HGCA

PROJECT REPORT No. 106

ORANGE WHEAT BLOSSOM MIDGE: SURVEY OF THE 1994 OUTBREAK

MARCH 1995

PRICE £2.00

PROJECT REPORT No. 106

ORANGE WHEAT BLOSSOM MIDGE: SURVEY OF THE 1994 OUTBREAK

by

J. N. OAKLEY

ADAS Bridgets, Martyr Worthy, Winchester, Hampshire SO21 1AP

This survey work commenced in October 1994 and lasted for two months. It was funded by a grant of £7,160 from the Home-Grown Cereals Authority (Project No. 0042/1/94).

Previous HGCA–funded work on orange wheat blossom midge is reported in *Research Review No. 28 Orange wheat blossom midge: a literature review and survey of the 1993 outbreak* by J. N. Oakley, which is available from the Home-Grown Cereals Authority for £6.00 (p & p inclusive).

Abstract

Examination of the 1994 HGCA Cereals Quality Survey samples has shown that levels of grain damage due to larvae of the orange wheat blossom midge (*Sitodiplosis mosellana*) were down overall in the areas of eastern and southern England where sprays were applied most intensively in 1994, but up nearly everywhere else. Nationally 9% of samples were above the yield loss threshold level of 10% and a further 28% of samples above the potential quality loss threshold of 5% grain damage. In areas where effective spray action was not taken damage had increased by about 50% on 1993 levels. The incidence of apparently missed crops within the eastern counties suggests that a similar increase would have taken place there but for the action taken. The loss to the UK crop is estimated as £20 million compared to £30 million in 1993. Spray action costing £6 million reduced the loss from a potential £50 million, giving a 1:5 cost:benefit ratio for the control measures applied.

Introduction

A serious outbreak of damage caused by orange wheat blossom midge (*Sitodiplosis mosellana*) larvae was first noticed in areas of eastern and southern England in 1993. Crop losses of over 50% were estimated in the worst cases, attracting widespread media attention. The damage was, unfortunately, detected too late for effective control measures to be applied. An analysis of the weather patterns at critical periods in the years leading up to the outbreak demonstrated that it had been caused by particularly favourable weather patterns in both 1992 and 1993 (Oakley 1994) which resulted in a rapid increase in numbers from the low levels known to infest all wheat growing areas in the UK.

Wheat blossom midge damage can be detected on grain after harvest, allowing retrospective analysis of crop damage. The samples from the Home-Grown Cereals Authority's Cereal Quality Survey were examined in 1993 to define the extent of the outbreak first noticed in that year. 21% of crops had been damaged to the extent that significant yield loss would have occurred, with a further 29% damaged to the extent that quality could have been reduced. The exercise was repeated in 1994 to evaluate the success of the control measures applied, and to give an indication of the ongoing risks for future years.

A strategy of spraying crops where more than one egg laying midge was seen on at least one in three ears for feed crops, or one in six ears for milling and seed crops, was proposed. Adoption of this strategy would have resulted in average grain damage levels no higher than 5% damaged grain and with no samples with more than 10% damaged grain.

Method

Samples of grain were collected by the HGCA's Regional Cereals Officers from a representative sample of wheat crops from across the UK. Samples were sent to the FMBRA for analysis and sub-samples were drawn from these samples for wheat blossom midge damage assessment in the ADAS laboratory at Reading.

A thousand grain sub-sample was taken from the grain sample and examined under an illuminated magnifier. Midge damaged grains were removed, and the grain was turned. This process was repeated until less than five further damaged grains were found after a turning.

Two threshold levels were recognised in categorising the damage caused. Where more than 10% of grain was damaged, the yield loss would have been above 5% in the field, more than repaying the cost of an effective spray. Where more than 5% of grain was damaged, quality may have been affected to the degree that milling premiums were lost, or the sample failed germination tests for seed.

Results

The mean percentage grain damage in 1994 was 4.2% compared to 6.6% found in 1993 (Table 1). Levels were lower in those areas where sprays were widely applied, but continued to increase elsewhere.

