick 0.1	
15	Sibutol + TMX		Mavrick 0.1

[a] Sibutol - a.i. bitertanol + fuberidazole (Bayer Crop Science)
[b] Sibutol Secur – a.i. bitertanol + fuberidazole + imidacloprid (Bayer Crop Science)
[c] Sibutol + TMX - a.i. bitertanol + fuberidazole + thiamethoxam (Bayer Crop Science + Syngenta)
[d] Fernpath Banjo – a.i. cypermethrin (Agriguard Ltd.)
[e] Mavrick - a.i. tau-fluvalinate (Makhteshim Ltd.)
DAT1 = days after Treatment 1 (D1).

Table 4. Treatments for the Syngenta funded experiment based at the Oxford site. 2003-04.

	Seed Treatment	**Insecticide Regime**		
Trt No.	**Drilling Date: 05/09/2003**	**D1 GS21 21/10/2004**	**D2 8 WAD 12/11/2004**	**D3 10 WAD 24/11/2004**
1	[a]Beret Gold			
2	Beret Gold	[d]Hallmark 0.25		
3	Beret Gold		Hallmark 0.25	
4	Beret Gold			Hallmark 0.25
6	[b]Beret Gold + TMX		Hallmark 0.25	
7	Beret Gold + TMX			Hallmark 0.25
8	[c]Sibutol Secur		Hallmark 0.25	
9	Sibutol Secur			Hallmark 0.25

[a]. Beret Gold - a.i.. fludioxonil (Syngenta).
[b]. Beret Gold + TMX – a.i. fludioxonil + thiamethoxam (Syngenta)
[c] Sibutol Secur – a.i. bitertanol + fuberidazole + imidacloprid (Bayer Crop Science)
[d]. Hallmark – a.i. lambda-cyhalothrin (Syngenta).
WAD – weeks after drilling.

3.2.3 Experiment 2. *Evaluation of crops most at risk from the autumn generation of gout fly including the effect of a) plant population and b) variety and management practice.*

Treatments and experiment design (also see Appendix 1)

Year 1 (2002-03) Experiment 2a was carried out at the Bury St Edmunds site only.

It has been suggested that early sown crops and crop areas with lower plant populations are more at risk from gout fly infestation and may be less able to compensate from attack (J Oakley, pers. comm). For this reason, experiment 2a was designed to investigate crops most at risk from gout fly attack and hence yield loss. In year 1, experiment 2a focused on the effect of different drilling dates and plant populations to investigate the effect of gout fly infestation (Table 5). Three insecticide programmes were then applied to these crops - untreated and Fernpath Banjo (a.i. cypermethrin, Agriguard Ltd.) at 2 timings (D1 (GS11-12) and D2 - 10 days after D1). These programmes were aimed at investigating the impact of no insecticide treatment on yield and also controlling the gout fly infestation in the contrasting crops to support future guidelines.

Table 5. Experiment 2a treatments at the Bury St Edmunds site. 2002-2003

Trt No.	Seed Trt	Drilling Date:	Seed Rate:	Insecticide Program:
1	[a]Sibutol	04/09/2002	Low	
2	Sibutol	04/09/2002	Low	[b]Fernpath Banjo 0.25 D1
3	Sibutol	04/09/2002	Low	Fernpath Banjo 0.25 D2
4	Sibutol	04/09/2002	High	
5	Sibutol	04/09/2002	High	Fernpath Banjo 0.25 D1
6	Sibutol	04/09/2002	High	Fernpath Banjo 0.25 D2
7	Sibutol	20/09/2002	Low	
8	Sibutol	20/09/2002	Low	Fernpath Banjo 0.25 D1
9	Sibutol	20/09/2002	Low	Fernpath Banjo 0.25 D2
10	Sibutol	20/09/2002	High	
11	Sibutol	20/09/2002	High	Fernpath Banjo 0.25 D1
12	Sibutol	20/09/2002	High	Fernpath Banjo 0.25 D2
13	Sibutol	04/10/2002	Low	
14	Sibutol	04/10/2002	Low	Fernpath Banjo 0.25 D1
15	Sibutol	04/10/2002	Low	Fernpath Banjo 0.25 D2
16	Sibutol	04/10/2002	High	
17	Sibutol	04/10/2002	High	Fernpath Banjo 0.25 D1
18	Sibutol	04/10/2002	High	Fernpath Banjo 0.25 D2

[a] Sibutol - a.i. bitertanol + fuberidazole (Bayer Crop Science)
[b] Fernpath Banjo – a.i. cypermethrin (Agriguard Ltd.)
D1 – GS11-12, D2 10 days after D1.
Low seed rate = 150 seeds/m^2
High seed rate = 350 seeds/m^2

Year 2 2003-04. Experiment 2b was carried out at both Bury St Edmunds and Oxford sites.

Following discussions with farm managers at Cereals 2003 and Agronomists' Alliance members it became apparent that the biggest concern was not necessarily gout fly infestation in strong healthy crops with well timed nitrogen inputs but thinner crops where compensatory tillering may not occur either due to the variety or poorly timed nitrogen inputs. For this reason, experiment 2b in year 2 was modified to reflect these concerns. Two varieties were selected with high tillering (Consort) and low tillering (Napier) habits these were then sown at two seed rates, low (150 seeds/m^2) and high, (350 seeds/m^2), with 0, 60 or 120 kg N/ha early (final total N was equal in all treatments – 200kgN/ha – Table 7) and with or without an early PGR treatment (Terpal 1.0 l/ha at GS30) (Table 6). These contrasting inputs were aimed at creating a range of crop canopies which would be more or less able to compensate from attack by gout fly and would support the guidelines to indicate what sort of crop areas would be most at risk. The full experimental layout is given in Appendix 3 and the treatments summarised in Tables 6, 7 & 8.

The intention in this experiment was not to include insecticide treatments, however, it was important to confirm that any yield differences could be attributed either to the physiology of the crop and/or its ability to compensate from a gout fly infestation. For this reason the two experimental areas for Experiment 2a were placed alongside other experiments at both sites which included both varieties and seed rates. The comparable treatments in these neighbouring experiments were Napier and Consort drilled at the high and low seed rates with all plots receiving the same total nitrogen as in Experiment 2b. These plots were then treated with a well timed cypermethrin treatment (i.e. GS11-12).

Table 6. Experiment 2b treatments at Bury St Edmunds and Oxford sites. 2003-04.

Trt No.	**Variety/ N input**	**PGR Early Terpal**	**Seed Rate (seeds/m^2)**
1	Napier - zero N early	Yes	150
2	Napier - 60kg N early	Yes	150
3	Napier - 120 kg N early	Yes	150
4	Napier - zero N early	No	150
5	Napier - 60kg N early	No	150
6	Napier - 120 kg N early	No	150
7	Napier - zero N early	Yes	350
8	Napier - 60kg N early	Yes	350
9	Napier - 120 kg N early	Yes	350
10	Napier - zero N early	No	350
11	Napier - 60kg N early	No	350
12	Napier - 120 kg N early	No	350
13	Consort - zero N early	Yes	150
14	Consort - 60kg N early	Yes	150
15	Consort - 120 kg N early	Yes	150
16	Consort - zero N early	No	150
17	Consort - 60kg N early	No	150
18	Consort - 120 kg N early	No	150
19	Consort - zero N early	Yes	350
20	Consort - 60kg N early	Yes	350
21	Consort - 120 kg N early	Yes	350
22	Consort - zero N early	No	350
23	Consort - 60kg N early	No	350
24	Consort - 120 kg N early	No	350

Table 7. Experiment 2b nitrogen inputs at Bury St Edmunds and Oxford 2003-04.

Variety	GS25	GS30	GS31
Napier	0	100	100
Napier	60	70	70
Napier	120	40	40
Napier	0	100	100
Napier	60	70	70
Napier	120	40	40
Napier	0	100	100
Napier	60	70	70
Napier	120	40	40
Napier	0	100	100
Napier	60	70	70
Napier	120	40	40
Consort	0	100	100
Consort	60	70	70
Consort	120	40	40
Consort	0	100	100
Consort	60	70	70
Consort	120	40	40
Consort	0	100	100
Consort	60	70	70
Consort	120	40	40
Consort	0	100	100
Consort	60	70	70
Consort	120	40	40

Table 8. Experiment 2b treatment timings for Bury St Edmunds and Oxford sites. 2003-04.

Site	Drilling date	GS25 N input	GS 30 N input	GS31 N input	GS30/31 PGR
Bury St Edmunds	08/09/03	09/02/04	06/04/04	05/05/04	20/04/04
Oxford	05/09/03	11/02/04	05/04/04	11/05/04	05/04/04

3.2.4 Assessments.

The dates of all assessments carried out are given in Table 9.

Table 9 Assessment dates for all experiments.

	Plant Est. & gout fly egg count	% plant infestation	LAI	BYDV assessment
2002-03				
Exp. 1 Oxon.	26/09/02	22/02/03	28/05/03	None
Exp 1 BurySEs	24/09/02	13/02/03	04/06/03	03/04/03
Exp .2a BurySEs	24/09/02 (1dd) 09/10/02 (2dd) 24/10/02 (3dd)	13/02/03	02/06/03	03/04/03
2003-04				
Exp 1. Oxon	13/10/03	13/02/04	24/05/04	15/04/04
Exp 1 (Syngenta) BurySEs	06/10/04	04/02/04	21/05/04	05/05/04
Exp.2b Oxon	13/10/04	13/02/04	24/05/04	15/04/04
Exp. 2b BurySEs	06/10/04	02/02/04	21/05/04	05/05/04

dd = drilling date.

Gout fly and parasitoid numbers

At each site and in each season yellow sticky traps were placed in the crop to trap both gout flies and parasitoids. Traps were set up in the field on metal stands to a height of approximately 0.5m surrounded by a wire netting cage to prevent animal damage. Traps were placed in the experimental area (4 traps per area) after crop emergence until the end of October with traps replaced every 7-10 days. The traps were then examined with a dissecting microscope to identify the number of gout fly (*Chlorops pumilionis* – Figure 1) and parasitoids (*Stenomalina micans* & *Coelinus niger* Figures 14 & 15) trapped.

Figure 14. *Stenomalina micans*, gout fly parasitoid.

Figure 15. *Coelinus niger,* gout fly parasitoid.

Plant establishment and gout fly egg counts

In all the experiments in both seasons the number of plants/m^2 and the number of gout fly eggs per plant and per m^2 were determined at GS11-12. Plant numbers were calculated by counting the number of plants in 4 x 0.5m rows selected at random in each plot. The number of gout fly eggs present on these plants was also recorded and expressed as gout fly eggs/m^2 and gout fly eggs/plant.

