

Full Length Research Paper

A regression on population fluctuations of Hemiptera in durum wheat cultivations in Western Macedonia, Greece

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The purpose of this study was to monitor population fluctuations of various species of Hemiptera during the growing season of durum wheat, in years 2009 and 2010. Samplings of insects were taken in eight periods to cover the late stages of durum wheat. Five Hemiptera species were recognized, three Pentatomoidea and two aphids. Sampling period showed the greatest differences ($p < 0.00001$). The obtained data showed that in the first sampling period, Pentatomoidea insect populations were low, reaching maximum between 4th and 5th period, except for *Eurygaster maura* which exhibited maximum between 3rd and 4th period. The aphid species exhibited almost the same behavior, where *Sitobion avenae* showed a rather unstable behavior in the second year of monitoring, but interaction between year and sampling periods was not found. *E. austriaca*, showed a few differences in number of individuals ($p < 0.005$) between the two years of experimentation. Maximum number of insect individuals found on each plant was between 7-8 for all insect species and total average values were lower. *Toxoptera gramineum*, showed the highest total average values for both years of monitoring, but this population size is not considered capable to cause serious damages. Damage level must always have to be decided in combination to other insect pest species. Cold weather may reduce total insect population, but it seems that within these years while temperature is increasing populations of the Hemiptera species tend to be lower.

Keywords: Durum wheat, population fluctuations, recording period, damage level.

INTRODUCTION

Cereals are of great importance in cultivations of the region of Western Macedonia, Greece and thus their enemies are studied thoroughly for species composition, seasonal dynamics and pest status of insects in relation to the region of cultivation.

Hemiptera is an important order of insects that often are described as the true bugs, comprising around 80,000 species of shield bugs, cicadas, aphids and others (CSIRO, 2007). They range in size from 1 millimetre to around 15 centimetres and share a common arrangement of sucking mouthparts. Many

species of Hemiptera are significant pests of crops and gardens, including many species of aphids and various scale bugs. A large number of Hemiptera species, especially aphids and bugs, may harm cereals (Dewar et al., 1982; Prescott et al., 1986; Migui and Lamb, 2004). Forty-three species of herbivorous Hemiptera (of various families) were collected on sorghum cultivations in South Africa and some of them are considered extremely harmful (Kruger et al., 2007). Although a large number of insect species can cause extensive injury to cereals, especially to wheat crops in the field, Pentatomoid species are by far the most important of these. A total of 25 species (Aelia species not included) were reported in Turkey, along with their economic importance (Lodos, 1981).

Several kinds of aphids infest small cereal grains

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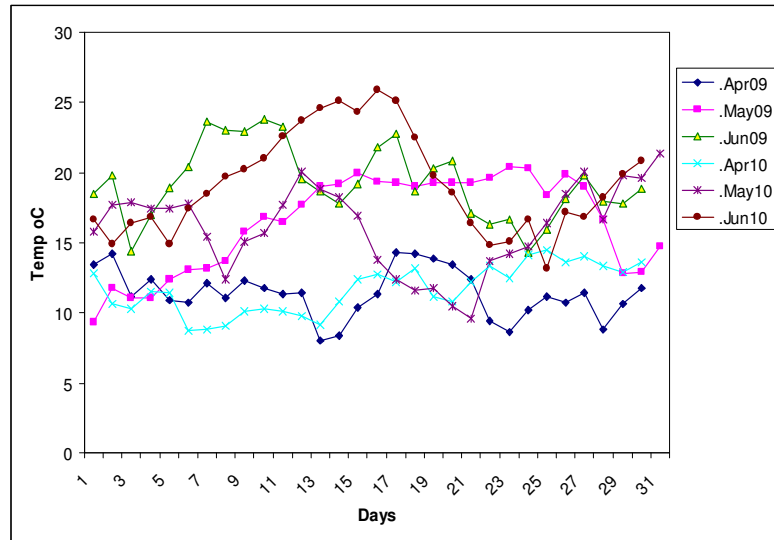


Figure 1. Temperature (in °C) fluctuations in daily basis for the three months of monitoring (April, May, June) in years 2009 (09) and 2010 (10)

Table 1. Meteorological data in the experimental area: Mean air temperature (temp) in °C, days of rain, Mean relative (Rel.) humidity (%), for the three months of monitoring in years 2009 and 2010.

