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EFFECT OF SOWING DATE ON SPECIES COMPOSITION OF INSECT PESTS ON WINTER TRITICALE DURING THE SPRING AND SUMMER IN BULGARIA

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Abstract

The effect of sowing date of winter triticale on the species composition of insect pests on the crop during the spring and summer growth stages was evaluated in Kostinbrod (Bulgaria) for the period 2009 - 2013. Forty-two damaging insect species belonging to six orders: Orthoptera, Thysanoptera, Hemiptera, Coleoptera, Hymenoptera and Diptera, were identified. In early spring (during the growth stages of tillering and stem elongation) the most damaging species for early winter sowings (sown during the last decades of September) were stem boring pests. Their complex included adults of Hemiptera, and larvae of Coleoptera and Diptera, among which *Opomyza florum* and *Phorbia fumigata* were the most important species. Damages caused by *O. florum* were prevalent in early sowings, while those caused by *P. fumigata* were more pronounced in late triticale sowings (sown in the second and third decade of October).

In late spring and early summer (during the growth stages of heading – ripening of winter triticale) the most damaging insects were sap-sucking species from the orders Thysanoptera and Hemiptera, and family Cecidomyiidae (Diptera). The wheat thrips *Haplothrips tritici* was the most abundant. Twenty five species of Hemiptera from the families Aphididae (3 species), Aphrophoridae (1 species), Cicadellidae (9 species), Delphacidae (1 species), Miridae (5 species), Pentatomidae (4 species) and Scutelleridae (2 species) were found to damage the leaves, spike and grains of winter triticale. The dominant species were *Aelia rostrata* and *Eurygaster maura*. Insect pests from the genera *Dolerus* and *Cephus* were of insignificant importance.

Key words: growth stages of winter triticale, insect pests, sowing date, damages

Introduction

Triticale is a new promising cereal crop with high potential fertility and valuable nutritional quality of the grain. For the past three years in Bulgaria, its area for cultivation has increased from 8590 ha to 12 000 ha and triticale is currently ranked fourth with respect to total growing area (after wheat, barley and oats). With respect to yield, triticale is ranked third, after wheat and barley (Agrarian reports, 2010, 2011, 2012). Fulfilling the potential of the crop is highly dependent on the application of modern technology for its cultivation, providing optimal conditions for the growth and development of plants. An important agricultural factor is the period of sowing, which could substantially change the plant health status of the crop through its influence on the distribution, density and activity of damaging phytophagous insects.

In the entomological literature, the data on the species composition of the insect fauna of triticale are scarce. The triticale pest list of the Republic of Belarus includes representatives from 6 orders: Hemiptera, Coleoptera, Thysanoptera, Diptera, Hymenoptera and Lepidoptera. In sowings of winter and spring triticale, the authors have established identical species composition of the pests, but different structure and abundance of the dominant species. In winter crops, the dominant species are *Sitobion avenae*, *Haplothrips aculeatus*, *Limothrips denticornis* and *Oscinella* sp. while in spring crops these are *Oscinella* sp, *Oulema melanopus* and *Rhopalosiphum padi* (Prohorova et al., 2000). According to Larsson (2005) two thrips species are common on triticale in southern Sweden:

Limothrips denticornis and *Thrips angusticeps* but *T. angusticeps* is not a significant pest. *L. denticornis* was found to cause the highest yield loss on triticale among the thrips species.

The data on the pest insect fauna of triticale in Bulgaria are scarce. The species and quantitative composition of the most important stem pests in the autumn and early spring growing seasons was studied (Krusteva and Ventsislavov, 2006; Krusteva et al., 2006; Krusteva and Karadjova, 2011). The pest complex includes larvae of Elateridae, *Chaetocnema* and Diptera, larvae and adults of Heteroptera. The insect pests of greatest importance in the autumn growing season are *Phorbia fumigata*, *Oscinella frit* and *O. pusilla*, and during the early spring period, these are *Opomyza florum* and *Phorbia haberlandti*. The aim of the present study is to obtain data on the species composition of the insect fauna during the late phenological stages of triticale in spring and early summer in relation to the sowing date. This information is necessary in order to develop monitoring and pest management programmes for winter triticale in Bulgaria.

