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BURNING BAN — THE FINAL STRAW ?

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BURNING BAN - THE FINAL STRAW
CONFERENCE WEDNESDAY 28 NOVEMBER 1990

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SLUG PROBLEMS IN RELATION TO STRAW DISPOSAL

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INTRODUCTION

Slugs can be troublesome pests of autumn-sown cereals, especially winter wheat grown on heavy soils. Damage to seeds and seedlings before emergence is especially serious and preventive action must be taken before the effects of damage are seen. Shredding of seedling leaves after emergence is not usually important, unless the crop is thin and growing badly (Port & Port, 1986). The aim of this paper is to examine the effects of straw residues on slug numbers and damage in cereals and to discuss ways in which slug damage can be minimised. The implications of straw disposal for slug problems in oilseed rape are also discussed.

EFFECTS OF STRAW RESIDUES ON SLUG NUMBERS AND DAMAGE IN CEREALS

Measurements of slug numbers from 1982 onwards in several field experiments on clay soils which favour slugs has shown a clear tendency for slug numbers to increase in the presence of straw residues, although this has not occurred in all sites in all years (Glen, Wiltshire & Milsom, 1984, 1988).

In general, highest slug numbers were recorded where cereals were direct drilled into straw or stubble, fewer were found in plots that were cultivated. Ploughing usually caused a greater reduction in numbers than minimum tillage, but slugs were still more abundant where straw was ploughed in than on equivalent burnt plots.

In one experiment in continuous cereals, numbers remained consistently higher on plots with straw residues than on burnt plots from autumn 1982 to summer 1985, then declined dramatically on straw plots and remained at low levels, similar to those on burnt plots during the following two years. The reasons for this decline are unknown, as weather conditions were favourable for slugs and numbers remained at high levels on other study sites. However, this finding illustrates that a previous history of high slug numbers does not mean that numbers will always remain high in that field, even when weather conditions remain wet. However, wet summers and autumns do in general encourage the build up of slug populations.

Despite widespread increases in slug numbers on plots in field experiments where straw residues were not burned, slug damage was only a problem in winter wheat direct drilled into straw or stubble. In the large programme of field experiments run jointly by ADAS and AFRC serious slug damage has been rarely encountered (Prew <u>et al.</u>, 1990). Thus although straw incorporation usually leads to increased slug numbers, it does not necessarily lead to increased damage. Straw provides an alternative food source for slugs, but this in itself probably has little effect on the likelihood of those slugs that are present in the soil causing damage to seeds and seedlings. It is only where seed-bed conditions enable slugs to move through the soil that they are able to kill significant numbers of seeds and young seedlings. The factors that influence the ability of slugs to damage seeds an seedlings are discussed in the following section.

METHODS OF OVERCOMING SLUG PROBLEMS IN CEREALS

Seed-bed conditions and depth of sowing

It has been known for some time that seed-bed conditions have an importan influence on slug damage, with damage being more prevalent in cloddy thar fine seed-beds and tending to be less severe on headlands and other areas field where machinery has compacted the soil (Gould, 1961). The beneficial effects of a fine tilth and seed-bed consolidation have also been demonstrate laboratory experiments (Stephenson, 1975; Davis 1989). Slugs have more difficulty in finding wheat seeds closely covered with small particles of soil thε seeds sown in coarse soil with large air spaces. Consolidation can lead to be seed cover either by breaking down larger clods into smaller particles or by compressing the aggregates so that there are smaller air spaces between th However, although a fine tilth and consolidation can be highly effective ways reducing slug damage, they have limitations.

On heavy soils where slugs are most troublesome, it is not always possible tc obtain a fine tilth in the autumn, either because the seed-bed is too wet or toc for machinery to break down larger aggregates of soil. A fine tilth may also be undesirable for agronomic reasons as winter rainfall impacting on bare soil ca lead to surface capping with resultant restricted air supply to roots and poor growth.

When large clods are present on the surface, rolling may simply push them d into the seed-bed. If rolling is done after drilling, seeds may be left exposed tc slug attack if clods are only pushed down into the soil, as suggested by Stephenson (1975). Nevertheless field experience indicates that rolling after drilling is often an effective means of reducing the severity of slug damage.

Consolidation of the seed-bed before drilling may result in shallow drilling of s because of limited drill penetration. A recent series of field experiments at IAC Long Ashton Research Station, funded by the Home-Grown Cereals Authority has shown that shallow drilling greatly increases the risk of slug damage to w wheat.