Month	Mean air temp.	Days of rain	Rel. humidity %
April 2009	11.4	3	60
May 2009	16.5	3	50
June 2009	19.3	3	48
April 2010	11.7	5	62
May 2010	16.1	5	62
June 2010	19.4	5	50

Data Source: www.meteo.gr

(Dixon, 1987), like Russian wheat aphid *Diuraphis noxia* (Kurdjumov), which can cause significant losses in cereal crops and thus is considered one of the main pests of wheat in Europe and United States. The saliva of this aphid is toxic to the plant and causes whitish striping on cereal leaves. Feeding by this aphid will also cause whitening of the flag leaf that curls around the head causing incomplete head emergence. Host plants are cereal grain crops including wheat and barley and to a lesser extent, wild grasses such as wheatgrasses, brome-grasses or ryegrasses (Michaud and Sloderbeck, 2005). In Serbia 11 aphid species have been reported and some of them are considered to cause important damages (Tomanovic et al., 2008). Knowledge of the seasonal dynamics (in relation to environmental conditions) of cereal aphids at the field scale could be important for pest management purposes (Dixon, 1998; Winder et al., 1999). In general, a significant number of pest individuals found in cereal cultivations is related to serious damages (Larsson, 2005; Kruger et al., 2007; Deligeorgidis et al., 2011).

The purpose of this study was to monitor and compare population fluctuations of various species of Hemiptera

during the growing season of durum wheat in the region of Western Macedonia, in years 2009 and 2010.

MATERIALS AND METHODS

This study was conducted in the prefecture of Kozani (region of Western Macedonia, Greece), in durum wheat cultivations of the variety Bronde, in a one-hectare field during the years 2009 and 2010. Five Hemiptera species were defined: wheat stink bug *Aelia rostrata* Boheman (Hemiptera: Pentatomoidea, Pentatomidae), tortoise wheat bug *Eurygaster austriaca* (Schrank) (Hemiptera: Pentatomoidea, Scutelleridae), tortoise corn bug *Eurygaster maura* (Linnaeus) (Hemiptera: Pentatomoidea, Scutelleridae), grain aphid *Sitobion avenae* (Fabricius) (Hemiptera: Aphididae), southern grain green aphid *Toxoptera gramineum* (*T. graminum*) Rondani (Hemiptera: Aphididae). Measurements were carried out during the growing season of wheat at late stages, for year 2009 sampling started from 27 of April and lasted until 15 of June and for year 2010 from 30 of April to 18 of June. Samplings of insects were taken in

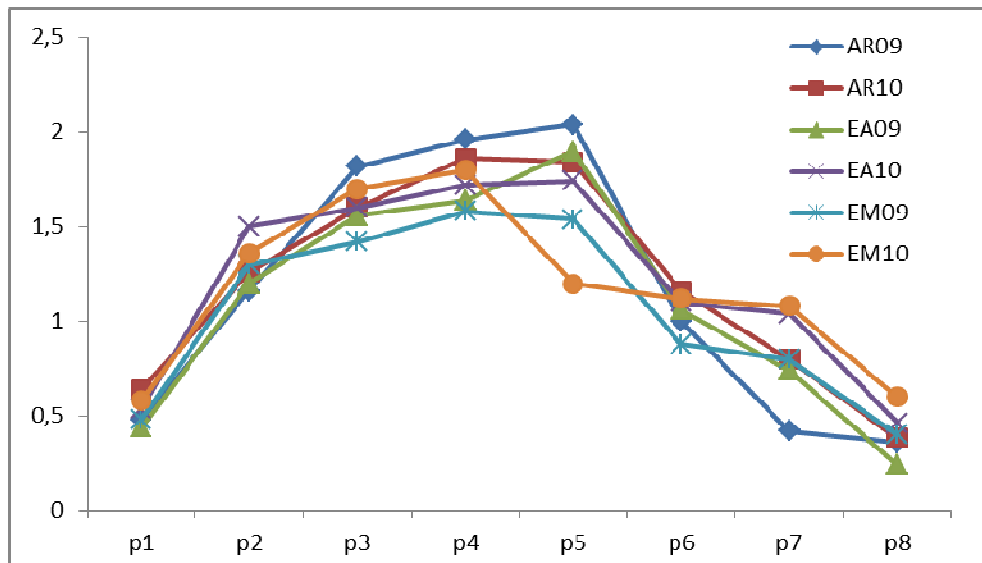


Figure 2. Population fluctuations (y-axis: mean number of individuals) across sampling periods (p1-p8), for three Hemiptera species: the bug *A. rostrata* (AR) as a control and *E. austriaca* (EA) and *E. maura* (EM), during the 2 years (2009: 09 and 2010: 10)

