Population Dynamics of the Leafhopper *Psammotettix alienus* Dahlb. and Two-Year Investigations into the Occurrence of *Wheat dwarf virus* (WDV) in Crops of Winter Barley Located in the Middle German Dry Region, Germany

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Abstract

From 2000 to 2001 the population dynamics of *Psammotettix alienus* Dahlb. were recorded using a sweep-net or a biocoenometer. The investigations were carried out in Zscherben near Halle (Middle German Dry Region). The imagines of the first generation of *P. alienus* could be observed for the first time at the beginning of May (2000) and at the end of May (2001), respectively. According to our results, in this area three generations of *P. alienus* are developed. In both years of our observations the barley-strain of *Wheat dwarf virus* (WDV) occurred. The main important infections appeared in autumn. Furthermore, during the whole period of our investigations the percentage of viruliferous individuals which were caught was recorded by means of a biological test. In June this percentage achieved 84.0% (2000) and 76.7% (2001), respectively. In the course of summer months of both years the percentage of viruliferous *P. alienus* decreased. In autumn of the year 2000 an increasing portion followed once again. However, in the year 2001 a continual reduction from > 70% in June to < 5% in late autumn could be observed.

Keywords: *Wheat dwarf virus*; WDV; *Psammotettix alienus* Dahlb.

INTRODUCTION

Since 1995 the occurrence of *Wheat dwarf virus* (WDV) has been recorded in the southern part of Saxony-Anhalt (FUCHS *et al.* 2001). This virus appears in crops of winter barley every year. However, the percentage of infected plants varies to a great extent from year to year as well as from field to field. Winter wheat suffers infections by WDV on a mentionable scale only in the case of an early sowing at the end of August or early September (MEHNER *et al.* 2001). Compared to WDV the BYDVs (*Barley yellow dwarf viruses*), which have been also registered, are a greater threat to both cereals. Frequently, the last mentioned viruses cause epidemics. The field experiments were carried out in Zscherben located in the Middle German Dry Region near Halle (Saxony-Anhalt). We used crops of winter barley and triticale (autumn 2001). Our investigations enclosed the following main points:

- Population dynamics of *Psammotettix alienus* Dahlb. (imagines and L5-instar) in the course of year.
- Detection of the share of viruliferous leafhoppers (only imagines) in the total field population in dependence on the time of year.
- Investigations of WDV and BYDVs incidence.

Finally, we make an attempt to find out relationships between these parameters.

MATERIALS AND METHODS

In the year 2000 our experiments were carried out in a crop of winter barley in Zscherben. In autumn 2000 the observations have been continued using a neighbouring field, likewise cultivated with winter barley. In autumn 2001 the last named site served further on as experimental field. The harvested barley was followed by triticale. It belongs also to the host plants of WDV (FUCHS *et al.* 2001).

The population dynamics of *P. alienus* were studied at intervals of 14 days from April/May to December. The leafhoppers were caught by means of a sweep-net (diam. 30 cm) and/or a biocoenometer (diam. 57 cm) with exhaustor. For each sampling 4 × 100 swing slaps with a sweep-net or 4 × 5 spots with a biocoenometer (altogether 5 m²) were needed considering four different points in the field.

In intervals of 14 days about 25 imagines caught with a sweep-net or biocoenometer were individually conveyed to a healthy barley plant at 2 to 3 leave stage. After 7 days a further transmission was carried out to healthy wheat plants at the same growing stage and also for a feeding period of 7 days. Four weeks p.i. the test plants were inspected for WDV by means of DAS-ELISA, in order to recognize the transmission of barley and wheat strain, respectively. All individuals of *P. alienus*, which could be found again, were preserved in 70% alcohol. Later on, we checked for the presence of WDV in single leafhoppers using the PCR.

30 subsequent single plants from five different points of the field (four sides of the field and the centre) were collected and tested for virus incidence by means of DAS-ELISA. The serological investigations were carried out in autumn, in spring – prior to the hatching of overwintered *P. alienus* – as well as in early summer.

RESULTS AND DISCUSSION

The population dynamics of *P. alienus* are demonstrated in Figures 1 and 2. In 2000 the first nymphs of the fifth instar were netted in the beginning of May, but in 2001 only at the end of May. Obviously, three generations were developed in 2000 and 2001.

