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SPATIAL DISTRIBUTION OF CEREAL APHIDS (HEMIPTERA: APHIDOIDEA) IN SERBIA

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Abstract

From 2004-2006 we surveyed aphids in cereal fields in Serbia. The spatial distribution among the sampling units was evaluated using the parameters of Taylor's power law. In our study of the three cereal aphid species [*Sitobion avenae* (F.), *Metopolophium dirhodum* (Walker) and *Rhopalosiphum padi* (L.)], Taylor's slope (b) values were indicative of an aggregated distribution among sampling units, although *M. dirhodum* showed a weaker aggregation trend on wheat than on rye. Also, in the paper we discussed relationships between the spatial distribution of aphids and their natural enemies.

KEY WORDS: Cereal aphids, Serbia, spatial distribution

Introduction

In Serbia, cereal agroecosystems of about 600,000 ha represent one of the most common crop cultures. Cereal aphids are generally one of the most important insect pests and limiting factors in cereal production worldwide (VICKERMAN & WRATTEN, 1979; D'ARCY & MAYO, 1997). The pest status of cereal aphid species depends on the region and is influenced by a complex of factors (clima, biotype status, seasons, life cycles, agrotechnical practices, natural enemies) (VICKERMAN & WRATTEN, 1979; DEAN *et al*., 1981; PLANTEGENEST *et al*., 1996). Although there are many publications about the spatial distribution of cereal aphids, none exist for the region of southeastern Europe. Spatial distribution of cereal aphids is affected by climatic condition and some biotic factors such as the quality of the host plant, dispersal efficacy and natural enemies (MANN *et al.*, 1995; ELLIOTT & KIECKHEFER, 2000). Knowledge of the spatial structure of cereal aphids within the field scale could be important for the purposes of pest management (WEISZ *et al.*, 1995; WINDER *et al.*, 1999). THIES *et al.* (2005) concluded that cereal aphid-parasitoid interactions are affected by processes acting on the landscape generally, rather than on individual habitats. The most important cereal aphids in Serbia are *Sitobion avenae* (F.), *Metopolophium dirhodum* (Walker) and *Rhopalosiphum padi* (L.) (PETROVIĆ, 1996).

For this paper the spatial distribution of cereal aphids in selected experimental wheat and rye fields in Serbia from 2004-2006 was studied.

Material and Methods

During the period 2004-2006 we surveyed live aphids in wheat and rye fields in Surčin and Galovica (44° 47' 21.60'' N, 20° 21' 20.18'' E). The experimental fields of wheat (Surčin 2004-2006) and rye (Galovica 2004-2005) were selected to study the spatial distribution of cereal aphids. These specific areas were chosen after samplings during the previous years indicated levels of heavy infestation by cereal aphids. All the experimental fields were situated on the southeastern edge of the Pannonian plain which is characterized by relatively low humidity and a wide range of seasonal temperatures (summer-winter). From May until July, samples were taken weekly in Surčin and Galovica from 10 preselected points, 20 m apart, within each field (two rows with five points in each row). From each point on each sampling date, 10 stems (KAVALLIERATOS *et al.*, 2002b) were collected at least 50 m from the edge of the field. All fields covered approximately 5-6 ha, were quadrate or subquadrate, were kept free from insecticidal applications, and had 500-600 plants/ m2. To avoid an increase in the number of specimens during transport to the laboratory, the number of different aphid species was counted in the fields. As well, all aphids were identified in the fields at the time of counting.

The spatial distribution among sampling units was evaluated by using the parameters of Taylor's power law (SOUTHWOOD, 1978; TAYLOR, 1984). This law describes the regression between variance and mean following a logarithmic transformation, according to the equation:

$$\log(s^2) = a + b\log(\bar{x})$$

where s^2 is the variance, $\bar{x}$ is the mean, a is the y-intercept and b is the slope of the regression line. This equation can be transformed as follows (SOUTHWOOD, 1978):

$$s^2 = A\bar{x}b$$

where *A* is the antilogarithm of a and constitutes a scaling factor dependent on the sampling unit and *b* is an index of species spatial pattern, with $b<1$, $b=1$ and $b>1$ indicating uniform, random and aggregated spatial pattern respectively (SOUTHWOOD, 1978; TAYLOR, 1984; DAVIS, 1994).

Results

To estimate the spatial distribution pattern of three of the most common aphid species (*S. avenae*, *M. dirhodum* and *R. padi*), during the period from 2004-2006 we applied the parameters of Taylor's power law (Tab. I). The slope (*b*) values of all three species were significantly different from 1, but only in the case of *S. avenae* and *M. dirhodum* on wheat were the y-intercept values significantly different from 0 for all the years examined (data for all sampling seasons were combined to obtain a sufficient number of mean-variance pairs). Also, the correlation coefficient values for Taylor's model were significantly different from 0. Hence, this model accurately describes the mean-variance linear relation for the current data set, at least in the case of the most abundant aphid species.

Table I. Taylor's estimates for each species, on each commodity
(for the combined data of all sampling seasons, for the most abundant aphid species).