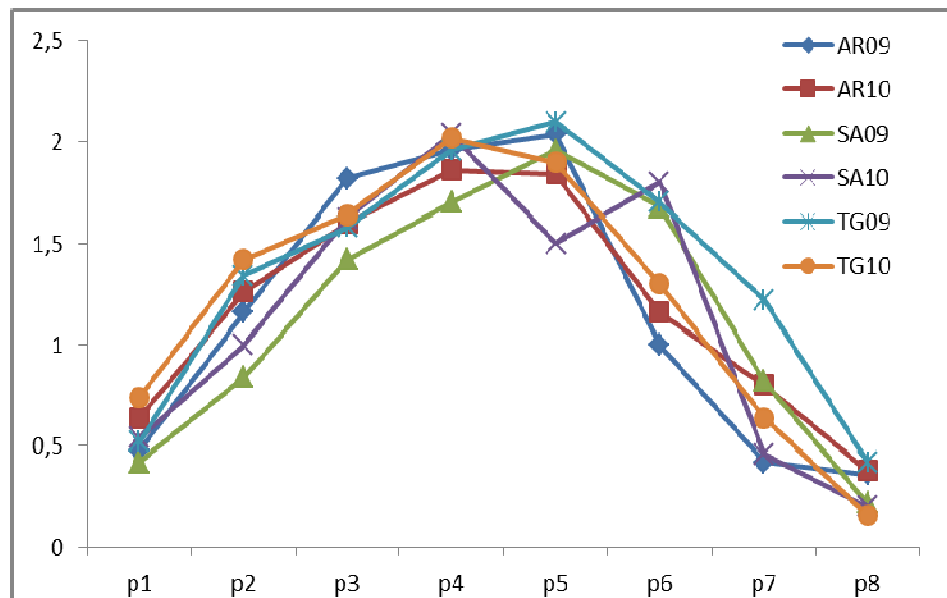


Figure 3. Population fluctuations (y-axis: mean number of individuals) across sampling periods (p1-p8), for three Hemiptera species: the bug *A. rostrata* (AR) as a control and the two aphids *S. avenae* (SA) and *T. gramineum* (TG), during the 2 years (2009: 09 and 2010: 10)

eight periods (every week) to cover the late stages of wheat. Measurements were made every about 100m in the field, with five wheat plants per sample, from 10 different places (replications) in the field. Total insect individuals (per species) on each wheat plant were counted according to Dewar et al. (1982) and Deligeorgidis et al. (2005, 2007). The average value of

the five plants was used in calculations to make data more representative and suitable for statistical analysis (with no transformations and absence of nested analysis). ANOVA was performed in SPSS 17.0 according to Snedecor and Cochran (1980), analyzing the following factors: year and sampling period (separately for each insect species used). Also, an array

Table 2. General mean of insect individuals (GM), sources of variability analyzed, degrees of freedom (df) and significance level, for the five Hemiptera species: *A. rostrata*, *E. austriaca*, *E. maura*, *S. avenae* and *T. gramineum*

Species	Source of variability	df	Significance level
<i>A. rostrata</i> GM= 1.174	Year	1	0.657
	Sampling period	7	0.00001
	Year X Sampling period	7	0.539
<i>E. austriaca</i> GM= 1.156	Year	1	0.005
	Sampling period	7	0.00001
	Year X Sampling period	7	0.931
<i>E. maura</i> GM= 1.115	Year	1	0.148
	Sampling period	7	0.00001
	Year X Sampling period	7	0.599
<i>S. avenae</i> GM= 1.139	Year	1	0.782
	Sampling period	7	0.00001
	Year X Sampling period	7	0.224
<i>T. gramineum</i> GM= 1.292	Year	1	0.121
	Sampling period	7	0.00001
	Year X Sampling period	7	0.431