Tables 1 and 2 comprise the average numbers of imagines which were caught per months as well as the percentage of viruliferous individuals. In both years, from May to early in July, the portion of leafhoppers which were able to transmit the virus into plants successfully achieved about 50% (maximum: 84% in 2000; 76.7% in 2001). This value declined to about 10% determined in stubble-regrowth from the end of July to September. In autumn 2000 (November) we observed a renewed rise to 34.3% in crops of autumn-sown winter barley. In the following year such an increase in viruliferous individuals failed to appear. However, we used a crop of triticale as experimental field. The detection of WDV in imagines of *P. alienus* using the biological test and the PCR led to comparable results. Table 3 informs about the experiments from 2001.

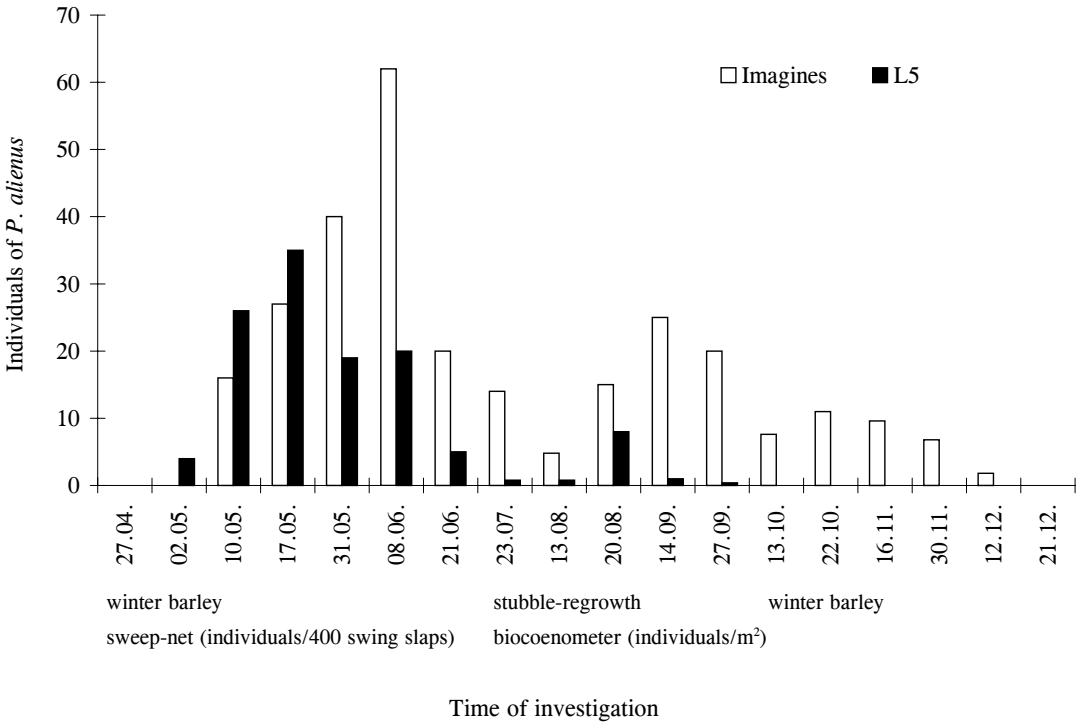

Figure 1. Population dynamics of *P. alienus* (imagines, L5 – instar) in crops of winter barley in 2000 in Zscherben (Saxony-Anhalt, Germany)