Plant infestation and parasitised larval numbers

In all the experiments and in each season the number of plants infected with gout fly larvae was assessed at GS25 by taking 3 x 0.1m quadrat samples at random from each plot. The whole plants were removed from within the quadrat and where necessary the plants were washed before assessment. In the lab., the number of plants with one or more infected tillers was counted and expressed as a percentage of plants infected. In most cases the presence of a gout fly larvae within a tiller was easy to identify based on the tale-tale "spring onion like" swelling of the base of the tiller. In cases where infestation with gout fly larvae was uncertain the tiller was dissected in order to establish whether a larvae was present. In some situations where severe levels of infestation had occurred the number of plants with more than one tiller infected was also recorded.

In year 1 of the project, infected plants from all the treatment plots in all experiments were assessed to determine the number of parasitised larvae. In year 2, following the experiences of year 1 only the untreated control plots were examined in the first instance. Depending on the level of parasitised larvae found in these samples, further samples would or would not be examined i.e. if very few parasitised larvae were found in control plots the samples from other treatment plots would not be examined. Parasitised larvae were identified by excising the gout fly larvae and then crushing them on a microscope slide. The presence of parasitoid pupae was then determined under a dissecting microscope. The number of parasitised larvae was recorded.

Leaf Area Index

At GS39-55 in all experiments in both seasons the leaf area index (LAI) of all the treatment plots was determined using a Delta-T Sunscan (Delta-T Devices. Cambs.). For each plot 5 LAI measurements were made across the rows from random positions within the plot.

BYDV assessments

In experiments where BYDV patches were apparent a full assessment of BYDV patches was made.

Harvest Parameters

In order to determine harvest parameters a 0.25m^2 quadrat sample was taken from each plot in all experiments in each season prior to harvest. In areas where BYDV patches had occurred care was taken to avoid these in order to get a measure of the likely impact of the gout fly infestation. The total dry weight of the samples, harvest index, number of ears/m^2, thousand grain weights and number of grains per ear were also determined where necessary. All plots were combined with a Sampo plot combine with a 2m cutter width. Grain moisture was determined and yield corrected to 15% moisture. Specific weight was also determined for all grain samples.

3.2.5 Geographic spread of gout fly.

Three approaches were taken to determine the geographic spread of gout fly and also the occurrence of gout fly parasitoids. In the first year of the project members of the Agronomists' Alliance were asked to comment on the occurrence of gout fly in their geographic area. At Cereals 2003 the project was demonstrated on the HGCA stand and visitors were asked their opinion about the spread of gout fly, their experiences and areas where they felt their crops were most at risk. In both years a range of sites (10 in year 1 & 18 in year 2) were identified that were perceived to be at risk from gout fly (Table 10 & 11). In year 1 the number of trapped gout fly were recorded and the percentage of tillers infected with eggs assessed. In year 2 the number of trapped gout fly and their parasitoids were recorded and the percentage of plants infected assessed. This work was carried out by Jon Oakley (ADAS), some of the work was additionally funded by Dow AgroSciences. Trapping insects, gout fly egg numbers and % plants infested were all assessed as previously described for Experiments 1 & 2 above. NB in year 1 it was the spring generation that was monitored.

Table 10. Trapping site details 2002-2003

Site	Crop	Variety	Sowing date
Clare, Suffolk	Winter Wheat	Claire	12/09/02
Borley, Essex.	Spring Barley	Optic	?
Walsham Le Willows, Suffolk.	Spring Barley	Optic	?
Ixworth, Suffolk.	Winter Wheat	Tanker	17/09/02
Bardwell, Suffolk	Spring Wheat	Paragon	15/01/03
Ixworth Thorpe, Suffolk.	Spring Wheat	Paragon	15/01/03
Tuddenham, Suffolk.	Spring Wheat	Soissons	15/01/03
Shippea Hill, Cambs	Spring Wheat	Paragon	14/03/03
Stuntney, Cambs.	Spring Wheat	Claire	18/02/03
Waterbeach, Cambs	Spring Wheat	Paragon	14/02/03

Table 11. Trapping site details 2003-2004

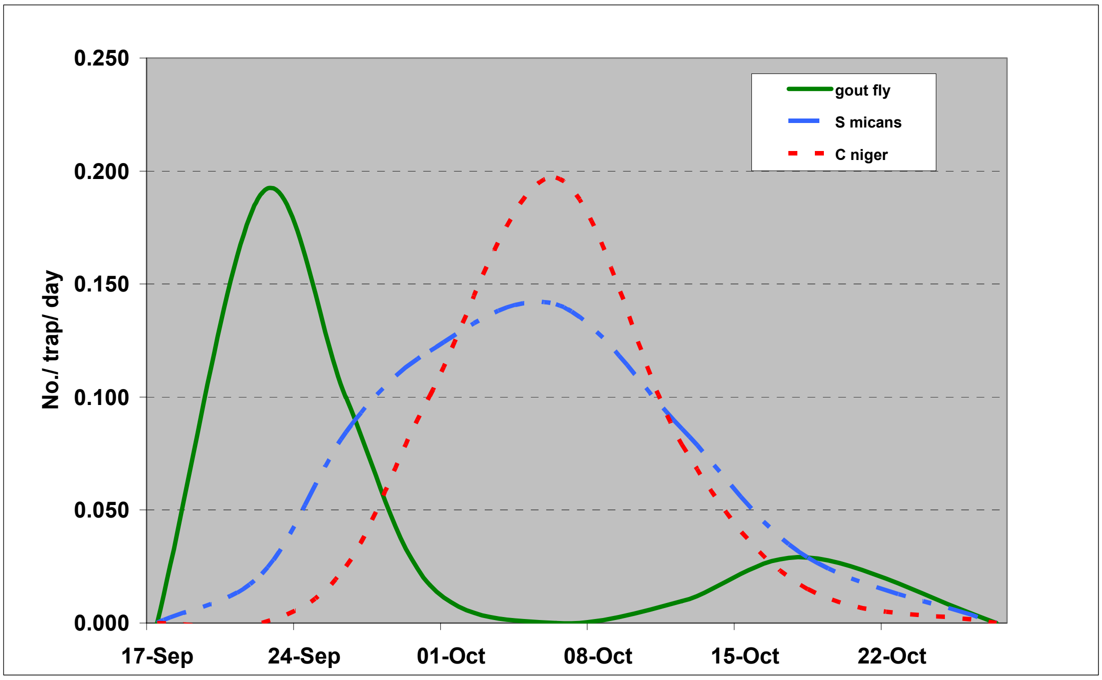
Site	Crop	Variety	Sowing date
Ashley, Suffolk	Winter Wheat	Malacca	19/09/03
Ixworth, Suffolk	Winter Wheat	Claire	24/09/03
Ixworth, Suffolk	Winter Wheat	Claire	24/09/03
Clare, Suffolk	Winter Wheat	Claire	25/09/03
Clare, Suffolk	Winter Wheat	Claire	22/09/03
Belchamp Otten, Suffolk	Winter Wheat	Claire	25/09/03
Belchamp Walter, Suffolk	Winter Wheat	Access	28/09/03
Thaxted, Essex.	Winter Wheat	Claire	23/09/03
Boxworth, Cambs.	Winter Wheat	Claire	16/09/03
Terrington, Norfolk.	Winter Barley	?	17/09/03
Brewood, Staffs.	Winter Wheat	Claire	02/09/03
Catherton, Shrops.	Winter Wheat	Claire	10/09/03
Much Wenlock, Shrops.	Winter Wheat	Claire	08/09/03
Trysull, Shrops.	Winter Wheat	Solstice	16/09/03
Upton Magna, Shrops.	Winter Wheat	Claire	23/09/03
Boningdale, Shrops.	Winter Wheat	Claire	15/09/03
Gleadthrope, Shrops.	Winter Wheat	Claire	23/09/03
Driffield, Yorks.	Winter Wheat	Claire	09/09/03

3.3 Results and discussion.

3.3.1 Trapped gout fly and parasitoid numbers

The gout fly and parasitoid numbers trapped per day was broadly similar in year 1 (2002-03) of the study at both sites with 0.09, 0.06 and 0.08 (Oxford) and 0.06, 0.08 and 0.05 (Bury St Edmunds) mean number of individuals trapped/day (*C. pumilionis: S. micans: C. niger* respectively). In year 2 (2003-04) the gout fly numbers were higher at the Bury-St Edmunds site than the Oxford site (no gout fly were trapped in Oxford) and parasitoid numbers were generally very low (<3 parasitoids in total). The time of trapping of the gout fly in relation to the parasitoids for year 1 is summarised in Figure 16. It can be seen that the gout fly are the first to appear increasing in number through time, followed after 2-3 weeks by the increase in number of the two parasitoid species, *S. micans* and *C. niger*. The patterns of population development in both parasitoid species were reasonably synchronous but the actual levels of *C. niger* were higher. As the numbers of parasitoids increased so the number of gout flies decreased. It is encouraging that parasitoids were present in both years but the duration of the study was too short to provide a true indication of the population dynamics of both the pest and the parasitoids.

Figure 16. Population dynamics of gout fly (*C. pumilionis)* and the parasitoids *S. micans* and *C. niger* (Oxford and Bury St Edmunds data combined (2002)).



3.3.2 Experiment 1. ***To establish an economic threshold and treatment window for the control of the autumn generation of gout fly using commercially available products.***

Plant establishment

The effect of seed treatment on plant establishment was only significant in one of the four experiments over the two years. At the Oxford site in 2002-03 Sibutol Secur significantly ($P<0.01$) increased the number of plants/m^2 compared with the Sibutol alone seed treatment with 240 and 208 plants/m^2 respectively. The reason for this is unclear but it is believed that the presence of Secur helped to reduce slug damage.

Gout fly egg counts

In 2002-03 the number of gout fly eggs/m^2 and eggs/plant were significantly reduced ($P<0.001$ and <0.01 respectively) with the addition of Secur to the Sibutol seed treatment at the Bury St Edmunds site (Figure 17 & Table 12). In contrast, at the Oxford site there was a significant increase in the number of gout fly eggs/m^2 in the Sibutol Secur treatment compared with the Sibutol alone treatment. This is likely to be an artefact of the significant increase in plant numbers/m^2 in this treatment rather than as a result of the Secur (as described above). This is supported by the fact that the number of gout fly eggs/plant was not significantly different between treatments (Table 12).

In 2003-04 gout fly numbers were very low at the Bury St Edmunds site and no differences in gout fly egg numbers either per m^2 or per plant were observed. At the Oxford site, where gout fly numbers were higher, Sibutol Secur and Beret Gold + TMX treatments both significantly reduced the number of eggs/m^2 and eggs/plant ($p<0.001$) in comparison with Beret Gold alone (Table 12).