Table 3. Total average and maximum number of individuals counted, for the five Hemiptera species on durum wheat plants, for each year (2009-2010)

Species and year	Year	Total average	Maximum
<i>A. rostrata</i>	2009	1.155	7
<i>A. rostrata</i>	2010	1.193	8
<i>E. austriaca</i>	2009	1.098	7
<i>E. austriaca</i>	2010	1.213	7
<i>E. maura</i>	2009	1.050	7
<i>E. maura</i>	2010	1.180	7
<i>S. avenae</i>	2009	1.133	7
<i>S. avenae</i>	2010	1.145	7
<i>T. gramineum</i>	2009	1.355	8
<i>T. gramineum</i>	2010	1.228	8

type regression based on mean values of population fluctuations of the five Hemiptera species on temperature fluctuations within the 8 sampling periods was conducted according to Snedecor and Cochran (1980), using MS Excel software.

RESULTS

Meteorological data showed different fluctuations between years during May and June temperatures (Figure 1) and some differences in rainy days and relative humidity (Table 1). Also, May of 2010 started warmer but in total, it was a little colder than May of 2009 because of late decreased temperatures and this reflects in lower (in relation to year 2009) insect populations in some cases (Figure 1, 2 and 3). Generally, May 2010 was more unstable month in comparison to May 2009. On the other hand, June 2009 and 2010 showed little differences.

According to the results presented in Table 2, for all insects studied, sampling period showed the greatest differences (significance level $p < 0.00001$). This fluctuation of the Pentatomoidea species is shown in Figure 2, for the 2 years of study. In the first sampling period, insect populations were low reaching maximum between 4th and 5th period, except for *E. maura* which exhibited maximum between 3rd and 4th period (especially in year 2010). The aphid species exhibited almost the same behavior as shown in Figure 3, where *S. avenae* showed a rather unstable behavior in the second year of monitoring, but nevertheless interaction between year and sampling periods (indicating different population fluctuations in the two years) was not found (Table 2). On the other hand, *E. austriaca*, showed a few differences in number of individuals (significance level $p < 0.005$) between the two years of experimentation (Table 2, Figure 2). Maximum number of insect individuals found on each plant was between 7-8 for all insect species and

total average values were lower, 1.05-1.355 adult insect individuals per plant (Table 3). *T. gramineum*, showed the highest total average values for both years of monitoring.

A regression of population fluctuations of the five Hemiptera species on temperature fluctuations within the 8 sampling periods, revealed great differences between years. No correlation was found between population fluctuations of the five Hemiptera species and temperatures in year 2009. For year 2010, correlation coefficients were negative and calculated approximately between -0.6 and -0.8.

DISCUSSION

Sampling period for all insects studied showed the greatest differences. This is a common phenomenon since insect populations vary within the year Deligeorgidis et al. (2005, 2007, 2011), Alavi et al. (2007) and Tomanovic et al. (2008). *Aelia rostrata* is one of the most important pests of wheat, barley and rye in Central Anatolia. It overwinters as an adult in the mountains and it has one generation per year, with five moults (Dikyar, 1981), for this it was chosen as a control insect to compare the Pentatomoidea and aphids' population fluctuations. In general, all Hemiptera studied showed almost the same behavior on population fluctuations, except for *S. avenae* which showed an unstable behavior in the second year of monitoring, but interaction between year and sampling periods (indicating different population fluctuations in the two years) was not found. In the middle of monitoring periods, there were an increased number of insect individuals, decreasing at late stages. This seasonal distribution of cereal aphids is affected by climatic conditions and biotic factors such as host plant quality, dispersal efficiency and natural enemies (Roitberg et al., 1979; Mann et al., 1995). These findings are in agreement to the data reported by Tomanovic et al. (2008), where the maximum number of cereal aphids was recorded from late May to middle June. This distribution is expected by aphids ecology data (Dixon, 1998). Hemiptera populations found more stable than thrips populations in the same area (Deligeorgidis et al., 2011).

