MEADOW-GRASS GALL MIDGE

LARS MONRAD HANSEN

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FOR FOOD AND AGRICULTURE
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Lars Monrad Hansen

Aarhus University
Department of Agroecology
Forsøgsvej 1
4200 Slagelse

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Authors: Lars Monrad Hansen, Department of Agroecology

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Abstract

The area with meadow-grass (*Poa pratensis*, L.) grown for seed production in Denmark is a significant proportion of the entire seed production. The meadow-grass gall midge (*Mayetiola schoberi*, Barnes 1958) is of considerable economic importance since powerful attacks can reduce the yield drastically. It overwinters as larvae in a puparium, in the soil, and begins to hatch on average in late April, but the time is depending on the temperature. Emergence of the meadow-grass gall midge in spring takes place over a 2-3 week period.

Beginning of emergence of the meadow-grass gall midge takes place after the puparies have obtained 114 ± 21 day-degrees calculated from January 1st, with a biological development zero at 5 °C. The top of the flying curve achieves after 179 ± 29 day-degrees.

With this information, the farmers can fairly accurately spray just before the flight curve has its maximum. Therefore, the spraying frequency could be lowered significantly and in many cases lowered to only one insecticide application in meadow-grass every year.

Introduction

The area with meadow-grass (*Poa pratensis* L.) grown for seed production in Denmark is about 9.000 hectares and is a significant proportion of the entire seed production. Especially the meadow-grass gall midge (*Mayetiola schoberi* Barnes 1958) is of considerable economic importance, since powerful attacks can reduce the yield drastically (Barnes 1958a, Barnes 1958b). Only few papers are published on the meadow-grass gall midge in refereed periodicals and nothing in the last 30 years. Therefore, there is no information about the relation between the number of meadow-grass gall midges and yield loss. However, the cost of an insecticide application is only about 18 € per hectare which is equivalent to about 1% of the yield. Consequently many growers are every year routinely spraying their fields 2-3 times with an insecticide. This frequency of insecticide application is so high that with reference to ecological reasons it would be desirable to have it reduced.

The meadow-grass gall midge overwinters as larvae in a puparium, in the soil. In spring, the puparies move up to the surface where they can often be seen at the bottom of the crop. They begin to hatch on average in late April, but the time is depending on the temperature. Here, they mate, lay eggs on meadow-grass plants, after which the adults dies (Thygesen 1964). After hatching of the eggs the larvae moves to the main shoot of the plants where they produce galls. The larvae secrete various chemical compounds in connection with their food intake, which means that the plants in worst case will die but in most cases will be prevented from producing a seed stem. The larvae from this first generation are the harmful generation.

If there is no meadow-grass crop in the field for the gall midges to emerge up into, they must fly to another field with the host crop. Because of the gall midges are poor fliers many gall midges die in this flight. This is also the reason why there usually are relatively few meadow-grass gall midges in a first year's meadow-grass crop. However, in a second year's crop the infestation level can be extremely high and even higher in a third year's crop.

In Denmark, the meadow-grass gall midge has two generations, which also is the case in The Netherlands (Nijveldt 1980). Most of the eggs laid by the first generation in April to May will develop to puparies and overwinter until next spring. However, a smaller percentage will hatch in August-September. This second generation does not

in itself damage the crop, but will contribute to the reproduction and hence a higher number of gall midges in spring.

Emergence of the meadow-grass gall midge in spring takes place over a 2-3 week period. Time of emergence can be found by using water traps placed in the crop and then regularly examined for the presence of meadow-grass gall midges, but this is an extraordinarily laborious process.

However, it must be assumed that the temperature is an essential factor for the time of emergence of the meadow-grass gall midge. Therefore, it should be possible to calculate the number of day-degrees necessary for the emergence of the meadow-grass gall midge in spring. Consequently, a temperature model can be produced, and forecast of the flight time of the meadow-grass gall midge can then be given. After this farmers can fairly accurately spray just before the flight curve has its maximum, which means the spraying frequency could be lowered significantly. In many cases lowered to only one insecticide application every year but with a maximum of two applications in few fields.

This article describes a model for the emergence and maximum flight of the meadow-grass gall midge based on temperature measurements.