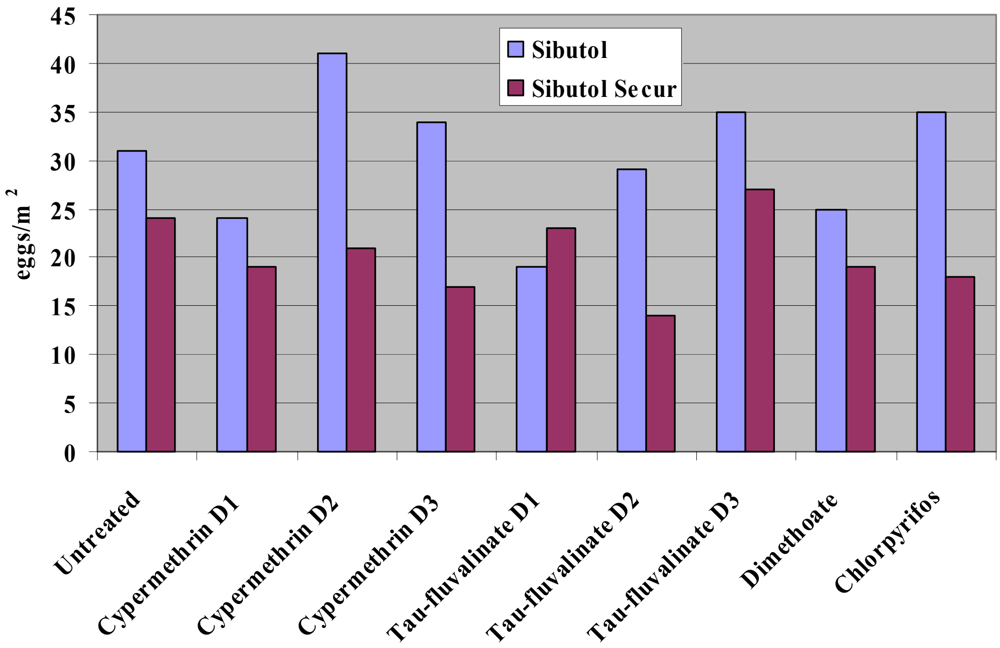


Figure 17. Gout fly eggs/m^2 at the Bury St Edmunds site in experiment 1, 2002-‘03 (5% LSD = 12).

Table 12. Factorial data analysis of mean eggs/m^2 and eggs/plant from all experiment 1 sites in 2002-03 and 2003-04.

Seed treatment	Mean eggs/m^2	Mean eggs/plant
BurySEs 2002-03		
Sibutol	30	0.14
Sibutol Secur	20	0.10
Probability	<0.001	<0.01
5% LSD	12	0.056
Oxon 2002-03		
Sibutol	113	0.55
Sibutol Secur	144	0.60
Probability	<0.001	nsd
5% LSD	34	na
BurySEs 2003-04		
Sibutol	7	0.04
Sibutol Secur	5	0.03
Sibutol + TMX	4	0.02
Probability	nsd	nsd
5% LSD	na	na
Oxon 2003-04 (Syngenta)		
Beret Gold	103	0.62
Beret Gold + TMX	77	0.45
Sibutol Secur	85	0.50
Probability	<0.001	<0.001
5% LSD	17.7	0.11

Percentage plant infestation

In 2002-03 the % plants infested with gout fly larvae was significantly reduced (p<0.001) in the Sibutol Secur treatment as compared with the Secur alone at Bury St Edmunds with and without foliar insecticide treatment (Table 13 and Figure 18). This is likely to be due to the reduction in egg numbers/plant already described (Table 11). In contrast, no differences in % infested plants was found between treatments at the Oxford site which was perhaps not surprising given that there were no differences in egg numbers/plant (Table 13 and Figure 19).

The effect of spray timing at both sites in 2002-03 had a large effect on the % plants infested with the D1 timing (GS11-12) significantly reducing (P<0.001) the % of plants infested compared with the two other timings (D2 10DAT1 & D3 20DAT1). The choice of pyrethroid did not have a significant effect on % plant infestation and the use of both Danadim (a.i. dimethoate) and Cyren (a.i. chlorpyrifos) at the D3 timing gave no better control of gout fly than either pyrethroid applied at the same timing despite their systemic activity (Figure 18 & 19).

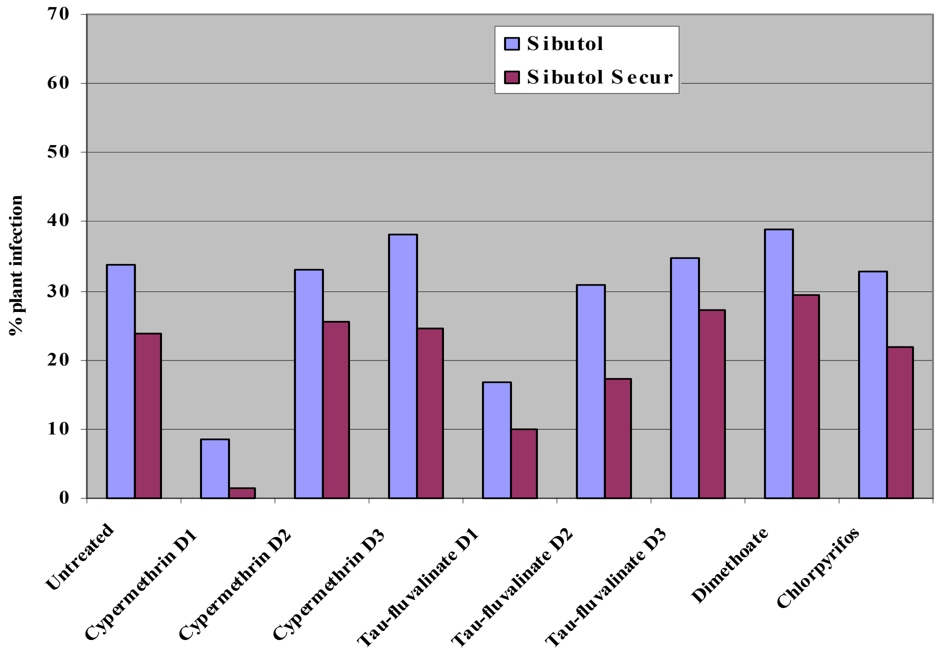


Figure 18. Percentage plant infestation at the Bury St Edmunds site, 2002-03. (5% LSD = 10.03).

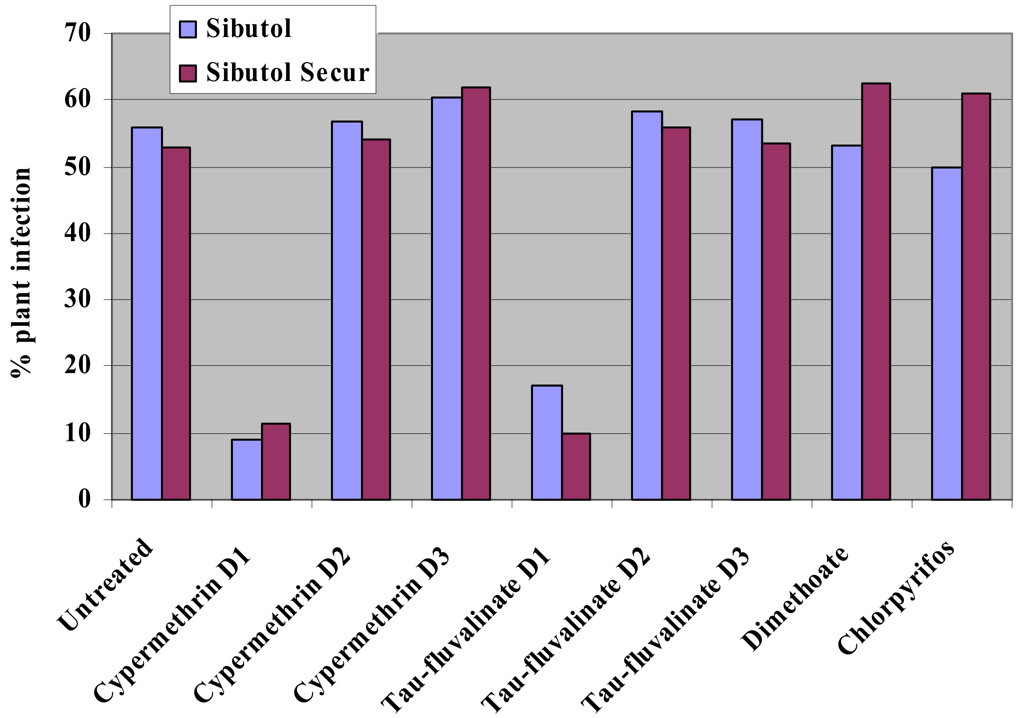


Figure 19. Percentage plant infestation at the Oxford site, 2002-03. (5% LSD = 14.90)

Table 13. Factorial data analysis of % plants infested from both experiment 1 sites in 2002-03.

	BurySEs 2002-03	**Oxon 2002-03**
Seed treatment		
Sibutol	27.0	43.1
Sibutol Secur	17.7	41.1
Probability	<0.001	0.447
5% LSD	4.37	na
Insecticide		
Fernpath Banjo (Cypermethrin)	21.9	42.3
Mavrick (Tau-fluvinate)	22.8	41.9
Probability	0.675	0.886
5% LSD	na	na
Timing		
GS11	9.2	11.9
+ 10 days	26.7	56.3
+ 20 days	31.1	58.2
Probability	<0.001	<0.001
5% LSD	4.37	6.39

In 2003-04, following the factorial analysis of the data from the assessment of the percentage plants infested with gout fly larvae at the Oxford site, no significant differences were found between seed treatments; insecticide product or treatment timing. This was perhaps not surprising as gout fly numbers were low and there were no difference in egg numbers/plant.

In contrast, at the Bury St Edmunds site in 2003-04, where gout fly numbers were higher, the % plants infested was significantly reduced ($P<0.001$) in the Syngenta seed treatment experiment (Figure 20). It is possible that the reduced numbers of eggs/plant resulting from the Beret Gold + TMX and Sibutol Secur treatments, compared with the Beret Gold alone, helped to reduce the subsequent % plants infested. Due to the design of the experiment it is difficult to determine whether the application of the cypermethrin treatment at D2 or D3 had an additional effect on reducing the number of plants infested as these primarily targeted BYDV. However, in the Beret Gold seed treatment there was no difference in the % plants infested with or without a cypermethrin treatment, this tends to suggest that the cypermtherin D2 and D3 treatments on the two other seed treatments had little or no effect on the percentage of plants infested. It is therefore likely that the main reduction in infested plants was due to the reduction in egg numbers as a result of the seed treatment.

