Session 3
Poster Presentations

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CLOVER: CEREAL BI-CROPPING

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ABSTRACT

A system for growing cereals, especially winter wheat, that requires substantially reduced inputs of N fertilizer, agrochemicals and management time is being developed in joint work between five research stations in Europe. The system relies on an understorey of white clover, (*Trifolium repens)* which becomes permanent and perennial to fix and supply N for cereal crops. The clover is defoliated in autumn and the cereal direct-drilled into it. Following cereal harvest, for silage or grain, the clover understorey is allowed to recover, defoliated in autumn and a second cereal crop direct-drilled into it to repeat the cycle. Altered physical conditions in the crop environment mean that weed, pest and disease problems are usually greatly reduced, with consequent savings in agrochemicals.

INTRODUCTION

Various attempts have been made to reduce over-production by limiting the agricultural area used for growing cereals. Chief among them are the various set-aside options, and although these largely achieve their aim of reducing cereals output they suffer serious disadvantages, not least of which are the socio-economic effects and the public perception that farmers are being paid for doing nothing. The impact of set-aside on wildlife, pests, diseases and weeds also leads to criticism of set-aside, as does the cost to the taxpayer of its administration and support.

Probably an alternative approach is to develop systems of cereal farming which produce lower yields, but that remain economically viable because they require greatly reduced inputs of fertilisers and agrochemicals. This in turn could obviate many of the environmental problems encountered with modern high input cereal production. A clover: cereal bi-cropping system is one such possible approach.

DESCRIPTION OF CEREAL: CLOVER SYSTEM

The system, which we are continuing to develop is simple and straightforward. It relies initially on establishing a sward of pure white clover (*Trifolium repens)* which becomes permanent and perennial. There are several different ways of establishing the clover which include i) producing a seed-bed and sowing clover seed into it (with no grass or other companion crop), (ii) under-sowing clover with a 'nurse crop' of spring cereal which is cut for whole-crop silage, (iii) sowing a mixture of grass and clover seed, allowing a clover rich sward to develop, (which can of course be used for livestock production) and then killing the grass with a herbicide - a low dose of paraquat or glyphosate works well.

In autumn the clover is grazed-off with sheep, or preferably cut and ensiled by mid-September, and then mown-short. Cereal seeds are direct-drilled into the defoliated clover. The cereal is allowed to develop and given a small amount of nitrogen (N) fertilizer (50 kg N/ha is suggested) in early spring. Subsequently the cereal relies on the N fixed by the clover. The cereal crop can be either cut for whole-crop silage, in which case the clover component provides a valuable protein-rich supplement, or else the cereal is left to grow to maturity and harvested for grain. The clover understorey survives, is left to recover and is then grazed or preferably cut for silage again and a second cereal crop is drilled into it to repeat the cycle. Work to date shows that two successive cereal crops can be grown in this way. Currently, an EU funded group are working on a project to develop this system for practical use and to investigate a wide range of specific aspects of its use.

WEED, PEST & DISEASE INCIDENCE

Weeds

In the several experiments completed (e.g. Jones & Clements, 1993) or in progress (Clements *et al*., in press) broad leaved weeds have generally not posed a significant problem; they are easily smothered by the clover canopy, which becomes very dense. However at some sites grass weeds, especially annual meadow grass (*Poa annua*), have been very troublesome. The situation appears to be exacerbated if the clover is grazed, rather than cut for silage. Grazing tends to be uneven, certainly compared with cutting, and leaves bare areas which are easily colonised by *Poa*. Clearly the number of *Poa* seeds in the seed-bank has a profound effect on the likely development of a weed problem. The *Poa* seed-bank may be especially large in ex-grass compared with ex-arable fields.

However, recent evidence suggests that although it can be severe the problem of annual meadow grass appears to be easily avoided by spraying the area prior to drilling the cereal in autumn with an appropriate herbicide e.g. low-dose of paraquat, which does not harm the clover permanently.

Pests

Aphids are the major pest of cereal crops, but in early work and some current experiments their numbers are greatly reduced in bi-cropped areas. There may be a number of factors contributing to this e.g. (i) the relatively low N status of the cereal which provides a less than ideal diet for aphids, (ii) the presence of large numbers of predatory beetles and spiders in the clover understorey and (iii) the ever-present green mantle of clover may interfere with aphids ability to locate cereal crops.

