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NEW DATA ON THE BIOLOGY OF THE RED SPOTTED BUG (*Spilostethus* [=*Lygaeus*] *equestris* L., Het., *Lygaeidae*) CAUSING THE ACHENE GREENING IN CONFECTIONERY SUNFLOWER HYBRIDS

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SUMMARY

Western European and especially German-based multinational food processing companies tend to grow confectionery sunflower hybrids and varieties in Hungary. This commercial product is highly preferred as substitute for walnuts, as filling in chocolate, bread and other bakery products, or as seasoning.

In the early 1990s, German companies rejected several truckloads of confectionery sunflower due to "greening of the kernel in the achene". Almost 90% of the rejected consignments originated from a sandy terrace in the region between the rivers Danube and Tisza, which at the time was severely infected with the *Asclepias syriaca* L. Field investigations revealed unambiguously that the greening of the kernel in the achene had been caused by the red spotted bug (*Spilostethus [=Lygaeus] equestris* L.). This species is able to cause extensive damage and discontinuity in the so-called shoulder part of the achene with its powerful stinging-suctorial mouth organ. Intensive chlorophyll synthesis begins in the damaged area due to the solar effect, which is undoubtedly the cause for the greening of the kernel in the achene.

In this investigation, we studied confectionery sunflower fields in two neighboring areas (Bácsalmás and Katymár) for extent of damage caused by *Spilostethus [=Lygaeus] equestris* L. While in Bácsalmás (that district less infected with the *Asclepias syriaca* L.) we found a damage of decreasing intensity (8.85 damaged achenes per sunflower disc) as advancing towards the centre of the field, this value was almost three times as high, reaching 31.71 of damaged achenes per disc, in the area of Katymár (the area severely infested with *Asclepias syriaca* L.). Though the numbers are not very high in themselves - assuming that a well-developed disc contains 1100 to 1200 seeds - the damage may result in significant reduction of kernel quality.

Our extensive research into the causes of the greening of the sunflower kernels made it clear that *Spilostethus [=Lygaeus] equestris* L. had a significant influence on the chemical composition of the damaged achenes: it

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increased the proportion of linoleic acid (C-18:2) by about 2.5%. That affects the lasting quality of the achene unfavorably (Horváth and Bujáki, 1991).

For this reason, a comprehensive study of the biology of *Spilostethus [=Lygaeus] equestris* L. was undertaken in order to develop effective protection methods. This study was a pioneer investigation of exogenous and endogenous factors that might obstruct the use of confectionery sunflower hybrids and varieties in food industry.

Key words: **confectionery sunflower, *Spilostethus* [=*Lygaeus*] *equestris* L., *Asclepias syriaca*, *Vincetoxicum officinale*, cucumber mosaic virus**

INTRODUCTION

Figure 1: Red spotted bug (Spilostethus [=Lygaeus] equestris L.)

According to Günther (1975), *S.equestris* L. is indigenous from southern England to Siberia, and from central Sweden to the Mediterranean areas. It is less common north of Central Europe; it prefers areas with warmer climate. It likes staying on the ground or in the flowers of various plants. It especially likes the tame poison or swallowwort (*Vincetoxicum officinale* Mnch., *syn.: Cynanchum vincetoxicum* (L.) Pers.).

Data on the life history of *S.equestris* L. in Hungary are extremely scarce, despite the fact that the species is widespread in the country. Information on its host plants and behavior can only be found in the publications of Horváth (1984; 1986; 1987b; 1989; 1999) and Bujáki and Horváth (1992).

Horváth (1984) inferred the host plant specialization of the species from the total nitrogen contents of various plant seeds, such as those of the *Asclepias syriaca* L., and the sunflower (*Helianthus annuus* L.). The amino-acid composition in the seeds of *A.syriaca* is similar to those of the sunflower, soybean or peanut. It may be assumed that this similarity explains why *S.equestris* sucks on the ripening achenes of the sunflower (Horváth, 1984).

MATERIAL AND METHODS

This study was carried out in the districts significantly different in respect to infection with *Asclepias syriaca* L. - Bácsalmás (free of *Asclepias syriace* L.) and

Katymár (heavily infested with *Asclepias syriaca* L.), between 25 and 31 August 2001.

While *Asclepias syriaca* L. occurred only sporadically in forest strips and on the borders of commercial sunflower fields (hybrid seed production) in the Bácsalmás district, the occurrence of the weed was 20-25 specimen/m^2 in the Katymár district.