Table 1. HGCA Cereals Quality Survey 1994 % damaged grain

HGCA Region	Mean (1993 in brackets)	SD	range	number
East	3.4 (10.6)	3.21	0.2 - 16	134
South West	6.3 (4.7)	12.41	0.2 - 97	62
Midlands	3.7 (5.2)	3.11	0.2 - 13	99
Northern	4.3 (3.5)	3.55	0.1 - 18	60
Scotland	4.6 (1.7)	4.07	0.4 - 13	11
Northern Ireland	10.7 (-)		4 -18	2
Great Britain & NI	4.2 (6.6)	6.00	0.1 - 97	368

Looking at the distribution of damage according to the recognised categories (Table 2) it can be seen that overall an effective spray treatment was not applied in 9% of cases where it was needed to prevent yield loss. The greatest incidence of 'missed fields' was again away from the previously more heavily infested area. The quality threshold of 5% damage was exceeded in a further 28% of fields, but this would only be of potential significance in those fields destined for milling or seed markets.

Table 2. HGCA Cereals Quality Survey 1994% of samples with damage by categories

HGCA Region	< 5 % damaged	5 - 10 % damaged	> 10 % damaged
East	80	13	7
South West	63	24	13
Midlands	72	22	6
Northern	62	28	10
Scotland	55	27	18
Great Britain	63	28	9

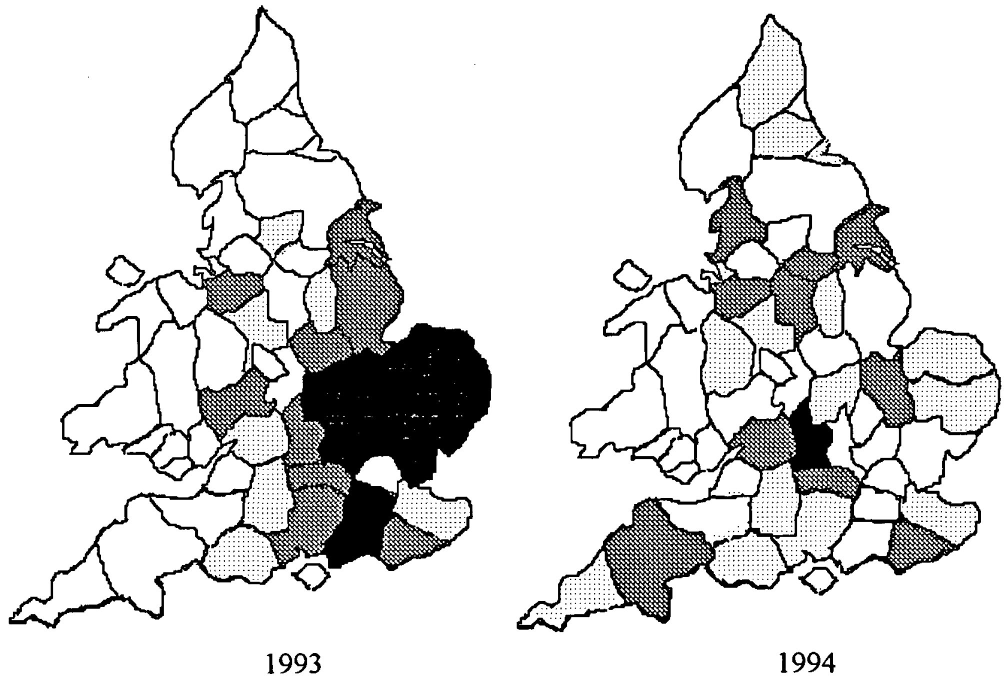

Figure 1. The average grain damage recorded in each county of England represented in the survey. (Above yield threshold - black; above quality threshold - mid-grey; 4-5% damage - light grey)

In 1993 the highest levels of damage (Figure 1, black tone) were in East Anglia, West Sussex and Surrey. In these areas, on the average, over 10% damaged grain was recorded. Surrounding counties (mid-grey tone) were infested at intermediate levels with between 6 and 10% of grains damaged. Levels elsewhere were lower, but 'hotspots' of damage were still detected giving average grain damage levels of 4-5% (light-grey tone) in most of the other main wheat growing counties in the south.

The effect of the control measures applied can be seen on the 1994 map, with levels reduced in those counties where the high level of midge incidence triggered widespread spraying. Around the fringes of this area more infestations appear to have been missed and necessary control measures not applied, resulting in an increase in damage to 150% of 1993 levels..