Material and methods

Every early April in the period 2003 to 2010 white water traps (Lewis 1959, Pollet and Grootaert 1994) were placed in meadow-grass fields located near the Department of Pest Management. Three water traps were placed in each of 3 fields about 50 metres from the edge. The water traps were placed in an equilateral triangle with 10 meter sides. The insects in the water traps were sampled twice a week, from the time of placement over the time of maximum flying of the meadow-grass gall midge to a point where the flying obviously was declining. This was a period of 3-4 weeks.

The sampled insects were placed in 70% alcohol, transported to the laboratory where they were identified and counted. Meteorological data were recorded at the Department's meteorological weather station located 2-3 km away from the experimental fields.

Microsoft Office Excel 2003 was used to calculate the statistics, and the number of day-degrees for beginning and maximum flight, calculated from individual integer values of biological development zero temperatures.

The selected biological development zero was determined as the number of day-degrees, which has the smallest percentage difference of standard error of mean in relation to the mean value. Initial flight is defined as the time when there were found more than 0.5 meadow-grass gall midges per trap per day. Maximum flight is defined, as the time for most meadow-grass gall midges were caught per trap per day.

The model is constructed on data from 2003 -2009 and verified on data from 2010.

Results and discussion

Flying curves of the meadow-grass gall midge are shown in figure 1. It is obvious that there is a big difference between the years.

In table 1, dates of beginning and maximum flight are shown. For the beginning of flight, there is a difference of 23 days from the earliest to latest. For the maximum flight, the difference is 22 days.

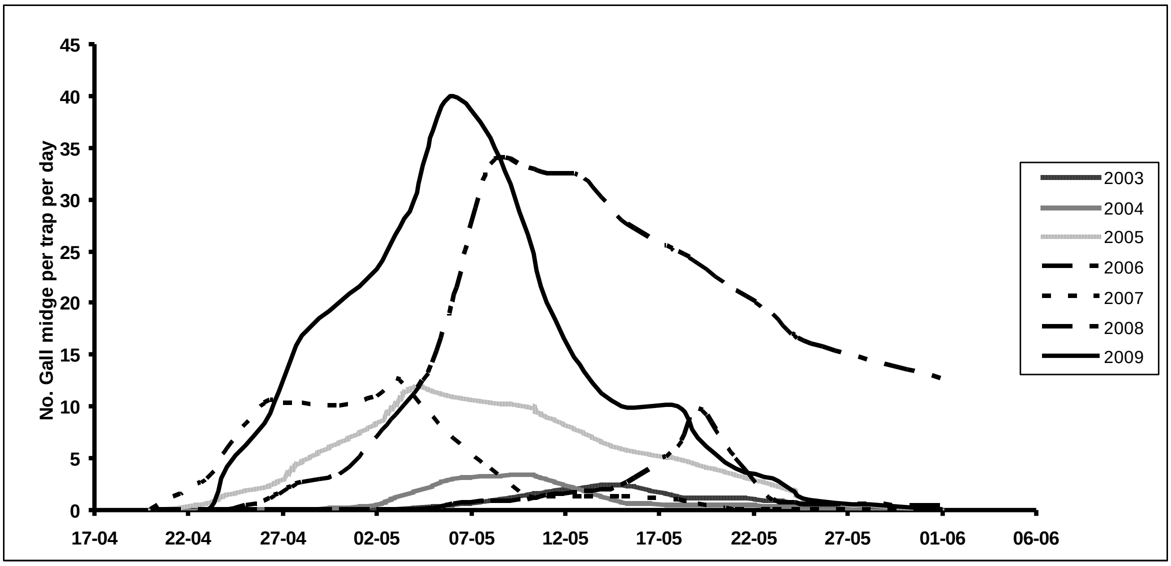

Figure 1. Flying curves of the meadow-grass gall mid

Since the biological development zero is not known for the meadow-grass gall midge, different number of day-degrees, are calculated for individual development zero temperature. Only integers are used, and it is probable that these results will be a little different if they were obtained by laboratory experiments. However, it is considered that an integer value is sufficient for a practical point of view. The results are shown in Table 2. As shown 5 °C is the biological development zero which has the smallest percentage difference of standard error of mean in relation to mean. Therefore, beginning of flight is calculated to 114 ± 21 day-degrees.