In at least one series of recent experiments aphid numbers have been extremely high, but this may be as a consequence of *Poa* infestations on the plot.

Diseases

The major virus diseases of cereals are aphid borne. As result of aphid numbers usually being reduced in our bi-cropping system so too are virus problems. Fungal diseases are also greatly reduced. Deadman & Soleimani (1994) showed that this is because many of the major fungal diseases are splash-borne and the clover canopy virtually prevents disease progression. Also, trash at the base of bi-cropped areas decomposes very rapidly, thus reducing the carry-over of some diseases including *Fusarium*, but this requires further investigation (M.L. Deadman personal communication).

FERTILIZER, AGROCHEMICAL & MANAGEMENT INPUT

There is a need to supply adequate levels of P and K fertilizer to support vigorous clover and cereal growth. However, N fertilizer levels are greatly reduced, as alluded to above, (50 cf. 150-200 kg N/ha for a conventional crop). The level of agrochemical usage for weed, pest and disease control are also greatly reduced and clearly there are fewer management decisions to be made regarding their choice and timing.

CEREAL YIELDS

In the first year of use yields of cereal within the bi-cropping system are about 60% of those of conventional crops (Table 1), but because of the greatly reduced inputs required the gross margin remains at about 90% of that for conventional crops. The clover's contribution of fixed N is expected to increase in subsequent years and lead to improved cereal yields with repeated cycles of the system.

TABLE 1. Whole crop silage and grain yields on bi-cropping experiment at Long Ashton 1994

	Silage yield			Grain yield		
	t/ha	s.e.m.	(df)	t/ha	s.e.m.	(df)
Bicropped	9.8	0.32	(19)	4.9	0.25	(19)
Conventional	15.9	0.33	(19)	8.3	0.26	(11)

OTHER ADVANTAGES OF THE BI-CROPPING SYSTEM

Casual observations show that the cereal: clover bi-cropping system greatly reduces soil erosion - presumably because the perennial and dense crop cover impedes sheet and rill water flow. The perennial nature of the crop with its complex entomofauna may also be of benefit to certain birds and wildlife species. Soil organic matter increases markedly under bi-cropping, which may be a further advantage.

LIMITATIONS

One limitation may be that livestock are needed to utilise the clover, but many ostensibly arable farms have a sheep enterprise and clearly these would be able to make full use of the legume component. Agro-climatological limitations are being explored in our current programme of work.

ACKNOWLEDGEMENTS

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INVESTIGATIONS USING SEX PHEROMONE AGAINST *BEMBECIA SCOPIGERA* (LEP : SESIIDAE)

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ABSTRACT

In this study , adult emergence and the flying period of *Bembecia scopigera* were determined in 1, 2 and 3 year- old infested sainfoin (*Onobrychis viciifolia*) fields by various methods including sweep netting , attractive bait traps , counting hollow cocoons and sex pheromone traps. In 1, 2 and 3 year - old infested fields between 1984- 1987, the first moth appeared in early and mid- July and countined to be found October or mid - September.The pest had one generation per year in Ankara.The use of sex pheromone traps were satisfactory to determine both the first moth appearance and flying period. It was concluded that a sex pheromone could be used to control the pest or alternative to pesticide use .

INTRODUCTION

Sainfoin (*Onobrychis viciifolia*) is an important forage crop in the Central Anatolia Region of Turkey (Elçi, 1975). *Bembecia scopigera* is the most harmful and difficult to control pest of sainfoin . There is no satisfactory control measures for this pest,but an appropriate method is required.

To synchronise spraying time, It is essential to observe the first adult emergence and flying period. Various methods including sweep netting , attractive bait traps, counting holow cocoons and sex pheromone traps to achieve this were tested.

Pheromones have particular advantages for pest control because they are usually highly species- specific, leave no undesirable residues in the enviroment and are effective in minute quantities. Pheromones are being used to determine when pests enter crops, when numbers have built - up sufficiently to warrant control measures being taken or to predict the correct timing for such measures (van Emden, 1989) . In this study, we compared various methods with a sex pheromone trap, to determine the first moth emergence and flying period .

