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IMPORTANCE OF WHEAT DISEASE RESISTANCE FOR SUSTAINABLE AGRICULTURE.

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Summary

In 1996-1998, according virulence analysis of wheat powdery mildew the genes Pm4a, Pm1+Pm2+Pm9 were resistant to all isolates, Pm2+Pm6 were effective to all isolates only from western Slovakia, Effectiveness of Pm3d and Mld+mlha was similar throughout Slovakia. Genes Pm2, Pm3a, Pm3b, Pm3c, Pm3f, pm5, Pm7 and Pm8 were completely ineffective. In 1996-2000 we detected 12 races of leaf rust, the most frequently races were 61SaBa and 77SaBa. To the leaf rust isolates from Slovakia were completely effective only genes Lr9, Lr19, Lr24 and Lr28.

Key words: wheat, resistance, powdery mildew, leaf rust, physiologic races, pathotypes,

Introduction

The key objective in the agricultural production is better use of genetical potential of grown plants and prevention from environmental pollution. The main unfavourable consequences of high and uncoordinated use of agrochemicals was damage caused to useful microflora, hyperparasites, entomophages and cancerogenous effect of some chemical substances. By the breeding for disease resistance and growing resistant cultivars risk of pollution of the environment and food products is decreased because the application of fungicides can be substantially reduced.

Table 1 Effectiveness of resistance genes to the isolates of Blumeria graminis f. sp. tritici in the years 1996 – 1998 in Slovakia

Differential Cultivar	Gene of Resistance	Slovakia		
		West	Central	East
		in %		
Axminster	Pm1	5.0	28.2	46,7
Ulka	Pm2	0	0	6.7
Asosan	Pm3a	0	0	0
Chul	Pm3b	0	0	0
Sonora	Pm3c	5.0	-	6.7
Colibri	Pm3d	65.0	57.2	66.7
Michigan Amber	Pm3f	0	0	0
Khapli/8	Pm4a	100	100	100
Weihenstephan M1	Pm4b	0	0	46.7
Hope	pm5	0	0	0
Transec	Pm7	0	0	0
Salzmünder 14/44	Pm8	0	0	0
Amigo	Pm17	25.0	33.3	6.7
Kenya Civet	Pm2+6	100	58.4	33.3
Halle 13471	Mld+mlha	70.0	70.8	93.3
Normandie	Pm1+2+9	100	100	100
Carsten V - check	None	0	0	0

Material and methods

Virulence analysis from different localities of Slovakia were carried out at 59 samples of wheat powdery mildew (HUSZÁR 2000) and 200 samples of wheat leaf rust in the years 1996-2000 (BARTOŠ & HUSZÁR 1998; 1998 BARTOŠ et al. 1999; BARTOŠ et al. 2001). Tests on the virulence we realysed in seedling stage or on segments. Reactions to isolates of powdery mildew were tested on sixteen differential cultivars and the leaf rust isolates on 15 near isogenic Thatcher lines (NILs) possessing Lr genes and on 8 standard differentials (JOHNSON & BROWDER, 1966). Reaction of differentials to powdery mildew were tested by a scale 0-5 and infection types of leaf rust were evaluated according to STAKMAN et al. (1962).

Results and discussion

The data on the effectiveness of resistance genes to the isolates of powdery mildew are given in Table 1. The differential cultivars with resistance genes Pm4a and Pm1+Pm 2+Pm 9
were resistant against all isolates collected in Slovakia. Also in the Czech Republic the lowest frequency of virulence was found against the gene combination Pm1+Pm2+Pm9 (KLEM and TVARŮŽEK 1997). The gene combination Pm2+Pm6 (cvs Torysa, Estica, Sana + Pm8,) was effective only against isolates collected from western Slovakia. The occurrence of irulence against the gene combination Pm2+Pm6 in eastern and central Slovakia is probably caused by races from Hungary, where cultivars with that gene combination are widely grown (SZUNICS & SZUNICS 1996).

Table 2. Effectiveness of resistance genes to the isolates of Puccinia persistens subsp. triticina in the years 1997 – 2000 in Slovakia (in %)

Gene of resistance of NIL*	Years 1997	1998	1999	2000
Lr1	84.0-67.0**	73.0	88.6	77.8
Lr2a	***67.0***	***91.0***	***85.8***	***75.6***
Lr2b	67.0	64.0	82.9	64.5
Lr2c	20.0	0	0	2.2
Lr3	0	9.0	0	0
Lr9	100	100	100	100
Lr11	0	0	0	0
Lr15	33.0	27.0	0	35.6
Lr17	0	9.0	0	0
Lr19	100	100	100	100
Lr21	0	0	0	0
Lr23	70.0	0	20.0	47.0
Lr24	100	100	100	100
Lr26	0	27.0	2.9	4.5
Lr28	100	100	100	100