The damage caused by *Spilostethus equestris* L. was investigated in selected land strips as follows: ten randomly selected, adjacent sunflower discs were examined at 10-meter intervals (10 locations in total) from the border of the strip towards the center.

The purpose out this investigation was to assess the extent and frequency of damage caused by *Spilostethus equestris* L; partly as a function of the number of damaged achenes per disc, and partly as a function of the intensity of occurrence of *Asclepias syriaca* L. We also wanted to understand the cause of the greening of the kernel inside the achene, the phenomenon that adversely affects the export position of the confectionery sunflower hybrids. Our investigation was aimed at finding satisfactory answers both in respect to the export position of the confectionery sunflower seeds and in respect to the germination value (%) of hybrid seed.

RESULTS AND DISCUSSION

Tables 1 and 2 show the extent of damage caused by *Spilostethus equestris* L., depending on the rate of infestation by *Asclepias syriaca* L. (the main host plant of *Spilostethus equestris* L). The occurrence of this insect significantly increased in the areas infested with *Asclepias syriaca* L. Wintering of the imagoes was relatively unhindered due to mild winter conditions in recent years.

Table 1: Number of achenes damaged by *Spilostethus equestris L., Katymár, 2001*

Num.	Number of damaged achenes per location (10 discs from each location)										Total, pcs	Mean of 10 discs
	1	2	3	4	5	6	7	8	9	10		
	(10m)	(20m)	(30m)	(40m)	(50m)	(60m)	(70m)	(80m)	(90m)	(100m)		
1	47	50	36	20	20	16	16	15	19	8	247	24.7
2	59	63	40	60	10	20	20	10	21	16	319	31.9
3	65	50	38	30	15	25	12	16	20	20	291	29.1
4	70	48	45	40	16	16	13	10	14	5	278	27.8
5	96	44	47	48	17	29	10	14	20	26	351	35.1
6	20	60	62	35	32	30	15	22	26	10	312	31.2
7	34	35	34	46	38	26	24	20	20	11	288	28.8
8	75	70	46	45	30	30	26	18	13	16	369	36.9
9	60	46	40	60	26	31	32	26	16	18	355	35.5
10	70	49	39	32	24	48	40	30	20	11	361	36.1
Total:	596	515	427	416	228	269	208	181	189	142	3171	31.71

The damage caused by plant bugs was most severe up to 40 meters inside the fields (Tables 1 and 2).

Table 2: Number of achenes damaged by *Spilostethus equestris L., Bácsalmás, 2001*

Num.	Number of damaged achenes per location (10 discs from each location)										Total, pcs	Mean of 10 discs
	1	2	3	4	5	6	7	8	9	10		
	(10m)	(20m)	(30m)	(40m)	(50m)	(60m)	(70m)	(80m)	(90m)	(100m)		
1	26	23	26	10	9	5	0	3	5	4	111	11.1
2	32	30	31	8	8	4	4	0	0	4	121	12.1
3	18	21	41	6	11	4	3	2	6	0	112	11.2
4	24	16	22	11	4	0	0	2	5	3	87	8.7
5	27	18	10	8	0	3	2	4	3	0	75	7.5
6	30	23	11	10	11	6	2	0	0	0	93	9.3
7	16	20	14	14	0	3	6	0	0	2	75	7.5
8	10	16	23	10	10	0	4	3	5	0	81	8.1
9	18	17	10	3	6	2	0	0	5	0	61	6.1
10	23	20	8	6	2	2	0	0	7	1	69	7.2
Total:	224	204	196	86	61	29	21	14	36	14	885	8.85

The presence of and characteristic damage caused by the bugs can best be observed in that zone. The characteristic damage occurred both in the Katymár district, which was more extensively infested with *Asclepias syriaca* L., and the less infected Bácsalmás district. At the same time, it was proved that the damage caused by *Spilostethus equestris* L. (a species earlier referred to as a typical „border pest") (Horváth, 1989; 1991) is no longer restricted to the borders of production fields. Although in decreasing numbers, it is present as far as 100 meters into the field. This is worth paying attention to, especially because *Spilostethus equestris* L. may be a vector of the cucumber mosaic virus or other viruses, the presence of which can be demonstrated on *Asclepias syriaca* L. (Horváth, 1980; 1981). This is also supported by the observations from recent years that refer to the spreading of pathotype B of the cucumber mosaic virus (CMV), and the sunflower chloratic virus (SuCMoV) (Salamon, 2002; Lenardon *et al.*, 2001).