MATERIALS & METHODS

Adult emergence and flying period were determined in 1, 2 and 3 year- old infested sainfoin fields using ;

a - Sweep net : To determine the first moth emergence, one hundred net sweeps at 7 day intervals in each sainfoin field.

b - Attractive bait traps : In order to find the first emergence and flying period, a bait trap including 1 part boiled grape + 5 parts water and 2-3 g of yeast extract was used.The pots of each trap which were 2 l in size were filled 3 / 4 full with prepared bait. Nine pots were set up at 25 m intervals in sainfoin fields when the first pupae were found . The prepared bait in each pot was changed every two weeks. Traps were used from June to mid- October and checked weekly.

c - Counting hollow cocoons : The first moth emergence , emergence period and percentage of hollow cocoons were found, by assassing 25 - 100 indivuals (larvae, pupae , cocoon) . The moth emergence curve was drawn for 1 year- old sainfoin fields.

d - Sex pheromone traps : The commercial clearwing moth (*Synanthedon exitiosa*) sex lure used in the study to determine the first moth emergence and flying period was (3Z, 13 Z) - 3 - 13 - Octadecadienylacetate. Pherocon 1C traps were set up in mid - field , 1- 1.5 m above ground. The capsules and traps were renewed every two weeks and three weeks , respectively. The moths in each trap were taken weekly and counted to enable a curve for flying adults to be drawn.

RESULTS & DISCUSSION

The first moth emerged on 16 July, 1984 in 1, 2 and 3 year- old sainfoin fields, using netting, attractive bait trap, hollow cocoon counting and sex pheromone. In 1985, the first moth appeared on 2 July by sweep net and hollow cocoons but on 9 July , using attractive bait traps.

The first emergence occurred on 10 and 17 July , 1986 using sex pheromone traps and counting hollow cocoons respectively in 1 year - old fields ; but on 2 July , 1986 in 2 and 3 year- old fields.

The first moth appeared on 9 and 14 July, 1987 in sex pheromone traps or by hollow cocoon counting in 1 and 2 year- old fields, respectively.

It was concluded that the use of attractive bait traps and sweep netting were unsuccessful in attractting adults and determining the flying period.

A curve of adult emergence was drawn , using hollow cocoon counting in 1 year - old sainfoin fields between 1984 - 1987 (Fig. 1). The first moth appeared on 16, 2, 17 and 14 July in 1984, 1985, 1986 and 1987, respectively. *B. scopigera* emerged from 16 July to 3 September, 1984 ; 2 July to 14 August, 1985 ; 17 July to 22 August, 1986 ; and from 14 July to 10 September, 1987. The peak was obtained on 6, 14, 7 and 20 August in 1984, 1985, 1986 and 1987, respectively.

Hollow cocoon counts showed that the first emergence occured between 16 July- 27 August, 1984 in 2 and 3 year- old infested fields ; between 2 July- 14 August, 1985 in 2 year - old fields ; between 2 July - 22 August, 1986 in 2 and 3 year- old fields ; between 14 July - 27 August , 1987 in 2 year - old field.

The moth flying period determined by sex pheromone traps in 1, 2 and 3 year- old infested fields and 1986 are shown in Fig. 2. The first moth appeared on 10 July in 1 year-old and on 2 July in 2 and 3 year - old fields in 1986. The flying period occured between 10 July- 2 September in 1 year - old field ; 2 July - 12 September in 2 and 3 year - old fields. The first peak occured on 17 and 10 July in 1, 2 year - old and 3 year- old fields , respectively ; the second and third peak s were on 31 July and 28 August, in 1, 2 and 3 year-old infested fields, respectively.

The flying period using sex pheromone traps in 1 and 2 year- old fields , 1987 is shown in Fig. 3, The first moth emerged on 9 July in both sainfoin fields. The flying period occurred from 9 July to 12 October in 1 year- old fields ; 9 July to 21 September in 2 year - old fields. The first peak was obtained on 22 and 27 July in 1 and 2 year-old felds, respectively. The second and third peak occurred on 20 August and 10 September in 1 and 2 year-old fields , respectively.