Too few samples were received from Scotland for meaningful maps to be produced. The overall rise in levels from 1993 to 1994 was associated with more than 10% of damaged grains being recorded from both the Borders and Tayside. No samples were received from Northern Ireland in 1993; of the two seen in 1994 one had 18% of grains damaged, the fourth highest level detected in the 1994 survey.

The average damage levels may hide 'hotspots' of damage of great significance on affected farms, so maps are also presented of counties where maximum levels of damage exceeded threshold levels (Figure 2).

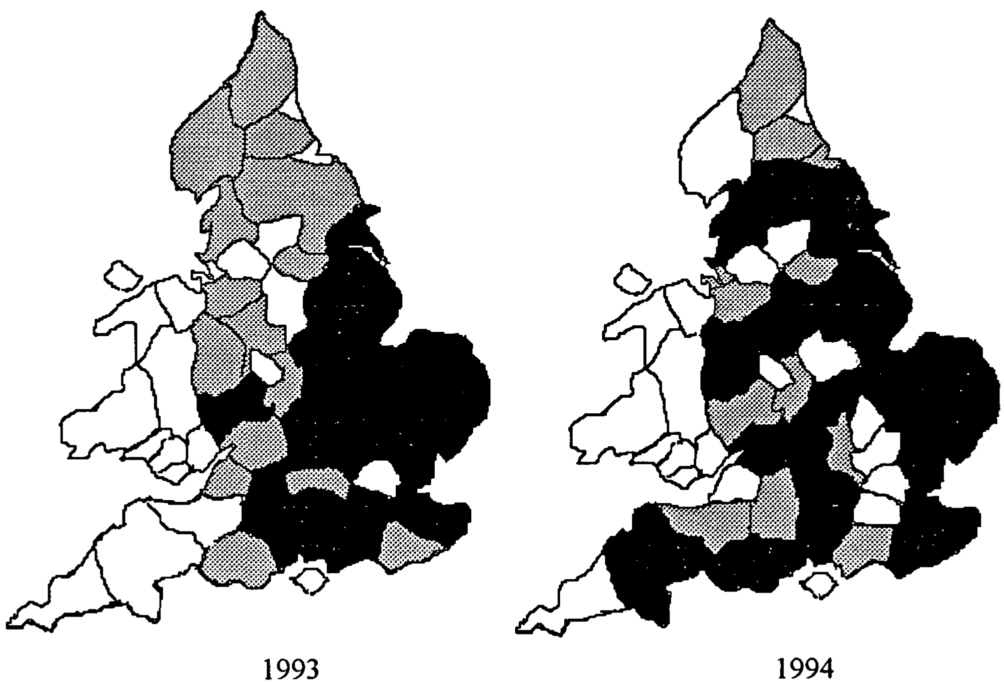

Figure 2. The maximum levels of damage found in each county (above yield threshold - black; above quality threshold - grey).

'Hotspots' of damage were spread over a wider area in 1994. A fuller listing of mean and maximum damage levels found (Table 3), shows that whilst the target of average damage levels no higher than 5%, with no samples above 10% was not widely achieved, damage in the majority of the previous heavily infested counties was reduced towards this level.

Damage levels were reduced well below target were Bedfordshire and Hertfordshire, suggesting that spray application may have been excessive in these counties. Levels were reduced (🡇) to about the target level in the other previously heavily infested counties where insecticides were applied to many crops, but remained static (➔) or increased (🡅) elsewhere. The figures should be treated with caution for counties wheresmaller quantities of wheat are growen, which were represented by very few samples. A fuller breakdown of levels found on different varieties of wheat in each county is given in the Appendix.

Table 3. Percentage of grains damaged by orange wheat blossom midge larvae in the Cereals Quality Survey by county.