The effectiveness of gene Pm1 increased towards eastern Slovakia. Effectiveness of Pm3d and Mld + mlha was similar throughout Slovakia. According to our results we can consider genes Pm2,Pm3a, Pm3b, Pm3c, Pm3f, Pm5, Pm7 and Pm8 to be ineffective. The gene Pm4b was partly effective only in eastern Slovakia, while in the other regions it was completely ineffective. The gene combination Pm2+Pm4b is present in cvs Simona and Sofia. Low effectiveness of the gene Pm17 was also detected. In the Czech Republic virulence against resistance genes Pm2, Pm4b, pm5 and Pm17 was also found. In Poland, frequencies of virulence to Pm1, Pm2, pm5, Pm7 and Pm8 were similar to those of the population of powdery mildew of wheat in Slovakia (STRZEMBICKA & LAZARSKA 1996).
The effectiveness of resistance genes to the isolates of leaf rust in the years 1997 – 2000 in Slovakia are given in Table 2. Near-isogenic lines (NILs) with resistance genes Lr9, Lr19, Lr24 and Lr28 were completely resistant to all examined pathotypes in all years. High effectivity against the leaf rust population was found in the genes Lr1, Lr2a and Lr2b. Virulence on Lr26, that is present in several registered cultivars, was common. Similarly, most samples were virulent on Lr3, also present in several registered cultivars. Resistance gene Lr11 and Lr21 were completely ineffective.
The data on occurrence of leaf rust races in the years 1996-2000 in Slovakia are given in Table 3. During the investigation period we detected 12 pathotypes of leaf rust. The most frequently determined isolates conformed to race 61SaBa (43 – 78 %), followed by race 77SaBa (8 – 20 %). Both races occurred in all years. To the less frequently determined races belong 14SaBa, 62SaBa, 2SaBa, 77, 61, 6 and race 14. The races 57SaBa, 12SaBa a 6SaBa were more frequent in the last year. Resistance genes Lr3 and Lr26 prevail in our registered cultivars. These genes are not effective to the most widespread race 61 SaBa. Cvs Astella, Hana, Viginta, Klea and Samanta contain gene Lr3, cvs Livia, Malvina and Iris gene Lr26, cv. Sofia genes Lr3 and Lr26. Cv. Estica displayed different reactions to three isolates of race 61SaBa. Similar differences were also found in the Czech Republic in cvs Asta, Blava, Danubia, Lívia and Samara (BARTOŠ et al., 1996). Cv. Estica belongs to the most resistant cultivars whereas cvs Boka and Solara were susceptible to all applied rust isolates.

Table 3. Occurrence of physiologic races of Puccinia persistens subsp. triticina in the years 1996-2000 in Slovakia (in %)

Year	Occurrence of races in %			
	< 10	10.1-20	20.1-40	>40
1996	14SaBa 77SaBa *2SaBa* 77 61	-		61SaBa
1997 *2SaBa*	62SaBa 77SaBa *57SaBa* 6SaBa 6	-		61SaBa
1998	12SaBa 77SaBa 77 14	-		61SaBa
1999	77SaBa 57SaBa 12SaBa 6SaBa 61	-	-	61SaBa
2000	2SaBa 77SaBa 6	57SaBa 12SaBa 6SaBa	-	61SaBa

NIL - near-isogenic line*
** - difference due to variable reaction of some isolates

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THE FIELD EFFICACY OF FUNGICIDES AGAINST MEAN LEAVES PATHOGENS OF BARLEY

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Summary

In the work, the field results of fungicide efficacy are presented. In agroecological conditions of Nitra, the fungicides efficacy was tested against *Blumeria graminis* f. sp. *hordei*, *Pyrenophora teres*, *Rhynchosporium secalis, Septoria nodorum* and *Fusarium* spp. infection. The highest biological efficacy (all of evaluated leaves) was decreasing in following order: flusilazole + carbendazim (1,0 $l.ha^{-1}$), epoxiconazole + tridemorph (0,8 $l.ha^{-1}$), epoxiconazole + tridemorph (0,6 $l.ha^{-1}$), epoxiconazole + fenpropimorph (1,5 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (0,8 $l.ha^{-1}$), epoxiconazole + carbendazim (1,0 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (1,0 $l.ha^{-1}$). The highest increasing of yield was observed in following downward order: epoxiconazole + fenpropimorph (1,5 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (0,8 $l.ha^{-1}$ and 1,0 $l.ha^{-1}$), epoxiconazole + carbendazim (1,0 $l.ha^{-1}$), flusilazole + carbendazim (1,0 $l.ha^{-1}$), and epoxiconazole + tridemorph (0,8 $l.ha^{-1}$ and 0,6 $l.ha^{-1}$). In all fungicide variants the decreasing of *S. nodorum* ears attack was observed, the best influence was recorded by using of epoxiconazole + tridemorph. The more markedly decreasing of *Fusarium* grains attack was observed only by flusilasole + carbendazim.