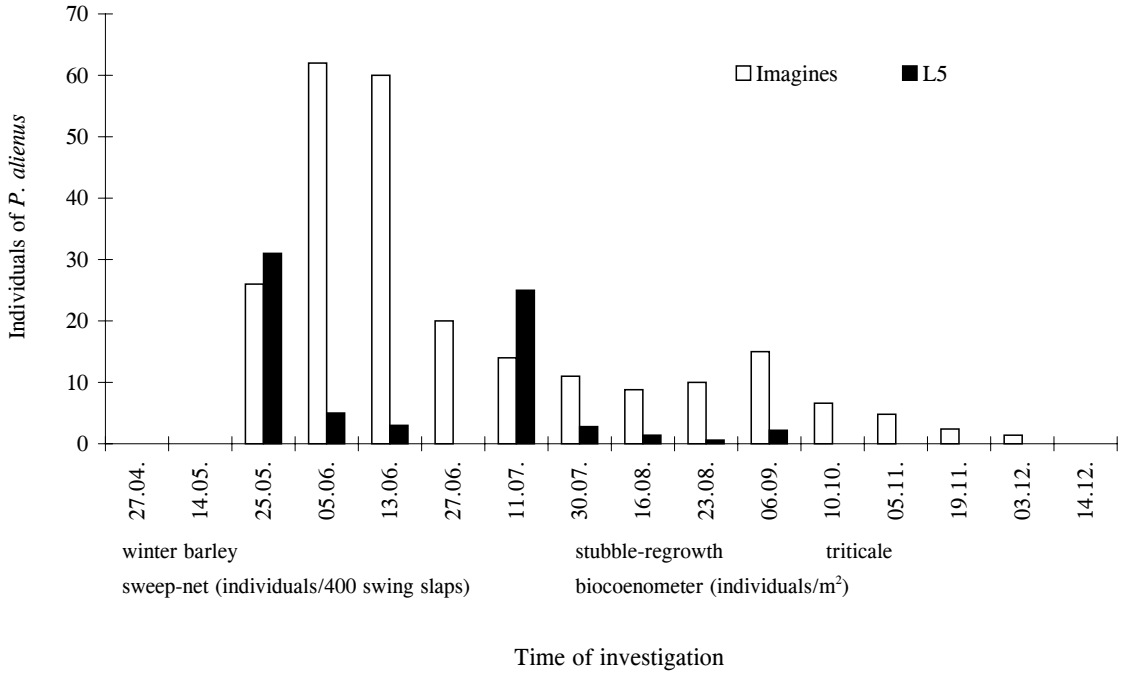

Figure 2. Population dynamics of *P. alienus* (imagines, L5 – instar) in crops of winter barley and triticale in 2001 in Zscherben (Saxony-Anhalt, Germany)

The portion of WDV carrying individuals (viruliferous individuals as well as individuals with a positive PCR reaction) reached to 19% on average. However, only 90% of all tested leafhoppers corresponded with regard to the biological test and PCR. About 7% of tested *P. alienus* reacted positively using PCR. Obviously, these individuals had incorporated WDV. But they were unable to surrender this virus to plants of barley or wheat. 2.7% of tested individuals showed a contrary situation.

As to the course of WDV incidence (Table 4) in crops of winter barley which were under observation considerable differences between 2000 and 2001 could be noted. In autumn of the years 1999 and 2000 the percentage of infected plants reached with 16% and 14.7%, respectively, an almost corresponding level. In spring 2000 (March/April), the value rose to 38.9%. However, in 2001 the attack went back to 10.7%. But it is to bear in mind, that only a seeming increase or decrease may be possible. Plants infected in late autumn are not recognized as virus-diseased by ELISA in November. Furthermore, an early WDV infection entails the death of diseased plants during the winter. They are not considered for sampling and testing in the

Table 1. Incidence of *P. alienus* (imagines) in crops of winter barley and percentage of viruliferous individuals after biological testing in Zscherben (Saxony-Anhalt, Germany) in 2000

Method of catching/ time of investigation	Sweep-net (individuals/ 400 swing slaps)		Biocoenometer (individuals/m^2)					
	May	June	July	August	September	October	November	December
Number of caught imagines of *P. alienus*	83	82	14.0	19.8	45.0	18.6	16.4	1.8
Percentage of viruliferous individuals	not tested	78.6	16.0	0.0	18.5	5.0	34.3	31.3
Crop	Winter barley		Stubble-regrowth			Winter barley		

Table 2. Incidence of *P. alienus* (imagines) in crops of winter barley and percentage of viruliferous individuals after biological testing in Zscherben (Saxony-Anhalt, Germany) in 2001