Species	n^a	$a \pm SE^b$	$b \pm SE^c$	R^d
Sitobion avenae (F.) (wheat)	23	2.4 ± 0.8*	1.9 ± 0.2**	0.87***
Metopolophium dirhodum (Walker) (wheat)	22	1.4 ± 0.6*	1.4 ± 0.2**	0.92***
Rhopalosiphum padi (L.) (wheat)	20	1.4 ± 0.5*	1.8 ± 0.4**	0.85***
Sitobion avenae (F.) (rye)	18	0.9 ± 0.7	1.8 ± 0.3**	0.96***
Metopolophium dirhodum (Walker) (rye)	16	1.5 ± 1.7	1.7 ± 0.3**	0.94***
Rhopalosiphum padi (L.) (rye)	16	1.3 ± 1.5	1.9 ± 0.5**	0.92***

[a] number of mean-variance pairs used in the analysis
[b] value of *y*-intercept for Taylor's regression
[c] slope value for Taylor's regression
[d] Correlation coefficient value for Taylor's model
* significantly different from 0 (two-tailed *t*-test at *n*-2 *df*)
** significantly different from 1 (two-tailed *t*-test at *n*-2 *df*)
*** significantly different from 0 (two-tailed *t*-test at *n*-2 *df*)

Discussion

In our study of the three cereal aphid species (*S. avenae*, *M. dirhodum* and *R. padi*), Taylor's slope (*b*) values were indicative of an aggregated distribution among sampling units both on wheat and rye. All three species showed a very similar aggregated capability on both crops, although *M. dirhodum* showed a weaker aggregation trend on wheat than on rye. The aggregated spatial distribution of cereal aphids is supported in several previous papers (DEAN & LUURING, 1970; WINDER *et al.*, 1999; FIEVET *et al.*, 2007). WINDER *et al.* (1999) reported a lesser aggregation intensity in comparison with the present results. In their study, the authors underlined the ephemeral nature of this aggregation, given that aggregation patterns among sampling dates were not associated. The present results are in accordance with the spatial distribution pattern of *Myzus persicae* (Sulzer) in tobacco fields (ATHANASSIOU *et al.*, 2005). Furthermore, KAPATOS *et al.* (1996) noted that in a cotton field in central Greece Taylor's estimates accurately described the aggregation pattern of *Aphis gossypii* Glover, supporting the wide applicability of Taylor's Power Law. Apparently, climatic conditions and intrinsic biological factors determine the aggregated distribution pattern of cereal aphids in cereal crops. Until now, no studies about spatial distribution of cereal aphids have been conducted in southeastern Europe. Evaluation of the spatial distribution pattern is very important for developing sampling plans which are among the key elements in pest management strategies. ATHANASSIOU *et al.* (2005) used Taylor's estimates to develop a sampling plan for aphids and the predator *Macrolophus costalis* (Fieber) on tobacco, based on the presence/absence of sampling units, as well as on the calculation of the optimum sample size and on the accuracy (precision) in estimating the mean. It is well- established that aphids indicate an aggregated spatial distribution among sampling units (KAVALLIERATOS *et al.*, 2002a, 2005). Hence, aphid sampling may not be accurate, since strong aggregation exponentially increases the required sample size, while at the same time decreases the accuracy of the sampling (KAVALLIERATOS *et al.*, 2005). Apparently, parasitic wasps also have an aggregated distribution among sampling units, as a direct consequence of the aphids' spatial pattern. However, different parasitoid species may have different spatial trends. Even in the case of low parasitism rates, some parasitoids may not follow the points with high insect densities and remain at more isolated host groups. For instance, in citrus trees, KAVALLIERATOS *et al.* (2002a) found that the the parasitic activity of *Binodoxys angelicae* (Halliday) was well "connected" with large aphid groups, while *Aphidius colemani* Viereck was found in more isolated groups. Apart from density-independent factors, natural enemies play an important role in the development of locally-developed aphid populations - even indirectly - since the presence of natural enemies is positively correlated with the host's aggregation (GOWLING & VAN EMDEN, 1994). Generally, the spatial distribution of prey is one of the key elements that determine prey suppression, and suppression is likely to be more efficient in the case of specialized natural enemies that respond more easily to aggregation cues (BOMMARCO *et al.*, 2007).

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ПРОСТОРНА ДИСТРИБУЦИЈА ЖИТНИХ ВАШИЈУ (HEMIPTERA: APHIDOIDEA) У СРБИЈИ

ЖЕЉКО ТОМАНОВИЋ, НИКОЛАС Г. КАВАЛИЕРАТОС И ХРИСТОС Г. АТАНАСИУ

Извод

У периоду 2004-2006 сакупљане су житне ваши са поља пшенице и ражи у околини Београда. Просторна дистрибуција између јединица узорака је анализирана Тејлоровом једначином. Наши резултати су показали да за три врсте житних вашију (*S. avenae*, *M. dirhodum* и *Rhopalosiphum padi*), Тејлорова (б) вредност указује на агрегатну дистрибуцију између узоркованих јединица, мада врста *M. dirhodum* је показала слабији агрегацијски тренд на пшеници него на ражи. Такође, у раду су дискутовани односи између просторне дистрибуције житних вашију и њихових природних непријатеља.

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