Materials and methods

The study was conducted in the experimental fields of the Institute of Soil Science, Agrotechnology and Plant Protection in Kostinbrod, Bulgaria with winter triticale variety *Vihren.* The crop was sown on September 25th, October 9th and October 26th (2009), September 26th and October 21^{ts} (2011), and September 28th and October 16^{ts} (2012). The population dynamics of leafhoppers (Cicadellidae, Delphacidae, Aphrophoridae), plant bugs (Miridae, Pentatomidae, Scutelleridae), adults of Chrysomelidae leaf beetles (*Lema cyanella*, *Oulema melanopus*, *Phyllotreta vittula*), cereal flies (Opomyzidae, Chloropidae and Anthomyiidae), Orthoptera and Hymenoptera were monitored using a sweep-net (5 sets of 20 sweeps, d=300 mm) in each surveyed field from early spring seedling emergence (from March - beginning of April, depending on the weather conditions) until harvest. Samples were collected once a week. The rule of "5 sweeps = 1m^{2}" was used to calculate the number of flies/m^2 (Mihailova et al., 1982). After the first symptoms of damage were observed (withering and yellowing of the main leaf) triticale plant samples of 0.5 linear meters were regularly collected and analyzed in the laboratory in order to establish the species composition of the pests, damaging triticale shoots. Damaged shoots were dissected and the phenophase and type of damage were documented. The pest species and their life stages were described. The percentage of damaged shoots per sample was calculated. Analyses of plant samples were carried out in 4-6 replicates in the phenophase of tillering and stem elongation (DC 21-39 on Zadoks growth scale) (Zadoks et al. 1974).

The population dynamics of Aphididae and larvae of *L. cyanella* and *O. melanopus* were monitored by counting insects on 100 stems (collected at 10 different locations, 10 stems per location) at 3-5 day intervals from inflorescence emergence until milk development (DC 50-77). The population dynamics of adults and larvae of Thysanoptera and larvae of *Sitodiplosis mosellana* were monitored by counting insects on 20 ears at 5-7 day interval during growth stages DC 50-85. The number of Aphididae and larvae of *L. cyanella* and *O. melanopus* per stem, as well as the number of adults and larvae of Thysanoptera and larvae of *S. mosellana* per ear were calculated. The percent of damaged grains by larvae of Thysanoptera and *S. mosellana*, and adults and larvae of Pentatomidae and Scutelleridae was established by counting the damaged grains on 30 ears during phenophases DC 85-92.

The species identification was performed as follows: for Aphididae after Blackman, Eastop (1989) and Emden (1972), for Thysanoptera after Zur Strassen (2003) and Schliephake and Klimt (1979), for Diptera after Beshovski (1985), (Kopaneva, 1980) and Hennig (1976), for Hymenoptera and Orthoptera after Kopaneva (1980), for Heteroptera by comparison to a collection identified by Yosifov, Bulgarian Academy of Science (BAS) and for Hemiptera (Aphrophoridae and Cicadellidae) using a collection, identified by Viola Bayryamova (BAS) and Venelin Pelov

(Institute of Soil Science, Agrotechnology and Plant Protection). The species composition of wireworms (Elateridae; Coleoptera) was not identified, only the percentage of shoots damaged by their larvae was calculated.

Results and discussion

During the period of the study, 42 species of insect pests from six orders were identified. Their relative abundance, density and degree of damage are closely connected to the phenological development of the triticale sowings and the climatic conditions. During early spring (DC 21-39), the sowings were infested by 24 species of insects, which include stem-boring, leaf-chewing and sap-sucking pests (Table 1). The most damaging group which comprises the highest number of species (13) is that of stem pests: adults of Miridae and Pentatomidae, larvae of Elateridae, *Chaetocnema aridula*, *Ch. hortensis*, and dipterans from the families of Opomyzidae, Chloropidae and Anthomyiidae

Table 1. Species composition of harmful insects on winter triticale during the growth stages of tillering and stem elongation of the crop (DC 21-39 on Zadoks growth scale)