Method of catching/ time of investigation	Sweep-net (individuals/400 swing slaps)			Biocoenometer (individuals/m^2)					
	May	June	beginning of July	end of July	August	September	October	November	December
Number of caught imagines of *P. alienus*	26	142	14	11.0	18.8	15.0	6.6	7.2	1.4
Percentage of viruliferous individuals	56.0	55.6	47.8	10.0	1.3	2.1	0.0	2.7	not tested
Crop	Winter barley			Stubble-regrowth			Triticale		

Table 3. Detection of WDV in individuals of *P. alienus* from Zscherben (Saxony-Anhalt, Germany) using biological test and PCR in 2001

Origin of *P. alienus*: Date	Detection of WDV by means of a biological test		Detection of WDV by means of PCR		Comparison between biological test and PCR			
	number of tested *P. alienus*	rate of transmission* (%)	number of tested *P. alienus*	percentage viruliferous individuals	Biol. test +/PCR +	Biol. test –/PCR +	Biol. test +/PCR –	Biol. test –/PCR –
Winter barley								
28.05.	25	56.0	11	45.5	3	2	3	3
05.06.	30	76.7	21	95.2	16	4	0	11
13.06.	30	46.7	11	63.6	6	1	0	4
20.06.	30	43.3	6	50.0	0	3	1	2
12.07.	23	47.8	18	55.6	5	5	2	6
Stubble-regrowth								
31.07.	30	10.0	22	13.6	1	2	0	19
10.08.	25	0.0	18	0.0	0	0	0	18
17.08.	28	3.6	17	0.0	0	0	0	17
24.08.	25	0.0	15	0.0	0	0	0	15
07.09.	48	2.1	42	0.0	0	0	1	41
Triticale								
10.10.	30	0.0	22	4.5	0	1	0	21
22.10.	30	0.0	22	0.0	0	0	0	22
06.11.	44	0.0	23	0.0	0	0	0	23
22.11.	30	6.7	10	0.0	0	0	0	10
Total	428	19.2	258	19.0	31 (12.0%)	18 (7.0%)	7 (2.7%)	212 (78.3%)

* successful transmission to healthy barley plants

Table 4. Incidence (%) of WDV and BYDVs in barley and triticale from 2000 to 2002 in Zscherben (Saxony-Anhalt, Germany)

Time of investigation	1999/2000 (winter barley)		2000/2001 (winter barley)		2001/2002 (triticale)	
	WDV	BYDVs	WDV	BYDVs	WDV	BYDVs
Autumn	16.0	0.7	14.7	10.0	0.0	41.3
Spring	38.9	0.0	10.7	39.3	0.0	78.0
Early summer	15.3	1.3	64.7	6.0	2.7	42.7

following spring. Nearly all infected plants are dying during the spring up to the early summer and they are not available for testing in June. In early summer 2000 it could be detected about 15% newly infected plants, but in June 2001 about 65%. This difference is not to explaine by the population dynamics of *P. alienus*. The course of vector incidence corresponded in both years to a great extent, apart from the different date of the first appearance. The BYDVs which were recorded in addition to WDV showed an increasing occurrence. The percentage of infected plants changed from 0% (spring 2000) over 39.9% (spring 2001) to 78% (spring 2002).

On the basis of our presented results it is possible to give the following conclusions:

Obviously, in the Middle German Dry Region, three generations of *P. alienus* are developed, especially under warm weather conditions. The first nymphs of the fifth instar and imagines appear between the beginning (2000) and the end (2001) of May (MANURUNG *et al*. 2002).

In spring (May and June), the portion of viruliferous individuals detected by means of the biological test attains relatively high values [50% on average; maximum (2000): 84%]. In contrast to this a very low level is to observe in stubble-regrowth from the end of July to September. During the autumn months the percentage of viruliferous individuals can somewhat increase (2000) or not (2001). The differences are not explainable.

Our results elucidate two periods for a preferred transmission of WDV by *P. alienus*: from May to June as well as from September to November. In the spring the threat to barley crops is somewhat smaller, for the population density of leafhoppers has normally a low level. As *P. alienus* is capable of developing a second and third generation the peak density of individuals could appear in September. In connection with a relatively high portion of viruliferous leafhoppers autumn-sown cereal crops are especially endangered, above all winter barley and early sown winter wheat. WDV infections in spring are observed to a different extent, but they have no or nearly no influence on the yield.

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