In Serbia the most important cereal aphids are reported to be *S. avenae*, *Metopolophium dirhodum* (Walker) and *Rhopalosiphum padi* (Linnaeus) (Petrović, 1996; Tomanovic et al., 2008). Except for *S. avenae* and *T. gramineum* we did not found any other aphid species (except of 2-3 individuals in total of *R. padi*). Maximum number of insect individuals found on each plant was between 7-8 for all Hemiptera species and total average values were lower. *T. gramineum*, showed the highest total average values for both years of monitoring, but this population size is not considered capable to cause serious damages (Dewar and Carter, 1984; Kruger et al., 2007). Damage level must always have to be decided in combination to other insect pest species (Larsson, 2005; Deligeorgidis et al., 2011). In cereals, Larsson (2005)

reported high thrips population density in the leaf sheath that contributed to a significant proportion of the yield loss. Kruger et al. (2007) recorded a few Hemiptera species that are found in high populations and subsequently harm cereal cultivations decreasing yield. In our study, we did not record these high populations and thus we concluded that these relatively low populations for all Hemiptera species studied, are not capable to harm wheat in the specific area of study. This may be the reason for the preference of wheat cultivation in the region of Western Macedonia, since farmers traditionally choose the most adaptive plant species.

Cold weather may reduce total insect population, but it seems that within these years while temperature was increasing populations of the Hemiptera species tended to be lower. A reasonable explanation may be that, in the specific area, physical enemies reproduce faster as temperature increases, keeping aphids and other Hemiptera species in low populations. According to Roitberg et al. (1979), Mann et al. (1995) and Deligeorgidis et al. (2011), population size may vary significantly under different environmental conditions or under the pressure of various biotic factors. Especially for aphids, optimum temperatures are reported to be within a narrow interval (Liu and Meng, 1999; Morgan et al., 2001; Diaz et al., 2007) and this remark was also reported for a few Hemiptera species (David, 1990; Luz et al. 1999; Diaz et al., 2008). These findings may reflect on low population size as a result of air temperatures deviating from optimum. In general, according to our findings, it seems that only in specific years environmental and biotic factors may affect significantly and sometimes unexpectedly population size and fluctuations.

REFERENCES

- Alavi J, Zur Strassen R, Bagherani N (2007). Thrips (Thysanoptera) species associated with wheat and barley in Golestan province, Iran. *J. Entomol. Soc. Iran.* 27(1): 1-28.
- CSIRO (2007). Hemiptera: bugs, aphids and cicadas. Insects and their allies. CSIRO. <http://www.ento.csiro.au/education/insects/hemiptera.html>
- David JG (1990). Development and survivorship of *Biprorulus bibax* (Hemiptera: Pentatomidae) under a range of constant temperatures. *Environ. Entomol.* 19(4): 874-877.
- Deligeorgidis PN, Ipsilandis CG, Fotiadou C, Kaltsoudas G, Giakalis L, Garsen A (2005). Fluctuation and distribution of *Frankliniella occidentalis* (Pergande) and *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) populations in greenhouse cucumber and tomato. *Pak. J. Biol. Sci.* 8(8): 1105-1111.
- Deligeorgidis PN, Ipsilandis CG, Kaltsoudas G, Sidiropoulos G, Deligeorgidis NP, Vaiopoulou M, Vardiabasis A (2007). Chemical control of *Thrips tabaci*, *Epitrix hirtipennis* and *Myzus persicae* in Tobacco fields in Northern Greece. *J. Entomol.* 4(6) : 463-468.
- Deligeorgidis PN, Deligeorgidis NP, Ipsilandis CG, Vardiabasis A, Stavridis D, Vayopoulou M, Sidiropoulos G (2011). Two thrips species in durum wheat cultivations in the region of Western Macedonia, Greece. *J. Entomol.* 8(5): 484-490.
- Dewar AM, Dean GJ, Cannon R (1982). Assessment of methods for estimating the numbers of aphids (Hemiptera: Aphididae) in cereals. *Bull. Ent. Res.* 72: 675-685.
- Dewar AM, Carter N (1984). Decision trees to assess the risk of cereal aphid (Hemiptera: Aphididae) outbreaks in summer in England. *Bull.*