County	change 1993-4	% damaged grain 1993 mean	1993 maximum	1994 mean	1994 maximum
Avon	→	5	5	3	3
Bedfordshire	↓	13	27	1	2
Berkshire	↑	6	9	6	16
Buckinghamshire	↓	10	21	3	7
Cambridgeshire	↓	13	29	6	13
Cheshire	→	7	7	6	9
Cleveland	↑	1	2	5	5
Cornwall	↑	3	2	4	4
Cumbria		5	5		
Derbyshire	↑	3	4	8	11
Devon	↑	3	4	8	26
Dorset	→	5	9	5	13
Durham	→	4	7	4	7
Essex	↓	11	20	3	11
Gloucestershire	↑	4	7	6	11
Hampshire	↓	6	14	5	11
Hereford & Worcs.	↓	6	12	3	8
Hertfordshire	↓	10	15	2	4
Humberside	→	6	29	6	18
Isle of Wight	→	3	3	2	2
Kent	→	5	26	5	16
Lancashire	↑	4	5	6	11
Leicestershire	↓	6	12	2	4
Lincolnshire	↓	7	14	3	13
Merseyside	↑	3	3	5	5
Norfolk	↓	11	36	4	11
Northamptonshire	↓	10	18	4	12
Northumberland	→	2	6	4	7
Nottinghamshire	→	5	10	5	10
Oxfordshire	↑	6	13	13	97
Shropshire	↑	3	6	4	10
Somerset	↑	2	2	3	7
Staffordshire	↑	4	6	4	13
Suffolk	↓	12	30	4	15
Surrey	↓	17	17	3	3
East Sussex	→	6	9	8	14
West Sussex	↓	10	16	2	6
Tyne & Wear		3	3		

Table 3 (continued)

County	change 1993-4	% damaged grain 1993 mean	1993 maximum	1994 mean	1994 maximum
Warwickshire	→	2	6	2	6
Wiltshire	↓	5	18	5	8
North Yorkshire	↑	2	7	3	11
South Yorkshire	↑	2	6	6	8
West Yorkshire	→	4	4	2	2
Wales		2	2		
Scotland	↑	2	5	5	13
Northern Ireland				11	18

The worst case of damage was in a sample of Haven wheat from Oxfordshire. Here 97% of grain was damaged and the Hagberg falling number was 99. This level of damage would be associated with a yield loss of at least 50%. The second highest level of damage found was also on Haven, reflecting the higher susceptibility of this variety in 1993. Crops of Riband were also well represented among the more heavily damaged samples, probably reflecting this variety's popularity as a second wheat as well as greater susceptibility.

The insecticide usage on the sampled crops is not known, so meaningful comparisons can not be made between the average damage for varieties, as the crops represented may have received different treatment regimes.

Discussion

Overall the level of damage in 1994 declined by 36% from that found in 1993. In counties to the south, west and north of the previously heavily infested area damage increased by an average of 50%. Spray usage in these counties was minimal and this general increase in damage reflects the moderately favourable nature of the 1994 weather during the critical stages of the midge's life cycle.

Given that damaged grains are on average reduced in weight by one third the loss caused to the predicted 13.4 million tonnes UK wheat harvest for 1994 is estimated as 167,500 tonnes. Had a 50% increase on the 1993 damage level occurred across the whole country to give an averaged of 10% damaged grains, the yield loss would have been 442,000 tonnes. The spray usage against wheat blossom midge in 1994 is estimated by the agrochemical industry to have cost £6 million. The return in increased yield produced by this investment is calculated as £30 million. In addition the protection of grain quality will have resulted in better prices for many samples

Quality was low in many of the more heavily damaged samples. A clear correlation was not observed between damage levels and Hagberg falling numbers as these were only reduced in those cases where damage triggered pre-dormancy sprouting. Midge larval damage probably does not directly trigger sprouting, but predisposes the grain to it. In consequence earlier harvesting of midge damaged crops of milling wheat is recommended as a means of preserving grain quality.

A rough approximation can be made between the grain damage categories and the numbers of larvae likely to have returned to the soil in terms of the ADAS soil sampling categories. In fields with grain in the under 5% damaged category, following numbers in the soil are likely to be low posing little threat to following crops. Following the 5-10% damaged category numbers will be moderate posing a threat in seasons favouring midge attack. Following the 10% or more damaged category soil numbers will be high, posing a threat unless the season is unfavourable for midges.