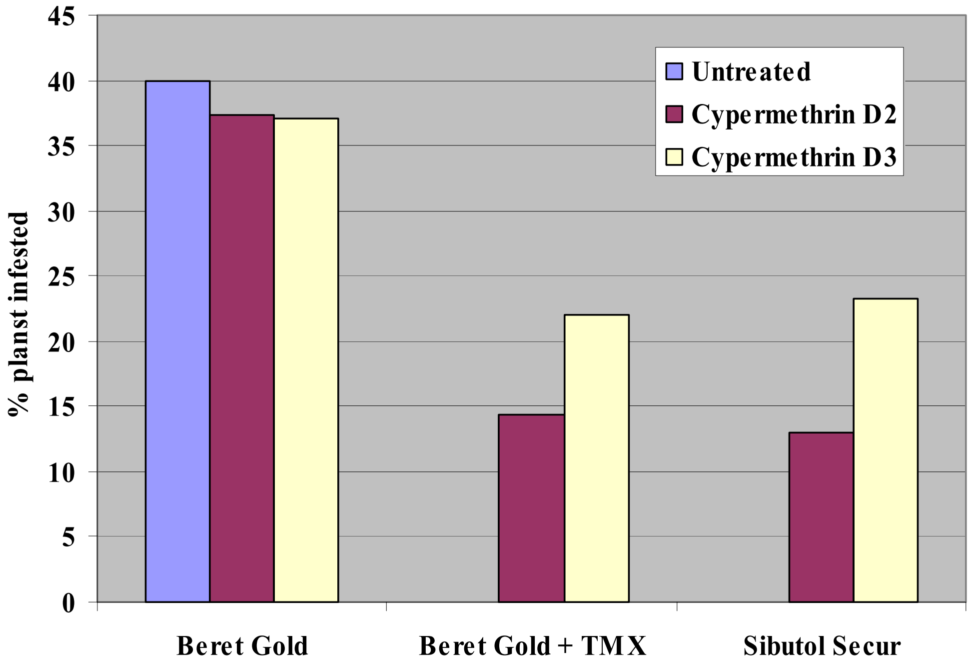


Figure 20. Percentage plants infested at the Bury St Edmunds site 2003-04 (5% LSD = 13.49) (Syngenta funded experiment).

BYDV

The occurrence of BYDV patches was found to be significantly higher ($p<0.001$) in treatments with the Sibutol seed treatments as compared with those treated with Sibutol Secur in year 1 (2002-03) of the project at both sites (Figure 21). However, in year 2 no differences in the levels of BYDV were found between seed treatments on either site.

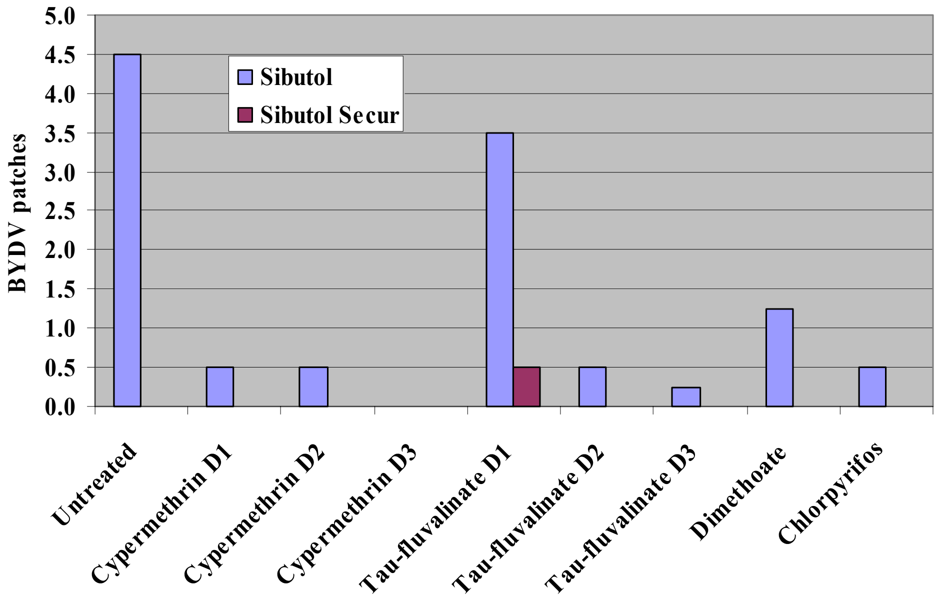


Figure 21. Percentage of BYDV patches at the Bury St Edmunds site in experiment 1, 2002-'03. (5% LSD = 0.99)

Leaf Area Index

In all the experiments carried out there was no significant difference in LAI at either site.

Yield

Following the factorial analysis of yield data in 2002-03 there was found to be a significant difference between seed treatment yields at the Bury St Edmunds site (P<0.01) (Table 14) and between insecticide timings at the Oxford site (p<0.001). However, it is important to bear in mind that the levels of BYDV had also been found to be significantly lower in the Secur seed treatments (Figure 21). In order to establish the reason for the yield differences harvest parameters such as grain number/ear, thousand grain weight and harvest index were all assessed. When sampling for the harvest parameters care was taken to take quadrat samples from areas which did not include BYDV infected plants (these were marked in the field using canes). If differences were found between treatments in these samples then it was likely they would be due to gout fly rather than BYDV.

Following analysis of all the harvest parameter data no significant differences in any of the parameters was found for either site (Appendix 4). It is therefore reasonable to assume that any yield difference can be attributed to BYDV rather than gout fly infestation. This finding is further supported by comparing yields in treatments which had different insecticide timings. In Figures 18 & 19 a comparison of D1 treatments with D2 and D3 treatments shows that despite 1-20% and 40%

differences in the percentage plants infested (Bury St Edmunds and Oxford respectively) no significant differences in yield were found between treatments (Figures 22 & 23).

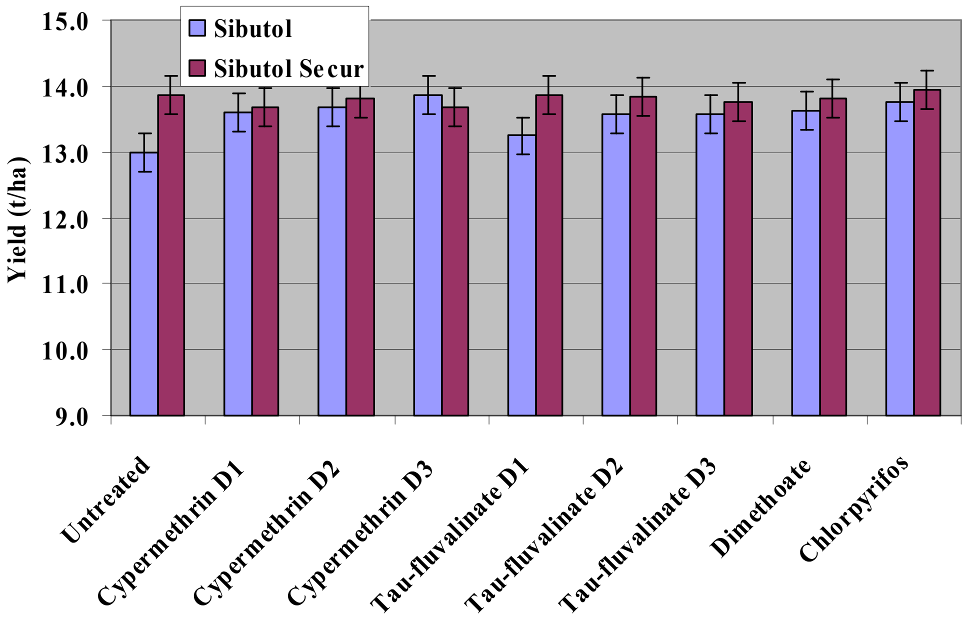


Figure 22. Yield (t/ha) at the Bury St Edmund site, 2002-'03 (5% LSD = 0.29).

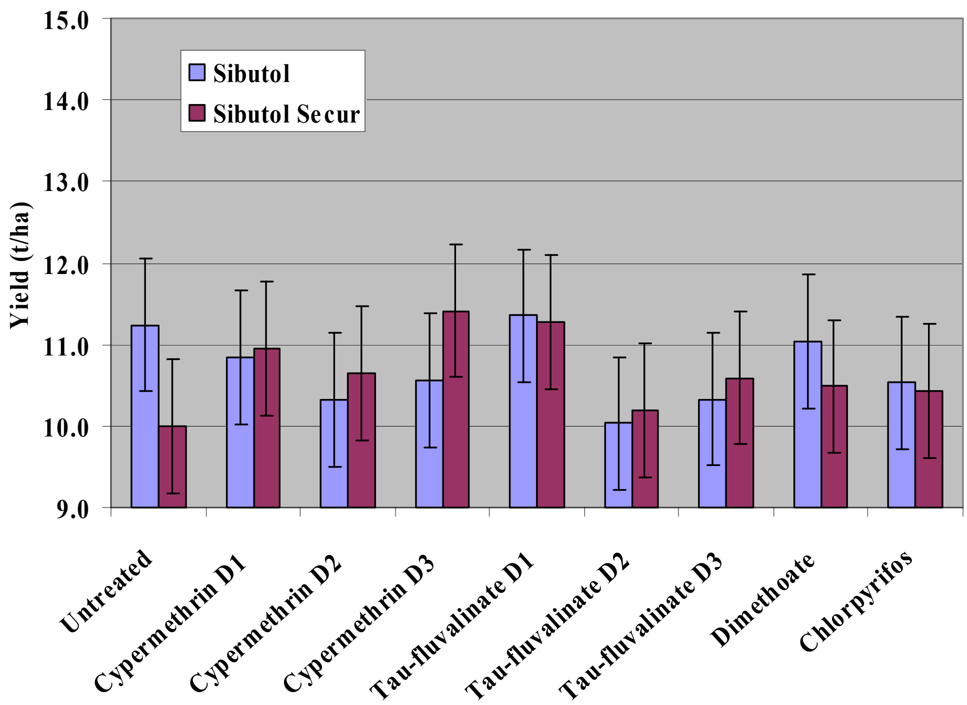


Figure. 23 Yield (t/ha) at the Oxford site, 2002-'03 (5% LSD = 0.819).

Table 14. Factorial data analysis of yield (t/ha) of experiment 1 in 2002-03.