- Ent. Res. 74: 387-398.
- Diaz BM, Muniz M, Barrios L, Fereres A (2007). Temperature thresholds and thermal requirements for development of *Nasonovia ribisnigri* (Hemiptera: Aphididae). *Environ. Entomol.* 36(4): 681-688.
- Diaz R, Overholt WA, Cuda JP, Pratt PD, Fox A (2008). Temperature-Dependent Development, Survival, and Potential Distribution of *Ischnodemus variegatus* (Hemiptera: Blissidae), a Herbivore of West Indian Marsh Grass. *Ann. Entomol. Soc. Am.* 101(3): 604-612.
- Dikyar R (1981). Biology and Control of *Aelia rostrata* in Central Anatolia. *EPPO Bulletin.* 11: 39-41.
- Dixon AFG (1987). Cereal aphids as an applied problem. *Agr. Zool. Rev.* 2: 1-57.
- Dixon AFG (1998). *Aphid ecology* (2nd ed.). Chapman and Hall. ISBN: 0412741806.
- Kruger M, van den Berg J, Du Plessis GJ (2007). A survey of sorghum panicle-feeding Hemiptera in South Africa. *SAT e-journal.* 3(1): 1-2.
- Larsson H (2005). Economic damage by *Limothrips denticornis* in rye, triticale and winter barley. *J. Appl. Entomol.* 129(7): 386-392.
- Liu SS, Meng X-D (1999). Modelling development time of *Myzus persicae* (Hemiptera: Aphididae) at constant and natural temperatures. *Bull. Entomol. Res.*, 89: 53-63.
- Lodos N (1981). Pentatomoid Pests of Wheat in Turkey. *EPPO Bulletin.* 11: 9-12.
- Luz C, Fargues J, Grunewald J (1999). Development of *Rhodnius prolixus* (Hemiptera: Reduviidae) under constant and cyclic conditions of temperature and humidity. *Memorias do Instituto Oswaldo Cruz,* 94(3): 403-409.
- Mann JA, Tatchell GM, Dupuch MJ, Harrington R, Clark SJ, McCartney HA (1995). Movement of apterous Sitobion avenae (Homoptera: Aphididae) in response to leafdisturbances caused by wind and rain. *Ann. Appl. Biol.* 126: 417-427.
- Michaud JP, Sloderbeck PE (2005). Russian wheat aphid-An introduced pest of small grains in the High Plains. Kansas State University, AES and CES, p. 1-4. <http://www.ksre.ksu.edu/library/entml2/mf2666.pdf>
- Migui SM, Lamb RJ (2004). Seedling and adult plant resistance to *Sitobion avenae* (Hemiptera: Aphididae) in *Triticum monococcum* (Poaceae), an ancestor of wheat. *Bull. Entomol. Res.* 94(1): 35-46.
- Morgan D, Walters KFA, Aegerter JN (2001). Effect of temperature and cultivar on pea aphid, *Acyrtosiphon pisum* (Hemiptera: Aphididae) life history. *Bull. Entomol. Res.*, 91: 47-52.
- Petrović O (1996). Aphids (Homoptera: Aphididae) on cereal crops. *Rev. Res. Work Fac. Agr. Belgrade.* 41: 159-168.
- Prescott JM, Burnett PA, Saari EE, Ransom J, Bowman J (1986). *Wheat Diseases and Pests: a guide for field identification.* International maize and wheat improvement center, CIMMYT, Mexico. D.F., Mexico.
- Roitberg BD, Myers JH, Frazer BD (1979). The influence of predators on the movement of apterous pea aphids between plants. *J. Appl. Ecol.* 48: 111-122.
- Snedecor GW, Cochran WG (1980). *Statistical Methods*, 7th ed. The Iowa State University Press, Ames, IA, USA, ISBN: 0-81381560-6. p. 507.
- Tomanovic Z, Kavallieratos NG, Starý P, Petrović-Obradović O, Athanassiou CG, Stanisavljević LZ (2008). Cereal aphids (Hemiptera: Aphidoidea) in Serbia: Seasonal dynamics and natural enemies. *Eur. J. Entomol.* 105: 495-501.
- Winder L, Perry JN, Holland JM (1999). The spatial and temporal distribution of the grain aphid *Sitobion avenae* in winter wheat. *Entomol. Exp. Appl.* 93: 277-290.