To estimate the comparable risk for 1995 in the same terms as used in 1994 some account has to be made of the remaining larvae in the soil from 1993 (Table 4). The results suggest that if the weather pattern favours the midges (one in three probability) damage is possible in up to 34% of fields, unless the weather is particularly unsuitable for the midges (one in three probability) further damage is probable in 10% of fields. These figures compare with a projection of 21% probable and 50% possible damage to wheat crops for 1994. The weather proved to be marginally in favour of the midges resulting in justified spray action or crop loss in missed fields in approximately 27% of crops. There remains a one in three probability that the weather will be unfavourable for midge attack, with few if any crops requiring protection.

Effective control of midge attack in a crop is dependent on the accurate timing of control measures. This need is consistent with the economic and environmental requirements to restrict the use of insecticides to crops in which they are needed to protect yield or quality. Experience in 1994 confirmed that the combination of high midge numbers and suitable weather during the susceptible stages was necessary to put a crop at risk. Observation in the evening enables an assessment of both factors. Where midge numbers are assessed during the day unnecessary sprays may be applied unless account is made as to whether the weather is suitable in the evening. The critical factor is whether it is dry, temperatures are above 15° C and wind speeds are below 11 km/hour at 8.30 in the evening. Unless these conditions are achieved the midges can not fly up to lay eggs on the ears. In unsuitable weather conditions the midges can survive for up to two weeks waiting for a suitable night. Crops may remain at risk until the bulk of the ears are in flower.

Table 4 Projected orange wheat blossom midge risks for 1995, based on HGCA Cereal Quality Survey results.

	% in damage level /category		
grain damage	< 5%	5 - 10 %	> 10 %
resulting soil population	low	moderate	high
1993/94 figures	50	29	21
carry-over in 1993 wheat fields	93	6	1
estimate of 1994 addition	63	28	9
cumulative risk for 1995		34	10

Action threshold levels for numbers of midges seen laying eggs on the crop remain at the levels suggested for 1994 of:

feed wheats	seed and milling wheats
one or more midges per three ears OR 200 midges per m^2	one or midges per six ears OR 100 midges per m^2

The chemicals approved for control of wheat blossom midges (chlorpyrifos, fenitrothion and triazophos) are effective against both the adult midges and unhatched eggs. Other insecticides are effective under some circumstances, but results have been variable and where other insecticides are used effective control can not be guaranteed.

All of the insecticides active against wheat blossom midges are also toxic to a range of non-target insects. It is strongly recommended that a conservation headland is left unsprayed wherever an insecticide is sprayed against wheat blossom midges. Where the spray is applied promptly the midges are controlled nearly as well on the conservation headland as in the rest of the field. This is due to the extremely active nature of the midges in the hour before dusk, when they fly a considerable distance before settling to lay eggs, flying into and out of the sprayed parts of the field.

Conclusions

- Nationally 4.2 of grains were damaged by wheat blossom midge damage, representing a loss of crop worth £ 20 million.

- Levels of damage were lower in those areas where many fields were sprayed. In those areas where few crops were treated damage levels increased by 50% above 1993 values.

- Numbers of larvae returning to the soil will add to the threat posed to 1995 crop posed by larvae remaining in the soil from previous years. Given a moderately suitable year for the midges 10% of crops may be at risk in 1995, rising to as many as 44% of crops if the weather is highly favourable.

Appendix

Average percentage grain damage found by variety and county. Where the results from several samples are meaned, the total number of samples is given in parenthesis. Full information on derivation to county level is not available for Scotland or Northern Ireland.

Variety	Cambridge	Essex	Suffolk	Norfolk	Northants
Admiral		2.9 (2)			
Appollo	2.3			7.6	
Avalon	0.6				
Beaver		2.1 (2)	10.9	2.0 (2)	
Brigadier	2.3 (3)	2.8	3.1	2.1 (2)	
Cadenza	4.1		3.3	3.5	
Camp Remy	0.5				
Estica		6.2 (2)			
Galahad		5.1			
Haven			3.6 (3)		
Hereward	3.1 (2)	1.8		3.2 (2)	
Hunter	3.5 (4)	2.9 (4)		4.9 (4)	
Hussar		2.9 (2)	3.7 (2)	2.4	
Mercia	1.5		1.3 (3)	4.2 (2)	1.2
Pastiche					0.6
Riband	4.0 (6)	0.9 (2)	7.6 (4)	4.7 (2)	7.6 (3)
Slejpner					5.2
Soissons	2.5 (3)	0.6	0.6 (2)	1.3	2.8 (3)
Spark	13.2		0.9	4.3	
Axona		1.5			
Cannon					0.5