The first of these experiments, in autumn 1987, produced the surprising resul most damage occurred in consolidated seed-beds, and least damage in loos seed-beds (Glen, Milsom & Wiltshire, 1989). Examination of the plots, howeve suggested that this anomaly could be related to differences in depth of seeds consolidated and loose seed-beds. When the experiment was drilled, the Farmhand drill penetrated to greater depth in loose than in consolidated seed beds, which presented greater resistance to drill penetration than loose seed-beds. There was a significant negative correlation between seed depth and sl damage in this experiment: the shallower the seeds were sown, the greater w the slug damage. This finding on the effect of sowing depth on slug damage ir field agreed with the results of a laboratory experiment by Stephenson (1975) contradicted a widespread belief that shallow sown seeds would be at less ris slug damage than deeper sowings, because shallow sown seeds would emer more quickly and therefore be at risk of slug damage for less time (Gair, Jenki Lester, 1987).

Correlation analysis indicated that the biomass of slugs present in the soil and the percentage of fine soil in the seed-bed were also important in determining the level of slug damage in the above experiment. (Seed depth together with these other two factors accounted for almost all the variation in slug damage between treatments.) Thus it was not possible rigourously to separate the effects of drilling depth from other factors affecting slug damage in this experiment.

As depth of sowing is largely within the farmer's control, it was clearly important to establish the true nature of the relationship between seed depth and slug damage. Therefore two further experiments were done to establish whether shallow sown seeds were at greater risk of slug attack than seeds sown at normal depth, and whether this effect was consistent on different sowing dates.

In autumn 1988, winter wheat was sown with a Farmhand drill, into coarse seed-beds at two depths (c. 20 mm and c. 40 mm) on three dates, with or without methiocarb pellets broadcast on the surface of the soil immediately after drilling (Glen, Milsom & Wiltshire, 1990). This timing and method of pellet application is one of those recommended by ADAS for control of slug damage to winter wheat (ADAS, 1984). Seed depths were measured shortly after emergence.

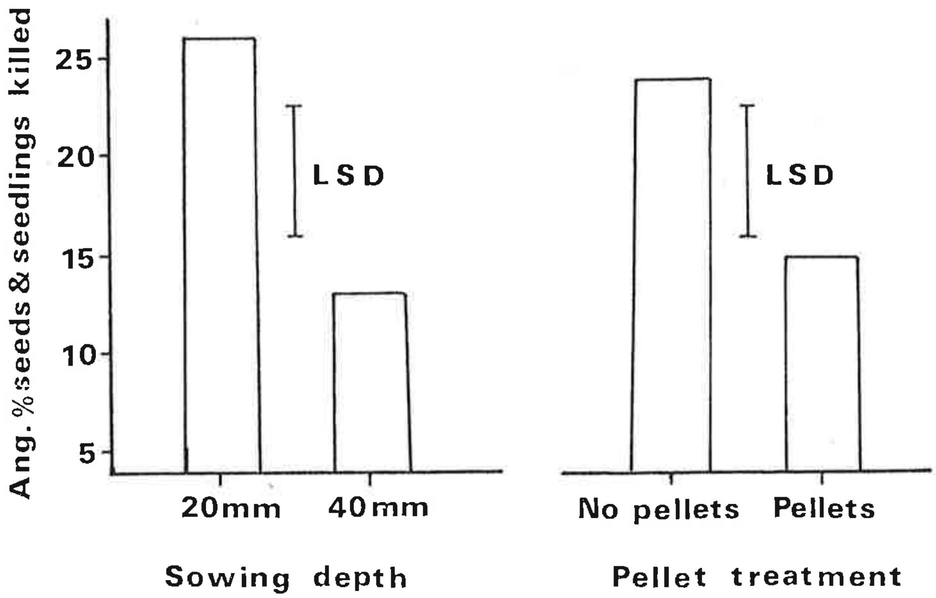

Fig. 1. Effects of seed depth and of methiocarb pellets on slug damage to seeds and seedlings sown on three dates in autumn 1988 (after Glen, Milsom & Wiltshire, 1990). (LSD = least significant difference.)