	BurySEs 2002-03	**Oxon 2002-03**
% CV	1.9	5.4
Seed treatment		
Sibutol	13.59	10.57
Sibutol Secur	13.77	11.01
Probability	<0.01	0.016
5% LSD	0.351	0.119
Insecticide		
Fernpath Banjo (Cypermethrin)	13.72	10.79
Mavrik (Tau-fluvinate)	13.64	10.79
Probability	0.230	0.969
5% LSD	na	na
Timing		
GS11	13.60	11.10
+ 10 days	13.72	10.30
+ 20 days	13.72	10.97
Probability	0.157	<0.001
5% LSD	na	0.429

In 2003-04 it was perhaps not surprising to find no significant difference in harvest yield data (% CV = 2.7%) or harvest parameters at the Oxford site in Experiment 1 as no differences in eggs/plant or % infested plants was found. However, despite a significant reduction in % infected plants (15-29 % Figure 20) in the Syngenta seed treatment experiment no differences in yield (% CV = 2.9%) or harvest parameters were found. This suggests that despite over 40% plants infested in untreated plots, the plants were able to compensate resulting in no significant yield loss. There is clearly no relationship between the % of plants infested with gout fly and yield as demonstrated in Figure 25. Although there would be expected to be yield differences between sites and season if the % plants infested with gout fly was having a significant impact on yield then the relationship between the two would be expected to have a better fit than an R^2 = 40. From Figure 25 it can be seen that yields of between 13-14t/ha can still be achieved in some cases even with the % plants infested over 40%.

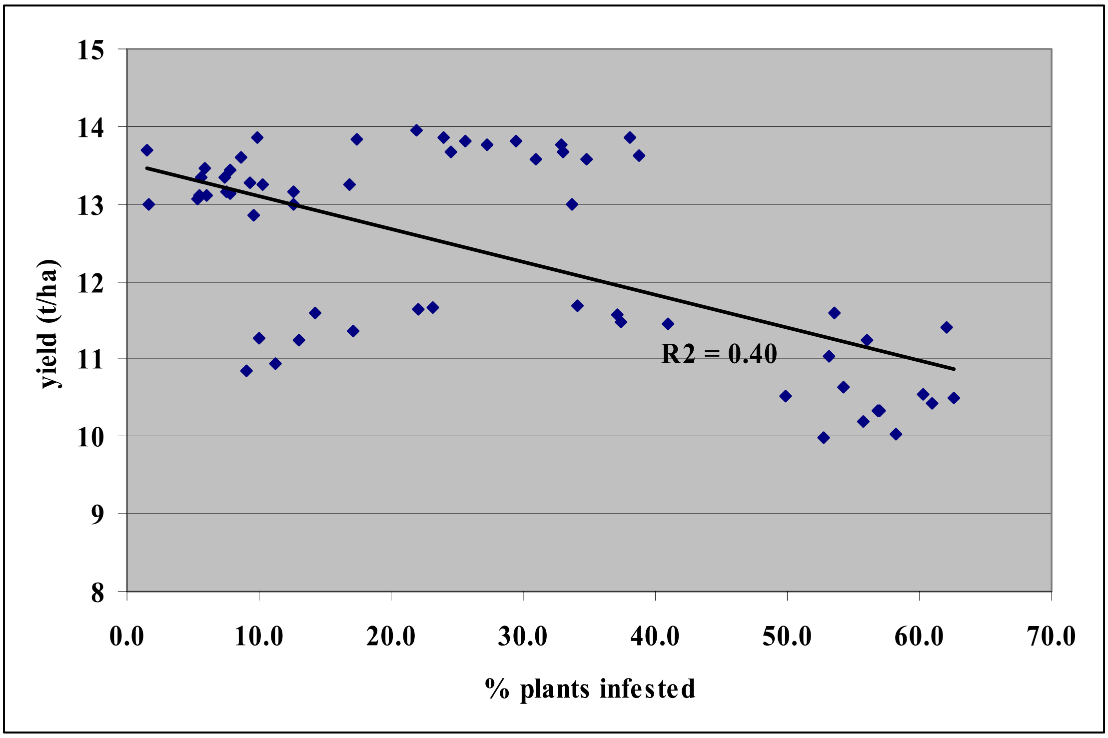


Figure 25. Regression analysis of yield data with % plants infested from Experiment 1 data.

3.3.3 Experiment 2a. *Evaluation of crops most at risk from the autumn generation gout fly:- Effect of plant population.*

Percentage plants infected

In Experiment 2a it was apparent that the early drilled, low seed rate plots were most at risk from attack by gout fly. In the early drilled, low seed rate treatment over 50% of plants were infested. Levels of gout fly were significantly lower in both the mid. Sept. and early Oct. drilled plots, with no plants infected in the latter. The higher seed rate (in untreated plots) had 20% less plants infested.

This experiment also demonstrated the importance of insecticide timing. In both the high and low seed rates the D1 (GS11-12) insecticide timing significantly reduced the % plants infested. The D2 treatment did reduce the % of plants infested but not significantly (Figure 26, Table 15).

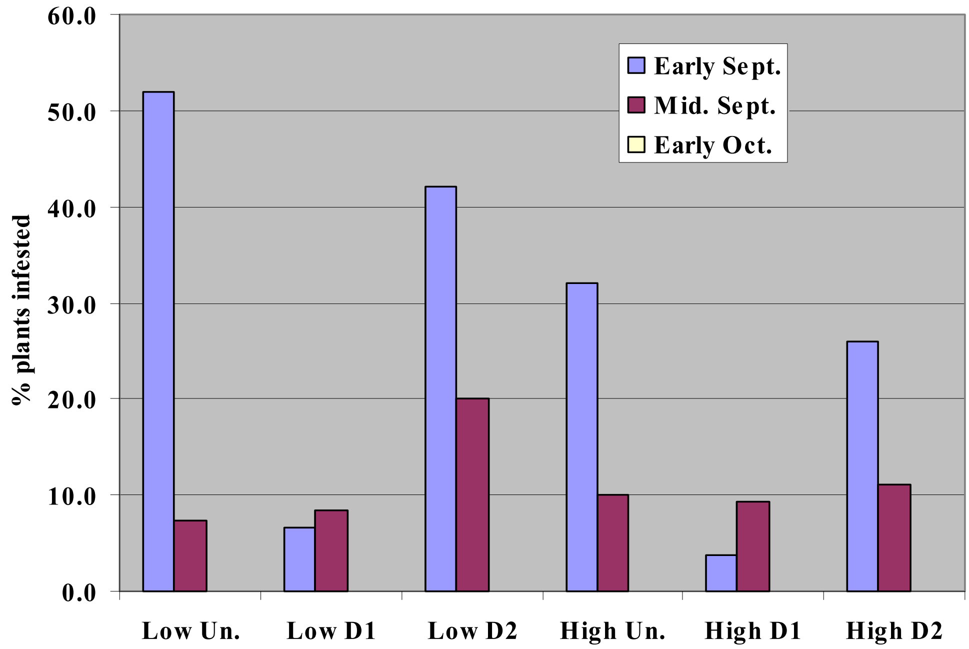


Figure 26. Percentage plants infested in Experiment 2a comparing drilling date, seed rate and insecticide timing at the Bury St Edmunds site (2002-03) (5% LSD = 12.26).

Yield

Comparison of the untreated yields within both the high and low seed rate treatments with the respective D1 and D2 treatments at each sowing date demonstrated that in no case did gout fly significantly reduce yields (Figure 27). Not surprisingly, there were significant difference between drilling date and seed rate but this was a physiological response rather than as a result of gout fly.

In the majority of harvest parameters there was also no differences found. However, grains/ear were significantly reduced ($P<0.001$) in the low seed rate, untreated plots drilled in early Oct. as compared with the corresponding D1 and D2 treatments. It should be noted that at this drilling date no gouted tillers were found, it can therefore be assumed that the reduction in grains/ear was due to another factor such as BYDV (Figures 26 & 28).

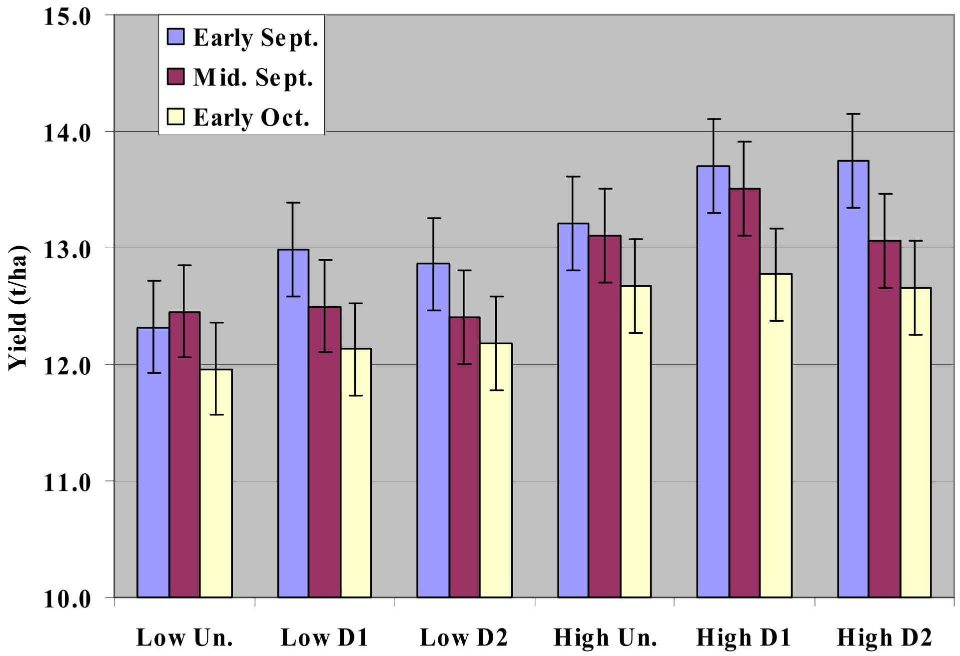


Figure 27. Yield (t/ha) in Experiment 2a comparing drilling date, seed rate and insecticide timing at the Bury St Edmunds site (2002-03).