The moth flying period and emergence curve when using sex pheromones and hollow cocoon counts in 1 year- old infested fields, 1986 are shown in Fig. 4 . The first emergence occurred on 10 and 17 July in sex pheromone traps and from hollow cocoon counting , respectively. The flying period and emergence period occurred between 10 July - 2 September; 17 July- 22 August in sex pheromone traps and by hollow cocoon counting, respectively. The maximum moth numbers were trapped on 17, 31 July and 28 August in sex pheromone traps but on 7 August by counting hollow cocoon.

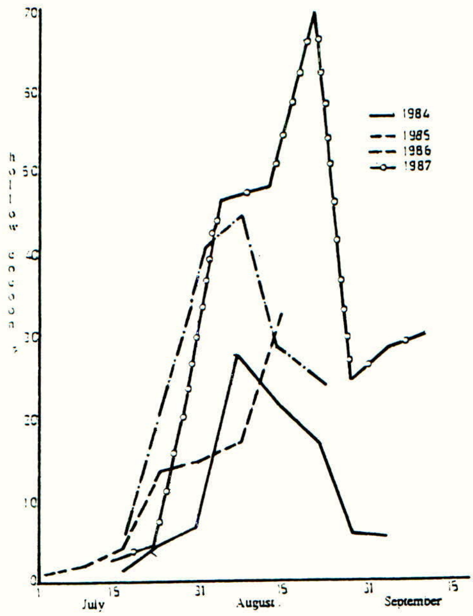

FIGURE 1. The curve of moth emergence of *B. scopigera* in 1 year-old infested sainfoin fields, using hollow cocoon counting method.

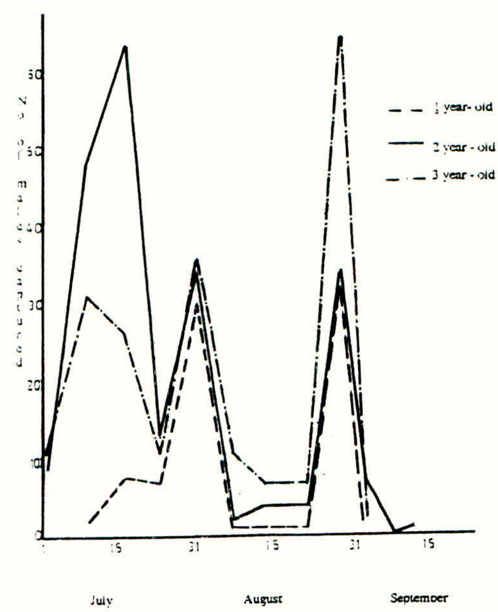

FIGURE 2. The seasonal occurrence of males of *B. scopigera* in 1986 in sex pheromone traps

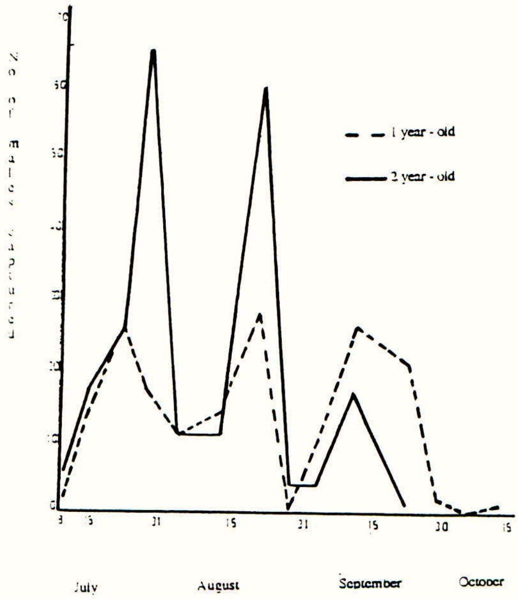

FIGURE 3. The seasonal occurrence of males of *B. scopigera* in 1987 in sex pheromone traps