Group of pests	Order	Family	Species
Stem pests	Hemiptera	Miridae	*Lygus rugulipennis* Poppius 1911
			Stenodema virens (Linnaeus 1767)
		Pentatomidae	*Aelia acuminata* (Linnaeus 1758)
			A. rostrata Boheman 1852
	Coleoptera	Elateridae	*Agriotes spp.*
		Chrysomelidae	*Chaetocnema aridula* (Gyllenhal 1827)
			Ch. hortensis (Geoffroy 1785)
	Diptera	Opomyzidae	*Opomyza florum* (Fabricius 1794)
		Chloropidae	*Elachiptera cornuta* (Fallen 1820)
			Lasiosina brevisurstylata Dely-Draskovits 1977
			Lasiosina herpini (Guerin-Meneville 1843)
			Oscinella frit (Linnaeus 1758)
		Anthomyiidae	*Phrobia fumigata* (Meigen 1826)
Leaf-chewing pests	Coleoptera	Chrysomelidae	*Lema cyanella* (Linnaeus 1758)
			Oulema melanopus (Linnaeus 1758)
			Phyllotreta vittula (Redtenbacher 1849)
Sap-sucking pests	Hemiptera	Aphididae	*Schizaphis graminum* (Rondani 1852)
			Sitobion avenae (Fabricius 1775)
		Cicadellidae	*Balclutha punctata* (Fabricius 1775)
			B. rhenana Wagner 1939
			Empoasca pteridis (Dahlbom 1850)
			Hardya anatolica Zachvatkin 1946
			Psammotettix provincialis (Ribaut 1925)
		Delphacidae	*Laodelphax striatellus* (Fallen 1826)

The results of the performed analyses show that among the stem pests, dipterans have greatest economic importance for triticale in early spring. During the period of the study, 6 species of order Diptera were identified. The percentage of stems damaged by dipteran larvae varied from 32% in early sowings to 42% in late sowings. The prevalent damages in the early sowings were caused by *O. florum* (31-38%), while damages from *Ph. fumigata* were predominant in the late sowings (11-

22%). The rest of the species in the group of stem pests have limited importance for winter triticale and did not show any significant differences in damage in relation to the sowing date: Elateridae sp. (0-1.6%), *Ch. aridula* and *Ch. hortensis* (0-2.4%) and Heteroptera (0-2.30%). The species belonging to the groups of leaf-chewing (*L. cyanella, O. melanopus, Ph. vittula)* and sap-sucking insects (Aphididae, Cicadellidae and Delphacidae) have no economic importance for the crop during early spring and were established at densities below 1 individual / m^2.

The insect pest fauna during the later phenophases of the development of triticale, from the end of booting to ripening (DC 40-92), established during the years of the investigation includes 34 species from 6 orders (Table 2). The group of sap-sucking insects is represented by the highest number of species and shows greatest overall abundance. It includes insects from the orders Thysanoptera, Hemiptera and Diptera. Two species from order Thysanoptera were established, of which *H. tritici* was dominant. It was the most abundant and persistent pest in triticale sowings. In 2013 mass development of *H. tritici* adults was established at the beginning of heading (DC 45-55), while the abundance of larvae was highest during the stages of early milk to soft dough (DC 73-85). There were no significant differences in the peak densities of *H. tritici* adults and larvae in relation to the sowing date (11 versus 10 adult individuals per ear; 36 versus 40 larvae per ear). In 2010, the larvae of *H. tritici* were developing together with the larvae of *S. mosellana*. They suck sap from the stamen, ovary and grains during milk and dough development. One to 4 (rarely 8) larvae of *H. tritici* and 1-13 larvae of *S. mosellana* were found to develop in one grain. Grains with 1-2 larvae of *S. mosellana* were most common. The results of the performed analyses showed that the relative quantity of damaged grains per ear varied from 15.3 to 41.6% for *H. tritici* and from 0.25 to 4.9% for *S. mosellana* in the early and late sowings, respectively. At these densities of the larvae, the quantity of severely damaged grains was 8.6-14.3%. The interior of such grains is completely destroyed and they are discarded during harvest.

The data on the species diversity and density of Hemiptera do not show significant differences in relation to the sowing date. Ten species from two families were established: Aphrophoridae (1 species) and Cicadellidae (9 species). Three species from genus *Psammotettix* were prevalent: *P. provincialis, P. striatus* and *P. alienus.* The peaks in the overall abundance of leafhopper pests in the crops with different sowing dates during the period of the investigation did not exceed 5 individuals/m^2 at the phenophase of dough development (DC 83-85) in the first decade of July. *Philaenus spumarius* was second in importance in the fields during 2012. The species established in the sowings during heading (DC 52-60) and reached its maximum density during milk development (DC 77-83) in the beginning of July: 2.4 and 2.15 individuals/m^2 for the first and second sowing, respectively. In spring, aphids had low density and no economic importance for the triticale crop. The prevalent species was *Sitobion avenae*, reaching maximum density of 1 to 3.6 individuals per ear for early sowings and 0.2 to 0.7 individuals per year for late sowings at the phenophase of anthesis – milk development (DC 62-79).