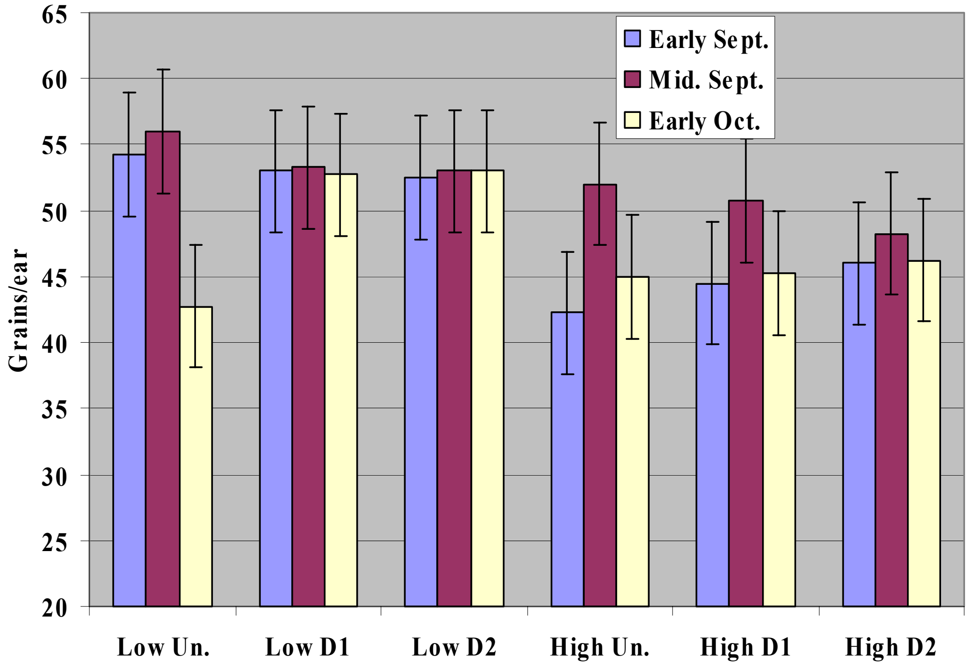


Figure 28. Grains/ear in Experiment 2a comparing drilling date, seed rate and insecticide timing at the Bury St Edmunds site (2002-03).

Table 15. Factorial data analysis of % plant infestation, LAI and yield data in Experiment 2a, Bury St Edmunds site (2002-03).

	% plant infestation	**Leaf Area Index**	**Yield**
Drilling date			
Early Sept.	27.1	5.165	13.136
Mid. Sept.	11.1	4.675	12.837
Early Oct.	0	4.207	12.394
Probability	<0.001	<0.001	<0.001
5% LSD	5.01	0.2786	0.165
Seed rate			
Low (150seeds/m^2)	15.2	4.301	12.42
High (350 seeds/m^2)	10.3	5.064	13.158
Probability	0.02	<0.001	<0.001
5% LSD	4.09	0.2275	0.135
Insecticide timing			
Untreated	16.9	4.506	12.619
D1	4.7	4.767	12.931
D2	16.5	4.774	12.816
Probability	<0.001	nsd	<0.01
5% LSD	5.01	na	0.1648
Interaction F-Test Prob.			
Drilling date *seed rate	0.024	0.661	0.384
Drilling date * insecticide timing	<0.001	0.994	0.038
Seed rate * insecticide timing	0.302	0.904	0.783
Drilling date * seed rate * insecticide timing	0.434	0.889	0.627

3.3.4 Experiment 2b *Evaluation of crops most at risk from the autumn generation of gout fly:- Effect of variety and management practice.*

The aim of these experiments was to determine whether following gout fly infestation the plants were able to compensate under different physiological conditions i.e. with delayed nitrogen, in low or high tillering varieties, with or without early PGR applications. The ability of the crop plants to compensate could be measured within each variety by measuring Leaf Area Index and by comparing final crop yield.

Gout fly egg counts and % plant infestation

At the Bury St Edmunds site there were significant differences (P = <0.01) in the number of gout fly eggs/m^2 between seed rates and between varieties. In the Napier treatments low seed rates had 129 eggs/m^2 compared with the high rate with 173 eggs/m^2. In the Consort treatments the low seed rate had 178 eggs/m^2 compared with the high seed rate with 207 eggs/m^2. However, these differences did not seem to be translated into differences in % plant infestation as there was no significant difference between treatments: % plant infestation was 37% (low seed rate – Napier), 37 % (high seed arte – Napier, 46% (low seed rate – Consort), 38 % (high seed rate- Consort).

At the Oxford site, in contrast to the previous year, there were very low levels of gout fly. In none of the treatments were there any significant differences in either the number of gout fly eggs/m^2 (maximum 5 eggs/m^2) or the % of plants infected (maximum 25%).

In order to make direct comparisons with treated plots % plants infested were determined in additional plots which were part of neighbouring experiment. These plots (Napier, high and low seed rates and Consort high and low seed rates) received a well timed Cypermethrin treatment at GS11-12. At the Bury St Edmunds site, the mean % infested tillers was 10% (+/- 2.1%) and at the Oxford site 5% (+/- 1.6%).

LAI and Yield

Although both LAI and yield were significantly different (P<0.001) between varieties and seed rates, there were no significant differences between nitrogen application timings. Thus although the LAI of the crop canopies was significantly different between nitrogen regimes i.e. 4.23 – 5.49 (Bury St Edmunds) and 5.22 – 6.21 (Oxford) this was not sufficient to result in yield differences. Similarly, the only significant differences (p=<0.001) in harvest index and specific weight were between varieties.

Yields at the Oxford site followed the expected pattern of Consort having higher yields than Napier and the higher seed rate higher yields than the low seed rate. Differences in the early N regime did not result in any significant yield differences. None of the yield differences could be attributed to gout fly as levels were too low at the experimental site (Table 16 & Figure 30).
Yields at the Bury St Edmunds site followed a similar patter to those at the Oxford site i.e. Consort higher than Napier and high seed rate higher than low seed rate. Again, there were no differences between early N regimes suggesting that the crop was able to compensate at a later stage. The intention in this experiment was not to include insecticide treatments, however, it was important to confirm that yields differences could be attributed to the physiology of the crop and its ability to compensate from a gout fly infestation. For this reason the two experimental areas for Experiment 2a were placed alongside other experiments which included both varieties and seed rates. The comparable treatments in these neighbouring experiments were Napier and Consort drilled at the high and low seed rates with all plots receiving the same total nitrogen. These plots were then treated with a well timed Cypermethrin treatment (i.e. GS11-12). From comparison of these data with those in Experiment 2b it suggests that either the levels of gout fly at the Bury St Edmunds site were not higher enough to result in a significant yield loss or that the plants were able to compensate. Yield differences that were observed were most likely to be attributable to physiological differences between varieties and seed rate (Table 16 & Figure 29)

Table 16. Yield (t/ha) (+/- SEs) of neighbouring plots to Experiment 2b experiments following a well timed Cypermethrin spray application at GS11/12.

Treatment	BurySEs	Oxon.
Napier – Low seed rate	9.42 +/- 0.32	11.35 +/- 0.44
Napier High seed rate	9.87 +/- 0.41	11.63 +/- 0.43
Consort Low seed rate	10.53 +/- 0.35	11.96+/- 0.52
Consort High seed rate	10.71 +/- 0.42	12.23 +/- 0.39

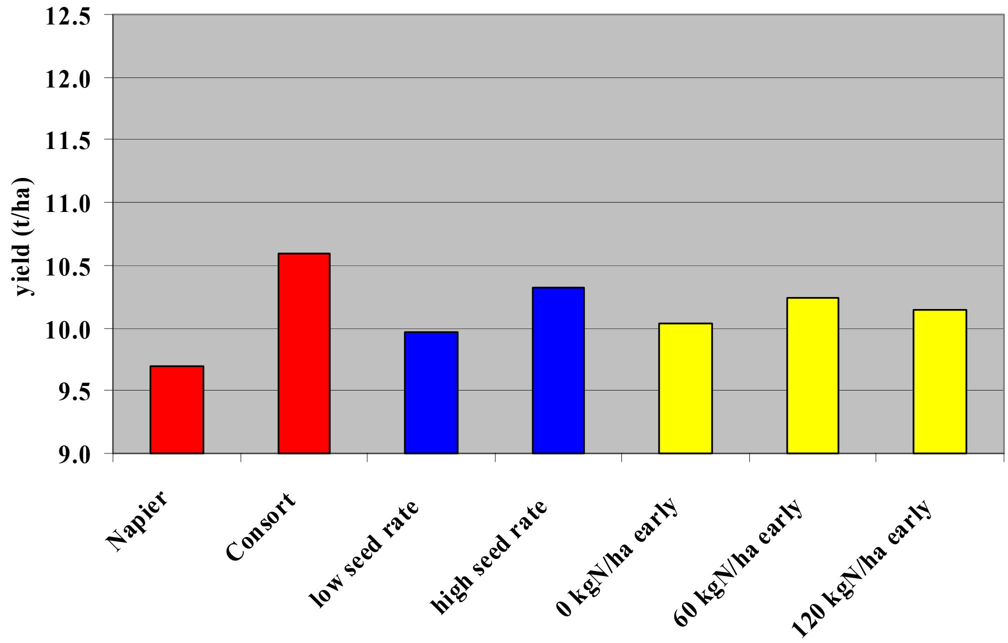


Figure 29. Factorial analysis of yield (t/ha) at the Bury St Edmunds site for Experiment 2b (Variety 5% LSD = 0.136, Seed rate 5% LSD = 0.136, Early N regime 5% LSD na.).

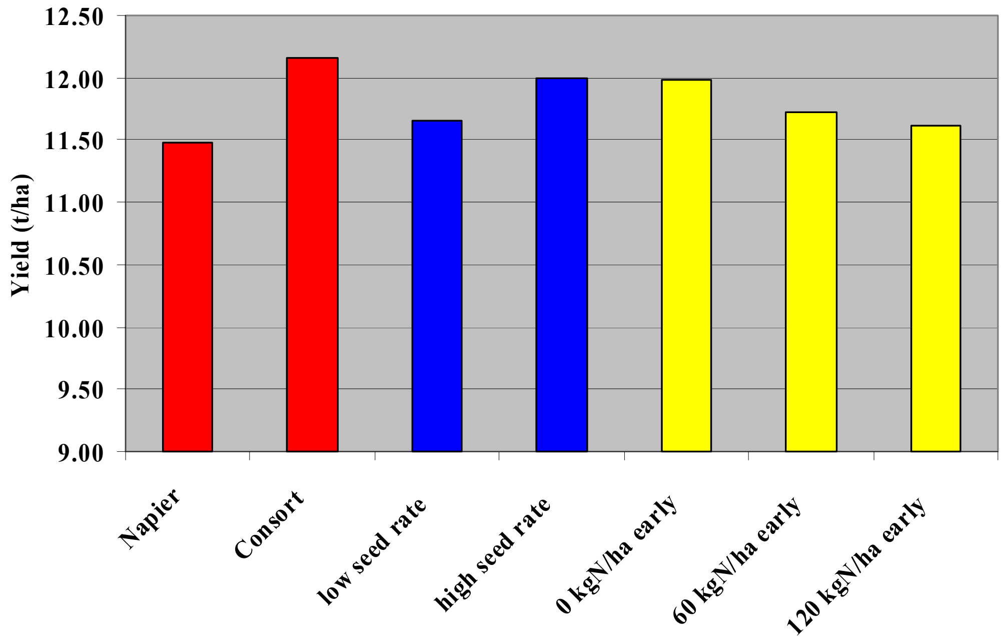


Figure 30. Factorial analysis of yield (t/ha) at the Oxford site for Experiment 2b (Variety 5% LSD = 0.170, Seed rate 5% LSD = 0.170, Early N regime 5% LSD na.)