Variety	Beds	Herts	Bucks	Berks	Oxon
Beaver		2.0 (2)			
Brigadier		0.7 (2)			
Estica					1.5
Haven					96.5
Hereward		3.9	1.2	2.1	2.1 (2)
Hunter		3.6 (2)	7.1		0.8
Hussar				3.0	2.6
Mercia	1.2 (3)	1.6			
Riband	1.7	1.6	0.9	8.2 (2)	6.9 (2)
Soissons	1.9 (2)				4.7 (2)
Baldus			3.6		

Variety	Wilts	Dorset	Somerset	Devon	Cornwall
Beaver			7.2		
Brigadier	8.3	4.0			
Estica		1.1			
Haven				26.8	
Hereward	1.9	2.2	3.3	6.0	
Hunter	3.1 (2)	12.3			
Hussar	1.3		2.8	1.1	
Mercia		1.6	0.2		
Riband	4.9 (5)	6.7 (2)		0.7	
Soissons					3.6
Spark	6.5				
Axona	9.2				

Variety	Kent	Surrey	E Sussex	W Sussex	Hants
Avalon				1.0	
Beaver	5.8				
Brigadier	1.1				4.2 (2)
Genesis				0.5	
Haven			14.2		
Hereward	2.5 (2)		6.3	0.8	
Hunter	12.7 (2)			6.3	6.2
Hussar	1.0	3.1			10.6
Mercia					0.4
Riband	0.2				2.3 (2)
Soissons	6.4		3.9	1.8	4.9 (2)
Spark	5.5				
Axona	1.9				

Variety	Avon	Glos	Hereford & Worcs	Warwick
Beaver		10.0 (2)		
Brigadier	1.1			
Cadenza				1.6
Haven			0.6	
Hereward		3.8	1.2	0.8
Hunter		3.4 (2)	7.8	
Hussar				1.8
Mercia				0.9 (2)
Riband		5.5 (2)	3.4 (6)	2.1 (2)
Soissons	3.3			5.8
Zodiak			1.8	

Variety	Leics	Notts	Derby	Lincs	Humberside
Admiral					6.0 (2)
Avalon				5.3	
Beaver		6.3 (2)		5.8	
Brigadier		0.7 (2)		3.9 (6)	7.9 (3)
Cadenza				6.5	
Estica				2.1	
Haven			4.7		12.9
Hereward	2.7 (2)	6.5 (2)		1.7 (4)	7.4 (3)
Hunter	3.1 (3)			2.0 (2)	6.7 (2)
Hussar				3.6 (5)	3.3 (3)
Mercia				3.7	5.2
Rialto					8.1
Riband	1.9 (3)	5.8 (3)	10.6	4.2 (12)	3.9 (4)
Slejpner				2.1	3.4 (2)
Soissons	3.9 (3)			2.5 (2)	
Spark				2.5	
Spartan			7.4		
Axona				3.5 (2)	
Baldus				5.2	
Tonic				3.2	

Variety	Staffs	Shrops	Cheshire	Merseyside	Lancs
Beaver				4.8	
Brigadier		9.8			
Galahad		5.8			
Haven			8.9		
Hunter	13.2		3.2		
Mercia	1.1	0.6			
Riband	1.2	3.2 (5)			5.9 (2)
Zodiak	1.0				

Variety	South Yorks	West Yorks	North Yorks	Cleveland	Durham
Brigadier		2.1	2.8 (3)		
Estica	3.5				
Haven			3.7 (2)		
Hereward	5.9	0.9	2.5 (6)		
Hunter			5.1		2.2
Hussar			2.3 (2)		
Mercia			1.0		
Riband	5.6		3.3 (6)		5.3 (2)
Soissons			1.3		
Spark				4.5	
Tonic	8.0		4.9		

Variety	Northumberland	Scotland	Northern Ireland
Haven	4.7		
Hereward	2.3 (2)		
Hunter		5.2 (2)	
Hussar			3.6
Mercia	6.6		
Riband	5.2	4.4 (9)	17.8