The pest fauna of order Heteroptera during the late spring and early summer is represented by 11 species from the families Miridae (5 species), Pentatomidae (4 species) and Scutelleridae (2 species). The species of the genera Aelia and Eurygaster have greatest economic importance. Their mass development during the years of investigation was observed during anthesis (DC 62-68), peaking at 1.58-0.65 individuals / m^2, and during dough development and ripening (DC 81-92), peaking at 0.45-2.14 individuals / m^2 for early and late sowings, respectively. The most abundant species were *A. acuminata, A. rostrata* and *E. maura* in the early sowings and *A. rostrata* and *E. maura* in the late sowings. The adults and larvae of cereal bugs suck sap from the stems, leaves and ears, but they mainly damage the grains during milk and dough development and ripening (DC 73-92). The grain damages varied from 4.66-7.03% in late sowings to 8.11-9.09% in early sowings.

The insect pests from the other two groups damaging the leaves, ears and stems of triticale were with low densities and had no significant economic importance.

Table 2. Species composition of harmful insects on winter triticale during the growth stages of booting - ripening of the crop (DC 40-92 on Zadoks growth scale)

Group of pests	Order	Family	Species
Sap-sucking pests	Thysanoptera	Phlaeothripidae	*Haplothrips tritici* (Kurdjumov 1012)
		Thripidae	*Limothrips denticornis* Haliday 1836
	Hemiptera	Aphididae	*Rhopalosiphum padi* (Linnaeus 1758)
			Schizaphis graminum (Rondani 1852)
			Sitobion avenae (Fabricius 1775)
		Aphrophoridae	*Philaenus spumarius* (Linnaeus 1758)
		Cicadellidae	*Balclutha punctata* (Fabricius 1775)
			B. rhenana Wagner 1939
			Cicadula placida (Horvath 1897)
			Empoasca pteridis (Dahlbom 1850)
			Hardya anatolica Zachvatkin 1946
			Macrosteles laevis (Ribaut 1927)
			Psammotettix alienus (Dahlbom 1850)
			P. provincialis (Ribaut 1925)
			P. striatus (Linnaeus 1758)
		Miridae	*Leptopterna dolabrata* (Linnaeus 1758)
			Lygus rugulipennis Poppius 1911
			Notostira erratica (Linnaeus 1758)
			Stenodema virens (Linnaeus 1767)
			Trigonotylus caelestialium (Kirkaldy 1902)
		Pentatomidae	*Aelia acuminata* (Linnaeus 1758)
			A. rostrata Boheman 1852
			Carpocoris fuscispinus (Boheman 1850)
			Dolycoris baccarum (Linnaeus 1758)
		Scutelleridae	*Eurygaster austriaca* (Schrank 1776)
			E. maura (Linnaeus 1758)
	Diptera	Cecidomyiidae	*Sitodiplosis mosellana* (Gehin 1857)
Pests damaging leaves and ears	Orthoptera	Acrididae	*Calliptamus italicus* (Linnaeus 1758)
		Tettigoniidae	*Tettigonia viridissima* (Linnaeus 1758)
	Coleoptera	Chrysomelidae	*Lema cyanella* (Linnaeus 1758)
			Oulema melanopus (Linnaeus 1758)
	Hymenoptera	Tenhredinidae	*Dolerus puncticollis* C.G.Thomson 1871
Stem pests	Hymenoptera	Cephidae	*Cephus pygmeus* (Linnaeus 1767)

Conclusion

The insect pest fauna of winter triticale with different sowing dates (last decade of September-October) in 2009-2013 includes 42 species from 6 orders: Orthoptera, Thysanoptera, Hemiptera, Coleoptera, Hymenoptera and Diptera. During early spring (DC 21-39, Zadoks growth scale), the stem pests of order Diptera are most damaging to the sowings. The most important species were *Opomyza florum* and *Phorbia fumigata*. Damages caused by *O. florum* were prevalent in early sowings, while those caused by *P. fumigata* were more pronounced in late triticale sowings. In the phenophases of booting - ripening (DC 40-92, Zadoks growth scale), the most economically important pests were the species from the families Pentatomidae and Scutelleridae, and *Haplothrips tritici*. *A. acuminata, A. rostrata* and *E. maura* were the most abundant species in the early sowings

while *A. rostrata* and *E. maura* in the late sowings. There were no significant differences in the peak densities of *H. tritici* adults and larvae in relation to the sowing date.