3.3.5 Geographic spread.

Following responses from HGCA Agronomists' Alliance members and contact with visitors at Cereals 2003 it was apparent that large numbers of farm managers in England had at some time in 2001, 2002 and/or 2003 seen gout fly eggs or infested tillers in their fields. The geographic range seem to be across the majority of England reaching as far north as Humberside and Yorkshire, to the east in Lincolnshire, Norfolk and East Anglia, to the west in Worcestershire and Oxfordshire and in the south east in Kent and Suffolk and the south west in Wiltshire. Interestingly, no reports were received from Scotland, Wales or Northern Ireland. Several people from the south of England commented that they had had problems with both the autumn and spring generation. Many felt that although the autumn generation was more common, when they experienced the spring generation in spring crops it had a more devastating effect. Although this project focused on the autumn generation, the spring generation should not be ignored.

As can be seen in Table 17, large numbers of the spring generation of gout fly were trapped in some areas in 2003, most notable were Suffolk and Cambridgeshire. However, despite the large numbers of trapped gout flies the numbers of tillers/plants (%) infested with gout fly eggs was small (Table 18), this may have been due to adverse weather conditions or the presence of crop areas more favourable for egg laying.

Table 17. Number of spring generation trapped gout fly 2003.

	Mean	Gout flies	Per trap	Week	Ending…	
Site	**29/04/03**	**07/05/03**	**13/05/03**	**20/05/03**	**27/05/03**	**03/06/03**
Clare, Suffolk	0	11	131	48	35	9.5
Borley, Essex.	0	1.5	14.5	11	8	8
Walsham Le Willows, Suffolk.	0	0	0	0.5	1	0.5
Ixworth, Suffolk.	0	4.5	15	2	0.5	0
Bardwell, Suffolk	0	0	4	1.5	0.5	0
Ixworth Thorpe, Suffolk.	0	5	303.5	201	223.5	375
Tuddenham, Suffolk.	0	46	337	100.5	367.5	37
Shippea Hill, Cambs	0	0	19.5	27.5	23.5	227
Stuntney, Cambs.	0	12	183	106.5	38.5	735
Waterbeach, Cambs	0	27	434.5	448.5	1225	1226
Mean across sites	**0**	**10.7**	**144.2**	**94.7**	**192.3**	**261.6**

Table 18. Number of tillers (or *plants) with spring generation gout fly eggs 2003.

	%	tillers	(*plants)	with eggs	week	ending..
Site	**29/04/03**	**07/05/03**	**13/05/03**	**20/05/03**	**27/05/03**	**03/06/03**
Clare, Suffolk	0	0	0	0	2	0
Borley, Essex.	0	0	*0	*2	0	0
Walsham Le Willows, Suffolk.	0	0	*0	0	0	0
Ixworth, Suffolk.	0	0	0	0	0	0
Bardwell, Suffolk	0	0	0	0	4	0
Ixworth Thorpe, Suffolk.	0	0	15	42	34	36
Tuddenham, Suffolk.	0	0	8	22	18	8
Shippea Hill, Cambs	0	0	*0	0	0	0
Stuntney, Cambs.	0	0	2	20	2	2
Waterbeach, Cambs	0	0	2	46	20	22
Mean across sites	**0**	**0**	***2.7**	***13.2**	**8**	**6.8**

*50 plants examined owing to early growth stage.

Data from the field survey in 2003-04 demonstrated that gout fly were present at a range of sites (Table 19). It was encouraging to find parasitoids at some of these sites although their numbers were variable. Of the two gout fly parasitoid species *S. micans* was the most common, very few wasps of *C. niger* were found. The distribution of parasitoids geographically did seem to relate to areas where gout fly had been recorded over a longer period of time. Although only preliminary data, it may be the case that parasitoid numbers had not had the opportunity to build up in areas where gout fly had only just become established (Figure 31). For example, in Cambridgeshire and Suffolk where gout fly have been recorded for several years, parasitoids were found. In contrast, in Shropshire, Staffordshire, Northampton and Yorkshire where gout fly have been less common, few parasitoids were found. Future survey may help to support these observations (Figure 31).

Table 19. Trapped gout fly and parasitoids and the resulting percentage of infested plants 2003-2004.

Site	***Gout fly**	***S. micans***	***C.niger***	**% infested plants**
Ashley, Suffolk	50.5	6.5	0	66
Ixworth, Suffolk	11	12.5	0	10
Ixworth, Suffolk	20.5	19	0.5	10
Clare, Suffolk	2.5	4.5	0.5	16
Clare, Suffolk	2	4.0	0	6
Belchamp Otten, Suffolk	0.5	1	0.5	6
Belchamp Walter, Suffolk	3.5	9.5	0	5
Thaxted, Essex.	3.5	4	7	13
Boxworth, Cambs.	0.5	15	0.5	8
Terrington, Norfolk.	0	0	0	0
Brewood, Staffs.	1.0	0	0	28
Catherton, Shrops.	3.5	0	0.5	25
Much Wenlock, Shrops.	12.0	0	0.5	20
Trysull, Shrops.	8.5	0	0	92
Upton Magna, Shrops.	3.0	0	0	8
Boningdale, Shrops.	4.5	0	0	12
Gleadthrope, Shrops.	5.5	0	0	24
Driffield, Yorks.	0.5	0	0	20
Mean across sites	**7.5**	**4**	**0.5**	**20**

* *Chlorops pumilionis*.

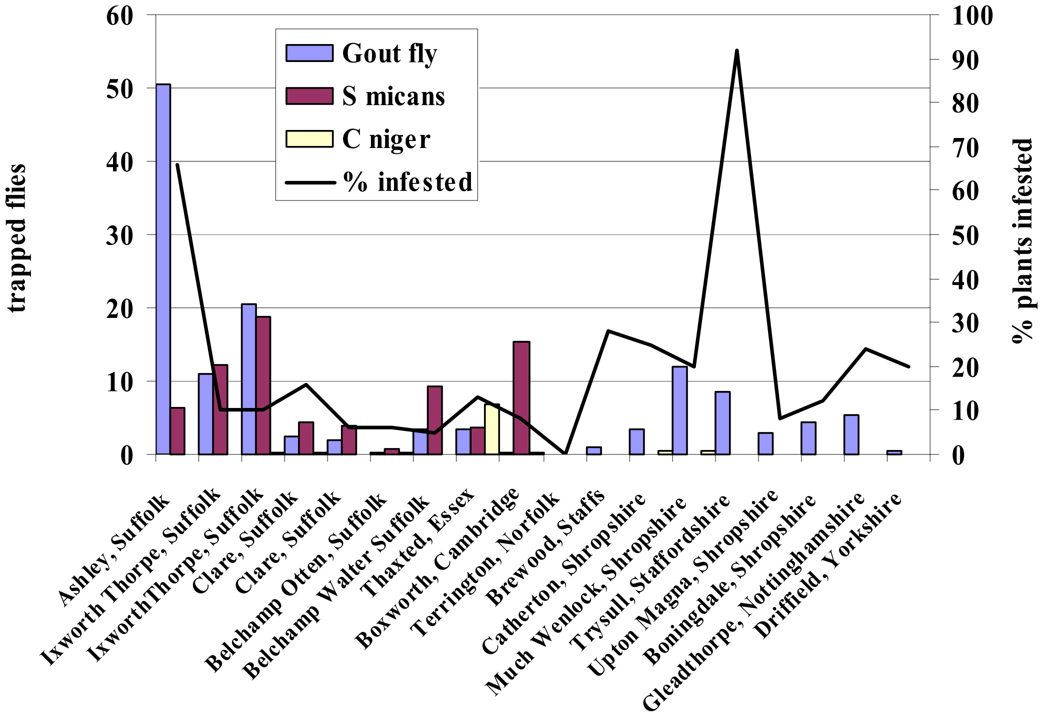


Figure 31. Geographic spread of trapped gout fly and its parasitoids (*S. micans and C. niger*) with % plants infested (2003-04 data).

3.4 Implications for levy payers.

1) Early drilled (early Sept.) crops have been found to be most at risk from gout fly, later drilled (October onwards) are less at risk and in many cases will avoid attack all together.
2) Insecticide seed treatments such as imidacloprid and the new Syngenta product TMX (a.i. thiamethoxam) can reduce gout fly egg numbers and the % of plants infested but only when overall gout fly populations are low (i.e. <40%).
3) The application of insecticide foliar applications can significantly reduce the % plants infested with gout fly but the timing of the application is crucial. The pest should be targeted at the GS11-12 stage, any later and control will be lost. Product choice is not as important as spray timing, a well timed pyrethroid will effectively control gout fly.
4) Despite high levels of gout fly in experiments (50-60% plants infested in some cases), no significant loss of yield was recorded that could be attributed to gout fly. This was even the case in thinner crops, stressed from low early nitrogen where some impact may have been expected. It seems likely that even at high levels (50-60% plants infested) the crop is able to compensate for the loss of tillers. It must however be remembered again that this study was investigating the autumn gout fly generation and not the spring generation and no comment on the loss of yield due to the spring generation can be made.

5) It seems very likely that in the vast majority of cases there is no need to be concerned about the effect of the autumn generation of gout fly on yield. However, in very high risk areas where an individual may have a concern the best option would be to use an insecticide seed treatment which would give effective control of BYDV whist at the same time reducing the levels of gout fly. Although this would not control the whole population it would reduce the numbers of plants infested.
6) The previous two points can be supported by carrying out a regression analysis of the data in this report. There is no relationship between crop yield and the % plants infested with gout fly.
7) Gout fly populations now seem to be widespread throughout England but not Scotland, Wales or Ireland with population levels varying year on year. Sheltered fields near woodlands are particularly at risk.
8) Parasitic wasp species which act as parasitoids to gout fly have been found at many sites with gout fly present. However, numbers are generally low (*S. micans* > *C. niger*). It may be that parasitoid numbers have not caught up with the progressing gout fly populations.
9) Despite the occurrence of parasitoids on experimental sites the levels of actual parasitism of gout fly was extremely low. It is likely that the parasitoid numbers need to increase significantly if they are to have a significant effect on gout fly numbers.
10) Whilst the recommendations based on this work would be not to treat autumn sown cereals to control gout fly, this could lead to a build up of problems on spring cereals where control is more difficult.

Appendix 1

Field site details.

Cornbury Park Farms.

2002-03.