Overall, the protection from slug damage provided by this additional 20 mm of sowing depth was comparable with that provided by the broadcast applications of methiocarb pellets (Fig. 1). The effects of seed depth and pellet application were consistent on all three sowing dates and their effects were complementary. Thus most seeds and seedlings were killed where seeds were sown at 20 mm depth without pellets, intermediate levels of damage were recorded where seeds were sown at 40 mm without pellets or where pellets were broadcast on seeds sown at 20 mm depth, and least damage was found where pellets were broadcast on seeds sown at 40 mm depth (Table 1).

Table 1. Effect of sowing seeds at different depths, with or without methiocarb pellets broadcast immediately after sowing, on the percentage of winter wheat seeds and seedlings killed by slugs in a field experiment in autumn 1988 (mean values for three dates of sowing).

	Seed depth			
	20 mm		40 mm	
	without pellets	with pellets	without pellets	with pellets
% killed by slugs	33.4	17.8	11.8	6.8

A third field experiment sown in autumn 1989 confirmed the effect of sowing depth on slug damage to winter wheat. As in the previous year, winter wheat was sown at two depths into coarse open seed-beds on three dates. Measurements after emergence revealed that the drilling depth was a little greater than in the previous year (c. 25 mm or c. 50 mm.) Despite differences in soil temperature and moisture between the three dates of sowing, there were, as in the previous year, no significant differences in slug damage between sowing dates. Whereas 26% of seeds sown at 25 mm depth were killed by slugs, only 9% of seeds sown at 50 mm were killed. This difference is highly significant ($P<0.001$).

In the field experiments sown in autumn 1987 and 1988 there were no significant differences in yield between treatments despite the differences in slug damage. However, in the third experiment sown in autumn 1989, seeds sown at 50 mm yielded significantly ($P<0.01$) more (7.37 t/ha) than seeds sown at 25 mm (6.76 t/ha). As this experiment was not designed to investigate the effect of slug damage on yield, it is not possible to say whether the yield increase from deeper sowing was due to the reduction in slug damage alone or whether other factors were involved. However, it is important that the cultural measure which reduced slug damage also gave a yield benefit.

Time of sowing

Later sowings of winter cereals are often considered to be at greater risk of slug damage than crops sown earlier in the autumn (Port & Port, 1986). However, Martin & Kelly (1986) considered that early sowings of wheat could be at high risk of damage because they tend to follow crops which encourage increases in slug populations. In the series of experiments described above, slug damage did not differ significantly between sowing dates ranging from late September to mid November, despite differences in soil temperature and moisture. However, seed-bed tilth was coarse and open on all sowing dates, making them favourable for slug activity, even early in the autumn. The difficulty of obtaining a good seed-bed in the wetter, colder conditions of late autumn may result in later sowings suffering more severe slug damage than earlier sowings.

Slug pellets

Cultural measures should always be regarded as the first line of defence against slug attack. Seeds sown at normal depth (c. 40 mm) into a reasonably fine seed-bed which has been rolled after drilling will rarely suffer from severe slug attack, even when large numbers of slugs are present in the soil. Where seeds have to be sown into cloddy, open seed-beds, slug pellets may well improve plant stand especially if seeds are sown at c. 40 mm depth. This is illustrated by the results of the experiment in autumn 1988 described above, where slug pellets broadcast after sowing wheat seeds at 40 mm depth gave the best protection from slug damage.

Chemical control of slugs in the UK is based at present on pellets containing metaldehyde or methiocarb together with a cereal-based bait. ADAS (1984) recommend that pellets should be broadcast on the soil surface a few days before drilling provided that the soil is not worked for at least three days following treatment. However, if conditions allow a good seed-bed to be obtained, it is not worth delaying sowing in order to allow treatments to be applied. Broadcasting pellets soon after drilling is recommended in this case. ADAS state that drilling bait pellets mixed with the seed is less effective than broadcasting but has given useful control when the seed-bed was very cloddy.

Of the two active ingredients used in slug pellets, methiocarb is effective against a wider range of slug species than metaldehyde, but results achieved by metaldehyde and methiocarb are often similar in the field especially when temperatures are relatively mild and where the field slug Deroceras reticulatum is the dominant species. In a field experiment in cereals at Long Ashton in relatively mild weather in autumn 1986, metaldehyde and methiocarb gave similar protection. However, methiocarb was more effective than metaldehyde when applied at low temperatures, close to freezing, in 1987 (Wiltshire & Glen, 1989). Nevertheless, recent results from Switzerland indicate that metaldehyde does not lose its inherent toxicity at low temperatures, but merely requires longer to take effect.