References

Agrarian report. (2010): Аграрен доклад, Зърно производство, Министерство на земеделието и храните, София (Grain-production, Ministry of Agriculture and Forestry, Sofia), p. 25-27.

Agrarian report. (2011): Аграрен доклад, Зърно производство, Министерство на земеделието и храните, София (Grain-production, Ministry of Agriculture and Forestry, Sofia), p. 27-29.

Agrarian report. (2012): Аграрен доклад, Зърно производство, Министерство на земеделието и храните, София (Grain-production, Ministry of Agriculture and Forestry, Sofia), p. 25-27.

Beschovski V. (1985): Фауна на България, Житни мухи Diptera, Chloropidae, Издателство на Българската Академия на Науките, София (Fauna Bulgarica, Diptera, Chloropidae, Publishing house Bulgarian Academy of Science, Sofia), 220 p.

Blackman R.L., Eastop V.F. (1989): Aphids on the world's crops. An Identification Guide, New York, 466 p.

Emden van H.F. (1972): Aphid Technology, London and New York, 344 pp.

Hennig W. (1976): 63a. Anthomyiidae. In Lindner, E. Die Fliegen der Palaearktischen region 7(2), Schweizerbart, Stuttgart, LVIII, 947 pp.

Kopaneva L. (1980): Определитель вредных и полезных насекомых и клещей зерновых культур в СССР, Ленинград, «Колос» (Identification guide for noxious and beneficial insects and mites on cereal crops in SSSR, Leningrad, "Kolos"), 335 p.

Krusteva H., Ventsislavov V. (2006): Видов състав на стъблените неприятели и повредите от тях по тритикале и ръж през есенния и ранно пролетния вегетационни периоди. Шести Международен Симпозиум „Екология – Устойчиво Развитие", 19-21 Октомври 2006, Научни трудове, Враца (Species compositions of stem boring pests and damages they caused on triticale and rye in autumn and early spring. VI-th International Symposium "Ecology-Stable Development, 19th-21st October 2006, Scientific works, Vratca), p. 209-216.

Krusteva H., Ventsislavov V., Karadjova O. (2006): Studies on The Species Composition of Stem-Boring Dipterous Pests and Damage Caused by Their larvae on Triticale and Rye. VIII-th European Congress of Entomology, September 17-22, 2006, Izmir, Turkey, Abstract book, p. 124-125.

Krusteva H., Karadjova O. (2011): Impact of triticale crop sowing date on the insect species composition and damage caused. Bulgarian Journal of Agricultural Science, 17 (No 4) 2011, p. 411-416.

Larsson H. (2005): Economic damage by *Limothrips denticornis* in rye, triticale and winter barley. Journal of Applied Entomology, 129, (7), p. 386-392.

Mihajlova P., Straka F., Apostolov I. (1982): Растително-защитна прогноза и сигнализация, Земиздат, София (Plant protection prognosis and signalization, Zemizdat, Sofia), 342 p.

Prohorova S., Tereshtchuk V., Nemkovich A. (2000): Фитосанитарное состояние посевов тритикале. Известия Академии аграрных наук Республики Беларусь (Phytosanitary state of triticale crop. Bulletin of Belarus Agrarian Academy of Science, No 2, p. 51-56.

Schliephake G., Klimt K. (1979): Thysanoptera, Fransenflügler. Die Tierwelt Deutschlands, 66: p. 1-475.

Zadoks J. C., Change T. T., Konzak C. R. (1974): A decimal code for the growth stage of cereals. Weed Research, 14, p. 415-421.

Zur Strassen R. (2003): Die terebranten Thysanopteren Europas und des Mittelmeer-Gebietes. Die Tierwelt Deutschlands, 74: p. 1-271.