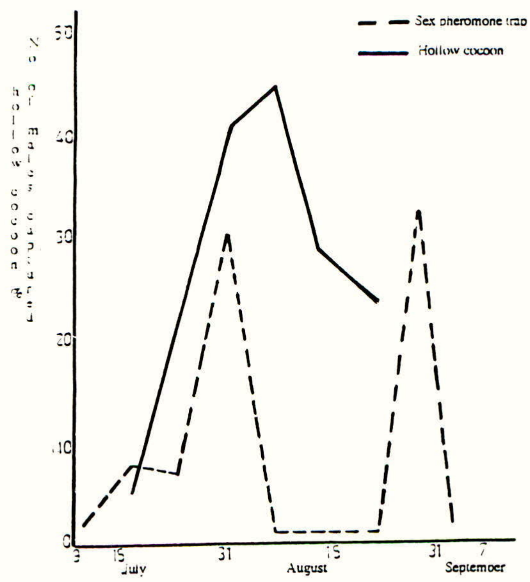

FIGURE 4. The seasonal occurrence of moth emergence of *B. scopigera* in 1986, using sex pheromone traps and a hollow cocoon counting method.

Moreover, as shown in Fig. 5 , the first emergence and catches were obtained on 9 and 14 July, 1987 in sex pheromone traps and hollow cocoon, respectively. The moths were trapped from 9 July to 12 October. Moth emergence occurred between 14 July- 10 September, using hollow cocoon counts . Moth trapping and emergence continued for 13 or 9

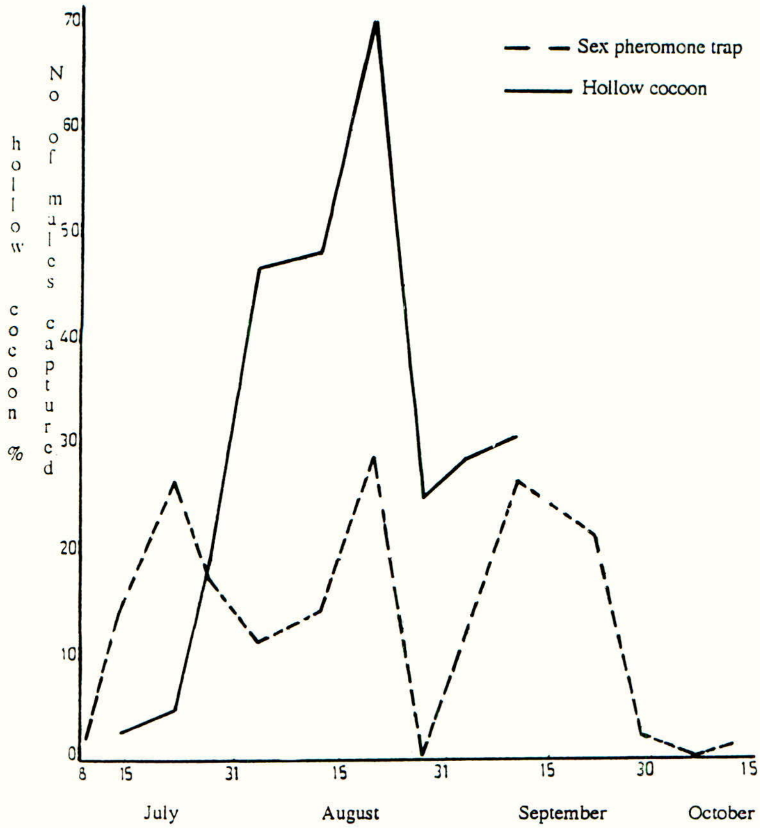

FIGURE 5 . The seasonal occurrence and the curve of moth emergence of *B. scopigera* in 1987 , using sex pheromone traps and a hollow cocoon counting method.

weeks in sex pheromone traps and hollow cocoon assesment, respectively. The peak was obtained on 22 July, 20 August, 10 September on sex pheromone, but only 20 August using hollow cocoon assesment, respectively.

It was concluded that the use of sex pheromone traps as effective in determining both the first moth appearance and flying period. As a result of the present and other studies , sex pheromones are being used to determine moth emergence and flying periods of Sesiidae , to control these pests and predict the correct timing of spraying (van Wetswinkol *et al* ., 1980 ; Neal, 1982 ; Potter & Timmons, 1984).

It is suggested that sex pheromone traps could be used to control *B. scopigera* in sainfoin fields. Attempts are being made to use pheromones in mass- trapping, confusion strategies.

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