Severe damage caused by the bug locally (in spots within infested strips of land) usually occurs after the shedding of tubular flowers (mid- or end of August).

The most common damage point was the connection point (coronula) of the tubular flower and the achene. This is a vulnerable and poorly protected surface for a period of 2 to 3 days, where the bug can easily penetrate the plant with its powerful stinging/suctorial mouth organ. However, the greening of the kernel hardly ever occurs at this point - which may be a crucial technical problem for the confectionery hybrids - contrary to the damage caused at the shoulder part of the achene, which mostly results (in 70% to 80% of the cases) in the greening of the kernel (chlorophyll formation started by the effect of sunshine, which penetrates through the large holes made by the pest).

The imagoes keep feeding on the achene and also on the axis inflorescentiae, the torus, and squame of the sunflower. At the reverse side of the disc, scars form over the injuries, which typically ulcerate and later become suberized. Such wounds may facilitate the penetration of various harmful fungi (*Rhizopus arrhizus* Fisher, in the first place).

In the course of this study, we observed an unusual method of egg laying of *Spilostethus equestris* L. This species typically lays eggs in the soil. However, as observed on 27 August 2001, several individuals gave up the normal way and laid their eggs among the achenes or in the area sheltered by the outermost row of achenes, the periclinium and the squamae. This had also been observed on an earlier occasion, on 11 August 1991. This observation is definitely a contribution to the biology of *Spilostethus equestris* L.

Our observations also made it clear that the classification of *Spilostethus equestris* L. as a minor pest has significantly changed in the past years. This species is playing a more and more important role among the numerous pests of the sunflower.

Studies on the sunflower germination biology carried out prior to or concurrently with our study have proved, among other things, that the damage caused by these plant bugs may be significant - although they do not attack the germs directly - because various species of fungi (*Alternaria* sp. *Botrytis cinerea*, etc.) that gather around the suction point are exceedingly harmful for the germ (Horváth-Bujáki, 1991).

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UNOS DATOS A LA BIOLOGÍA DE LA CHINCHE DE CAMPO (*Spilostethus* [*Lygaeus*] *equestris* L., *FAMILIA Lygaeidae, ORDEN Heterópteros)*, CAUSANTE DEL VERDEAMIENTO DEL AQUENIO DE HÍBRIDOS DE GIRASOL COMESTIBLE

RESUMEN

Las empresas multinacionales alimentarias de Europa Occidental, particularmente alemanas, de preferencia producen en Hungría híbridos y especies de girasol llamado “comestible”. Este producto de mercado se utiliza de preferencia como sustituyente de la nuez, o se incorpora en chocolate, pan, panecillo, etc., o se les pone encima al hornear.

A principios de los años 1990, las empresas alemanas se negaron a aceptar varios camiones de productos de exportación por causa de “verdeamiento del aquenio”. Alrededor de 90% de la mercancía rechazada provenía de la región de lomeríos de arena entre los ríos Danubio y Tisza, fuertemente infectada por asclepias *(Asclepias syriaca* L.*)*, conocida como hierba lechera. Durante los exámenes en el lugar se reveló que el verdeamiento del aquenio era causado por la *Lygaeus equestris* L. llamada chinche de campo. Esta especie, con su fuerte órgano bucal picador-chupador, causa heridas y defectos de continuidad de grandes extensiones en la “cresta” de los aquenios. En el lugar de la herida, a causa de la luz solar, empieza una intensiva generación de clorofila, resultando el verdeamiento del interior del aquenio.

Durante nuestras investigaciones examinamos las plantaciones de girasol industrial de dos regiones vecinas (Bácsalmás y Katymár) con respecto al daño causado por la *Lygaeus equestris* L. En Bácsalmás (la región menos infectada por la *Asclepias syriaca*), experimentando daños de intensidad decreciente hacia el interior de la plantación, el promedio de aquenios resultó a ser 8.85 unidades por disco, mientras en Katymár (zonas fuertemente infectadas por asclepsias) esta cifra casi se triplicó, alcanzando el valor de 37.71 unidades

por disco. Aunque las cifras en sí no son altas, considerando los 1,100-1,200 aquenios en un disco bien desarrollado, pero el defecto puede causar un considerable deterioro de calidad y a veces resultar la exclusión de la exportación.