Table 1. Dates of beginning and maximum flight of the meadow-grass gall midge

Year	Beginning of flight	Maximum flight
2003	4 May	13 May
2004	30 April	8 May
2005	27 April	4 May
2006	7 May	19 May
2007	21 April	1 May
2008	28 April	8 May
2009	25 April	6 May
2010	14 May	23 May

In Table 3 the results of maximal flight are shown. The biological development zero can also here be chosen to 5 °C by the same criteria as above, which strengthens the case that 5 °C is a practical value. The maximum flight can then be estimated to 179 ± day degrees.

Table 2. Day-degrees for beginning of flight calculated for different temperatures as biological development zero

Year	Biological development zero, °C					
	3.0	4.0	5.0	6.0	7.0	8.0
	Day-degrees					
2003	226	171	125	89	63	44
2004	203	153	110	73	45	26
2005	178	127	87	54	31	17
2006	185	145	107	76	52	38
2007	306	227	154	94	53	28
2008	265	180	111	60	31	19
2009	192	141	103	73	49	29
Mean	222	163	114	74	46	29
Standard error of mean (SEM)	47	33	21	14	12	10
Pct. SEM/Mean	21	20	18	19	25	34

Table 3. Day-degrees for maximum flight calculated for different temperatures as biological development zero

Year	Biological development zero, °C					
	3.0	4.0	5.0	6.0	7.0	8.0
	Day-degrees					
2003	307	243	188	143	108	80
2004	276	217	166	121	85	58
2005	234	176	129	89	59	37
2006	291	239	190	146	111	85
2007	397	307	224	154	104	68
2008	357	262	183	122	84	61
2009	285	223	174	133	98	67
Mean	307	238	179	130	93	65
Standard error of mean (SEM)	54	41	29	22	18	16
Pct. SEM/Mean	18	17	16	17	20	24

Puparies overwinter in the upper soil layers, so it is the soil temperature that should be measured to obtain the right number of day-degrees. However, the soil temperature is highly dependent on soil type, which means that if the soil temperature is not measured in the same soil type as the puparies are in the number of day-degrees will be calculated incorrectly. Therefore, for a more general forecast model , it is better using air temperature than soil temperature.

It is well known that gall midge puparies will not continue their development after winter diapause if the soil is too dry (Noll 1959). The amount of precipitation for 60 days before flying is shown in table 4. Apparently, this precipitation is sufficient, so the meadow-grass gall midge will not have their development postponed because of extremely dry soil. Therefore, it can be concluded that a model for the meadow-grass gall midge flying in spring can be constructed on the present data exclusively based on air temperature.

In 2010, 114 day-degrees (beginning of flying) were obtained 10 May. From table 1, it can be seen that the actual flying began 14 May. 179 day-degrees (maximal flying) were obtained 22 May. From table 1, it can be seen that the actual flying began 23 May.

It can be concluded that the model constructed on data from 2003 - 2009 fits exceptionally well the data from 2010. With the present model the farmers can fairly accurately spray just before the flight curve has its maximum. Therefore, the spraying frequency could be lowered significantly and in many cases lowered to only one insecticide application per field every year.

Table 4. Millimetre precipitation for 60 daays before beginning of flying

Year	Precipitation (mm)
2003	63
2004	105
2005	51
2006	73
2007	68
2008	83
2009	65
2010	62

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Department of Animal Science
Department of Food Science
Department of Agroecology
Department of Engineering
Department of Molecular Biology and Genetics

DCA can also involve other units at AU that carry out research in the relevant areas.

SUMMARY

The area with meadow-grass (Poa pratensis, L.) grown for seed production in Denmark is a significant proportion of the entire seed production. The meadow-grass gall midge (Mayetiola schoberi, Barnes 1958) is of considerable economic importance since powerful attacks can reduce the yield drastically. It overwinters as larvae in a puparium, in the soil, and begins to hatch on average in late April, but the time is depending on the temperature. Emergence of the meadow-grass gall midge in spring takes place over a 2-3 week period.

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