Field:- Hatching Hill
Variety:- Consort.
Crop:- 1st Wheat.
Total working area:- 18.98ha.

Previous cropping:-	2001/02 Hear Rape 2000/01 Split crop 1999/00 1st Wheat 1998/99 Peas.
Soil analysis:-	Soil pH – 7.9 P index – 1 K index - 2- Mg index – 1
Fertiliser inputs:-	Total N applied – 230 kg/ha Total S applied – 60 kg/ha

2003-04

Field:- Hazelwood
Variety:- Claire
Crop:- 1st Wheat.
Total working area:- 14.328ha.

Previous cropping:-	2001/02 Set aside 2000/01 1st Wheat 1999/00 Hear rape 1998/99 2nd wheat (milling)
Soil analysis:-	Soil pH – 7.6 P index – 2 K index - 3 Mg index – 2
Fertiliser inputs:-	Total N applied – 237 kg/ha Total S applied – 11 kg/ha

Field site details.

Rougham estates.

2002-03.

Field:- Bromes
Variety:- Marshall.
Crop:- 1st Wheat.
Total working area:- 12.94ha.

Previous cropping:-	2001/02 Hear Rape
	2000/01 Winter barley
	1999/00 1st Wheat
	1998/99 Winter beans
Soil analysis:-	Soil pH – 8.1
	P index – 2
	K index - 1
	Mg index – 1
Fertiliser inputs:-	Total N applied – 214 kg/ha
	Total S applied – 20 kg/ha

2003-04

Field:- Lake 207
Variety:- Marshall
Crop:- 1st Wheat.
Total working area:- 4.07 ha.

Previous cropping:-	2001/02 Hear rape
	2000/01 Winter barley
	1999/00 2nd Wheat
	1998/99 1st Wheat
Soil analysis:-	Soil pH – 7.6
	P index – 2
	K index - 1
	Mg index – 0
Fertiliser inputs:-	Total N applied – 191 kg/ha
	Total S applied – 18 kg/ha
	Total P applied – 60 kg/ha
	Total K applied – 60 kg/ha

Appendix 2

Cornbury Oxford.

2002-03

<u>Experiment 1</u>

G	18	3	6	15	10	14	8	5	12	9	11	17	4	7	13	1	16	2	5	1	16	13	8	14	3	11	10	7	2	15	12	17	6	18	9	4	G
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	
G	9	7	4	17	11	15	12	2	10	6	3	18	1	14	8	16	5	13	8	1	14	11	5	2	16	13	4	18	6	15	3	9	12	17	7	10	G
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	

Bury St Edmunds. **Suffolk.**

2002-03

Experiment 1

G G	2	17	13	16	6	11	10	14	1	3	12	15	5	18	8	7	9	4	G G
	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	
G G	10	17	5	12	16	7	11	13	6	14	9	4	2	15	18	3	1	8	G G
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
G G	7	1	9	11	8	14	4	3	18	15	2	13	17	12	6	16	10	5	G G
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
G G	12	6	16	15	2	7	13	17	8	1	14	5	3	10	18	11	4	9	G G
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	

Experiment 2

G G	6	5	2	1	4	3	G G	8	7	11	12	10	9	G G	16	18	15	14	17	13	G G
	55	56	57	58	59	60		61	62	63	64	65	66		67	68	69	70	71	72	
G G	1	6	4	3	5	2	G G	9	7	8	11	10	12	G G	17	15	14	16	13	18	G G
	37	38	39	40	41	42		43	44	45	46	47	48		49	50	51	52	53	54	
G G	2	5	6	4	1	3	G G	12	10	9	11	7	8	G G	16	13	18	15	14	17	G G
	19	20	21	22	23	24		25	26	27	28	29	30		31	32	33	34	35	36	
G G	6	1	3	5	2	4	G G	8	11	10	12	7	9	G G	16	14	13	17	15	18	G G
	1	2	3	4	5	6		7	8	9	10	11	12		13	14	15	16	17	18	

treatment number

plot number

Appendix 3

Cornbury Oxford.

2003-04

Experiment 1

G	1	10	13	3	7	11	8	15	5	2	4	12	14	6	9
	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
G	4	6	7	1	14	2	5	9	13	15	10	8	11	3	12
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
G	3	1	8	7	12	11	9	14	4	10	6	15	2	13	5
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
G	9	4	15	10	8	2	13	5	3	11	14	1	7	12	6
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Experiment 2

22	2	15	7	24	16	14	19	10	5	1	12	20	6	9	4	11	21	18	23	8	13	3	17	G
73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	
9	12	18	11	3	23	6	17	4	20	10	14	24	13	2	19	22	5	16	8	1	7	15	21	G
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	
5	8	24	4	19	16	22	21	7	6	13	15	18	23	11	2	12	20	17	14	1	10	9	3	G
25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
19	15	13	2	17	8	5	22	1	10	23	14	3	21	16	6	9	12	11	24	18	4	20	7	G
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

treatment number

plot number

Bury St Edmunds **Suffolk.**

2003-04

Beret Gold ST **Syngenta** **Experiment 2**

G	2	3	9	6	7	5	8	4	1
	28	29	30	31	32	33	34	35	36
G	8	7	3	1	4	6	2	5	9
	19	20	21	22	23	24	25	26	27
G	4	1	9	2	7	5	6	3	8
	10	11	12	13	14	15	16	17	18
G	6	9	5	3	8	7	1	4	2
	1	2	3	4	5	6	7	8	9

18	3	15	9	7	21	1	22	17	19	5	12	10	13	2	8	16	4	20	14	11	24	6	23	G
73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	
17	8	5	23	11	14	7	18	24	13	2	16	15	9	12	22	1	6	21	10	20	3	19	4	G
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	
22	4	23	20	6	11	18	24	10	2	19	21	3	7	14	9	5	13	17	12	8	15	1	16	G
25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
13	2	12	10	14	1	15	21	4	20	23	6	19	3	24	16	8	11	9	18	22	5	17	7	G
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	

treatment number

plot number

Appendix 4

Bury St Edmunds harvest parameter data (Experiment 1)

	Hwt (kg/hl)		No. ears/m2		No. grains/ear		TGW (g)		HI	
	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur
Untreated	74.33	75.18	707	632	41.25	41.50	40.38	41.50	0.57	0.56
Cypermethrin T1	75.13	75.08	706	662	40.00	43.50	41.50	40.90	0.50	0.58
Cypermethrin T2	75.43	74.93	747	714	42.25	40.25	40.65	41.45	0.56	0.57
Cypermethrin T3	75.05	75.33	633	704	43.75	42.25	41.33	41.75	0.56	0.56
Tau-fluvlinate T1	74.48	74.95	779	725	41.75	40.25	40.80	41.45	0.57	0.55
Tau-fluvlinate T2	74.88	74.98	668	690	41.25	39.75	41.28	42.40	0.57	0.57
Tau-fluvlinate T3	75.68	75.78	656	772	44.00	40.25	41.28	41.35	0.59	0.57
Dimethoate	75.35	75.20	675	684	45.00	41.00	40.88	41.43	0.57	0.56
Chlorpyrifos	75.20	75.55	661	726	43.50	41.00	42.18	42.00	0.57	0.56
F-test Proabability	0.124		0.466		0.334		0.156		0.38	
5%LSD	n/a		n/a		n/a		n/a		n/a	

Oxford harvest parameter data (Experiment 1)

	Hwt (kg/hl)		No. ears/m2		No. grains/ear		TGW (g)		HI	
	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur	Sibutol	Sibutol Secur
Untreated	72.50	72.80	611.00	561.00	44.75	45.00	36.52	37.27	0.61	0.60
Cypermethrin T1	72.98	72.28	630.00	613.00	42.25	44.25	37.92	37.60	0.60	0.59
Cypermethrin T2	73.68	72.63	536.00	673.00	45.75	44.00	36.57	36.30	0.60	0.61
Cypermethrin T3	72.28	72.80	587.00	602.00	44.50	45.50	36.97	35.32	0.60	0.61
Tau-fluvlinate T1	72.88	73.05	603.00	623.00	45.75	44.25	37.32	35.95	0.60	0.60
Tau-fluvlinate T2	72.58	72.73	563.00	599.00	44.75	41.75	36.02	37.07	0.60	0.60
Tau-fluvlinate T3	72.63	72.80	611.00	590.00	41.00	43.75	38.25	37.15	0.60	0.61
Dimethoate	72.10	72.15	591.00	616.00	46.00	43.75	36.45	37.10	0.61	0.60
Chlorpyrifos	72.53	72.95	657.00	572.00	42.00	44.50	37.12	36.32	0.60	0.60
F-test Proabability	0.234		0.393		0.769		0.296		0.999	
5%LSD	n/a		n/a		n/a		n/a		n/a	

Appendix 5.

Bury St Edmunds Experiment 2b.

	Leaf Area Index	**Yield**	**Specific weight**
Seed variety			
Napier	5.51	9.69	70.5
Consort	4.64	10.59	71.8
Probability	<0.001	<0.001	<0.001
5% LSD	0.317	0.136	0.22
Seed rate			
Low (150seeds/m^2)	4.72	9.97	71.2
High (300 seeds/m^2)	5.42	10.32	71.1
Probability	<0.001	<0.001	nsd
5% LSD	0.317	0.136	na
Early N regime			
0 Kg N/ha	4.23	10.03	71.2
60kg N/ha	5.49	10.24	71.1
120 kg N/ha	5.49	10.15	71.1
Probability	<0.001	nsd	nsd
5% LSD	0.388	na	na
Interaction F-Test Prob.			
Variety * rate	0.973	0.154	0.939
Variety * nitrogen	0.150	0.146	0.199
rate * nitrogen	0.494	0.587	0.996
Variety * rate * nitrogen	0.495	0.788	0.444

Oxford Experiment 2b

	Leaf Area Index	**Yield**	**Specific weight**
Seed variety			
Napier	5.97	11.48	65.4
Consort	5.57	12.16	66.7
Probability	<0.01	<0.001	<0.001
5% LSD	0.265	0.170	0.54
Seed rate			
Low (150seeds/m^2)	5.47	11.65	66.0
High (300 seeds/m^2)	6.07	11.99	66.1
Probability	<0.001	<0.001	nsd
5% LSD	0.265	0.170	na
Early N regime			
0 Kg N/ha	5.22	11.98	66.0
60kg N/ha	5.87	11.73	66.0
120 kg N/ha	6.21	11.61	66.1
Probability	<0.001	nsd	nsd
5% LSD	0.325	na	na
Interaction F-Test Prob.			
Variety * rate	0.810	0.587	0.256
Variety * nitrogen	0.857	0.031	0.026
rate * nitrogen	0.453	0.305	0.133
Variety * rate * nitrogen	0.781	0.748	0.573