Nuestras investigaciones dirigidas al examen de las posibles causas del verdeamiento del interior del aquenio también revelaron que la *Lygaeus equestris* L. afecta considerablemente al valor del contenido interior (Kernel content) de los aquenios dañados, aumentando la cantidad del ácido linoleico (C-18:2) a 2.5%, que influye desfavorablemente sobre la duración del almacenamiento de los aquenios (Horváth, Bujáki, 1991).

Para la elaboración de los posibles procedimientos de protección, por lo tanto, resultó necesario el examen completo de la biología de la chinche de campo. Estos estudios indicaron, a la vez, el comienzo del examen de todos los factores exteriores y endógenos que puedan afectar desfavorablemente a la utilización exitosa de los híbridos o especies de girasol comestible en la industria alimentaria.

QUELQUES DONNEES A LA BIOLOGIE DE LA PUNAISE DE COULEUR ROUGE ET NOIR *(Spilostethus* [*Lygaeus*] *equestris, FAMILLE Lygaeidae, ORDRE Heteropteres)* PROVOQUANT LE VERDISSAGE DE L'AKENE DES HYBRIDES DE TOURNESOL ALIMENTAIRE

RÉSUMÉ

Les entreprises multinationales agro-alimentaires de l'Europe Occidentale, et plus particulièrement celles de l'Allemagne, font exécuter la production des hybrides et espèces de tournesol dénomé "alimentaire" de préférence en Hongrie. Ce produit du marché est utilisé de préférence en vue de le substituer au noix, ou s'incorpore dans le chocolat, pain, petit pain, etc., ou se met sur leurs surfaces avant cuisson.

Au début des années 1990, les entreprises allemandes ont refusé l'import de plusieurs camions de produits à cause du "verdissage de l'akène". Environ 90% de la marchandise, provenant de la région des collines de sable - qui se situent entre le Danube et la rivière Tisza -, était fortement infectée par l'asclépiade *(Asclepias syriaca)*, connue comme cochons de lait ou petits cochons. Lors des analyses exécutées sur le dit lieu, il a été révélé que le verdissage de l'akène était causé par la *Lygaeus equestris,* dit punaise de couleur rouge et noir. Cette espèce cause des blessures et des défauts de continuité de grandes extensions sur la "côté" des akènes à l'aide de son appareil buccal piqueur-suceur puissant. Au lieu de la blessure, la lumière du soleil déclenche un processus de prolifération intensive de chlorophylle, et cela aura comme résultat le verdissage de l'intérieur de l'akène.

Lors de nos recherches, nous avons examiné les exploitations de tournesol industriel de deux régions adjacentes (Bácsalmás et Katymár) en vue de démontrer les dégâts causés par la *Lygaeus equestris*. A Bácsalmás (région moins touchée par l'*Asclepias syriaca*), nous avons observé des dégâts d'intensité diminuante vers l'intérieur de la plantation; le taux d'anomalies d'akènes était à l'orde de 8.85 graines par tournesol. Or à Katymár (zone fortement touchée d'asclépiade) cette moyenne a triplé, atteignant la valeur de 31.71 graines par tournesol. Quoique ces moyennes, en elles-même, ne soient pas trop élevées, en prenant en considération le nombre d'akènes d'un tournesol

bien développé (1.100-1.200), ces défauts peuvent causer une détérioration considérable de la qualité et résulter l'exclusion de l'exportation.

Nos recherches visant de déterminer les causes possibles du verdissage de l'intérieur de l'akène ont aussi révélé que la *Lygaeus equestris* a une influence considérable sur la valeur de contenu intérieur (Kernel content) des akènes détériorés, puisqu'elle augmente le taux d'acide linoléique (C-18:2) de 2.5%, ce qui influe défavorablement sur la durée du stockage des akènes (Horváth, Bujáki, 1991).

Ces faits démontrent la nécessité de mener une recherche approfondie de la biologie de la punaise de couleur rouge et noir en vue d'élaborer de procédés de protection. Ces études représentent le début de l'examen de tous les facteurs extérieurs et endogènes qui puissent affecter défavorablement à l'utilisation avec succès des hybrides ou espèces de tournesol alimentaire dans l'industrie alimentaire.