EFFECTS OF STRAW RESIDUES ON SLUG DAMAGE TO OILSEED RAPE

The increase in slug populations following straw incorporation in cereals could have important implications for slug damage to following crops of oilseed rape, where the seedling is the most vulnerable stage. Slugs are considered to be minor pests of this crop in the UK, although they are regarded as important pests in Belgium and France.

However, recent studies have shown that the susceptibility of oilseed rape seedlings to slug damage is inversely related to the glucosinolate concentration of the seeds, which is closely related to the glucosinolate concentration of the seedlings (Glen, Jones & Fieldsend, 1990). Thus the newer double-low cultivars of rape with diminished concentrations of glucosinolates are much more susceptible to slug damage than older single-low rape cultivars.

The combined effects of increased slug populations following straw incorporation and the greater palatability of double-low rape to slugs strongly suggest that in future years when rape seedlings emerge during wet weather, slug damage will be more severe than in previous years.

SUMMARY

In a series of experiments on straw disposal in winter cereals, there was a clear tendency for slug numbers to increase in the absence of burning. However, this did not necessarily lead to an increase in slug damage. Seed-bed conditions are important in determining the susceptibility of cereals to slug attack. Seeds should be sown into a seed-bed that is as fine as can be obtained without the risk of surface capping. Sowing seeds at a depth of c. 40 mm has result in substantially less slug damage than shallower sowing. Rolling after drilling is also likely to reduce the severity of slug damage. An application of slug pellets at about the time of drilling should help to reduce pre-emergence damage in cloddy seed-beds, especially when combined with drilling at c. 40 mm.

REFERENCES

ADAS (1984). Slugs and snails. Leaflet 115, Ministry of Agriculture, Fisheries and Food, UK, 17 pp.

Davis, A.G. (1989). Effects of soil compaction on damage to wheat seeds by three pest species of slug. Crop Protection **8**, 118-121.

Gair, R., Jenkins, J.E.E. & Lester, E. (1987). Cereal Pests and Diseases (fourth edition). pp 268, Ipswich: Farming Press.

Glen, D.M., Jones, H. & Fieldsend, J.K. (1990). Damage to oilseed rape seedlings by the field slug Deroceras reticulatum in relation to glucosinolate concentration. Annals of Applied Biology **117**, 197-207.

Glen, D.M., Milsom, N.F. & Wiltshire, C.W. (1989). Effect of seed-bed conditions on slug numbers and damage to winter wheat in a clay soil. Annals of Applied Biology **115**, 177-190.

Glen, D.M., Milsom, N.F. & Wiltshire, C.W. (1990). Effect of seed depth on slug damage to winter wheat. Annals of Applied Biology **117**, in press.

Glen, D.M., Wiltshire, C.W. & Milsom, N.F. (1984). Slugs and straw disposal in winter wheat. Proceedings 1984 British Crop Protection Conference - Pests and Diseases **1**, 139-144.

Glen, D.M., Wiltshire, C.W. & Milsom, N.F. (1988). Effects of straw disposal on slug problems in cereals. Aspects of Applied Biology 17, Environmental Aspects of Applied Biology Part 2, 173-179.

Gould, H.J.. (1961). Observations on slug damage to winter wheat in East Anglia, 1957-1959. Plant Pathology **10**, 142-146.

Martin, T.J. & Kelly, J.R. (1986). The effect of changing agriculture on slugs as pests of cereals. Proceedings 1986 British Crop Protection Conference - Pests and Diseases 2, 411-424.

Port, C.M. & Port, G.R. (1986). The biology and behaviour of slugs in relation to crop damage and control. Agricultural Zoology Reviews **1**, 255-299.

Prew, R.D., Cussans, G.W., Glen, D.M. & Jenkyn, J.F. (1990). Agronomic aspects of straw disposal. Agricultural Progress **65**, 39-46.

Stephenson, J.W. (1975). Laboratory observations on the effect of soil consolidation on slug damage to winter wheat. Plant Pathology **24**, 9-11.

Wiltshire, C.W. & Glen, D.M. (1989). Effects of molluscicides on slugs and soil arthropods in winter cereal crops. In Slugs and Snails in World Agriculture. (Ed. I.F. Henderson), British Crop Protection Council, Monograph No. 41, pp 399-406.