Key words: fungicide, barley, leaves pathogens

Introduction

In the field conditions, the most important pathogens of barley are *Blumeria graminis*, *Pyrenophora teres* and *Rhynchosporium secalis*. The pathogen reduces yield and on the other hand also the quality of grains. Therefore the chemical protection against them is in place. The most considered fungicides are based on strobilurins (JORGENSEN and NIELSEN, 1998), triazoles compounds (BLATTER, 1998), and etc..
The aim of work was the fungicides efficacy evaluating in field conditions of Nitra.

Material and methods

The field trials were realised in Experimental base of Slovak agricultural university (SPU) Dolná Malanta, near Nitra. The following fungicides were used in different variants:
A - kresoxim-methyl + epoxiconazole (as Juwel), dose 1,0 $l.ha^{-1}$, B - kresoxim-methyl + epoxiconazole (as Juwel), dose 0,8 $l.ha^{-1}$, C - epoxiconazole + tridemorph (as Tango), dose 0,8 $l.ha^{-1}$, D - epoxiconazole + tridemorph (as Tango), dose 0,6 $l.ha^{-1}$, E - flusilazole + carbendazim (as Alert S), dose 1,0 $l.ha^{-1}$, F - epoxiconazole + fenpropimorph (as Opus Team), dose 1,5 $l.ha^{-1}$, G - epoxiconazole + carbendazim (as Duett), dose 1,0 $l.ha^{-1}$, K - control variant.
The tested crop was barley, cv. "Kompakt". The efficacy of fungicides was appreciated against *Blumeria graminis* f. sp. *hordei*, *Rhynchosporium secalis, Pyrenophora teres* (on leaves); *Septoria nodorum* (on ears) and *Fusarium* spp. (in grains). The variants were realised in 3 repetitions, germinative capacity of seeds was 89,0 %. The fungicides were applied in growth stage DC 39, by using 500 $l.ha^{-1}$ of water. The evaluation were made in growth stages before application - DC 37-39, 14 days after application - DC 71 and finally in growth stage DC 93. There was 3 times per 30 plants tested. In each plant, there were three upper leaves evaluated. The used scale was 1-9 (9 - without infestation, 1 - 100 % infected area). The level of infestation was expressed as attack index and fungicides efficacy in %, according Abbott pattern.
The harvested grains were tested in laboratory. The seeds were surface sterilised in 1% NaOCl solution for 2 minutes, next washed up in redestilled water. The 5 surface sterilised grains were placed on Petri dishes with potato-dextrose agar (PDA) and incubated at 20°C 7-10 days under 12/12 photoperiods. 100 grains in 3 repetition were analysed in each variant. *Fusarium* colonies, which have overgrew from grains, were detected macroscopically and microscopically as *Fusarium* spp., without species specification. After incubation, the percentage of *Fusarium* spp. infected grains was evaluated.

Results and disscusion

Evaluation before spraying, DC 37-39: In evaluated growth stage were detected attack of *B. graminis* f. sp. *hordei*, *R. secalis* and *P. teres* occurred sporadically (Table 1). In spots of *B. graminis* were observed pure sporulation.
The *B. graminis* spots occurred on 2nd and 3td leaves, the ultimate leaves were without symptoms. In case of ultimate leaves the fungicides spraying was preventive one, in case of other leaves was repressive one.
Evaluation 14 days after fungicides spraying: The occurrence of *R. secalis* and *P. teres* was trivial in this growth stage too (Table 2).

Table 1 Attack Index (%) on barley, DC 37 - 39, Malanta 1999

Variant	*Blumeria graminis*			*Rhynchosporium secalis*			*Pyrenophora teres*		
	a	b	c	a	b	c	a	b	c
K	-	10,49	22,59	-	0,49	-	-	-	-
A	-	11,36	28,02	-	0,62	-	-	-	-
B	-	10,25	26,67	-	0,12	-	-	-	-
C	-	11,60	24,45	-	0,25	-	-	0,12	-
D	-	9,26	25,19	-	0,49	0,25	-	-	-
E	-	9,88	24,94	-	-	-	-	-	-
F	-	7,91	21,24	-	0,12	-	-	-	-
G	-	8,52	23,70	-	0,38	-	-	-	-

- Designation of variants are described in chapter Material and methods
  a - the last leaves (flag), b - the second leaves, c - the third leaves downward

Table 2 Pathogen's damage (attack Index (%)) and fungicides efficacy (BÚ) on barley, Malanta 1999

Variant	*Erysiphe graminis*				*Rhynchosporium secalis*			*Helminthosporium teres*		
	a	b	C	BÚ (%)	a	b	c	a	b	c
K	19,63	29,63	43,33	-	-	0,75	-	-	1,73	3,34
A	12,10	25,93	33,46	22,80	-	-	-	0,25	-	0,99
B	11,98	20,99	31,48	30,39	-	0,37	2,10	-	0,38	0,86
C	10,00	20,86	30,12	34,14	-	-	-	-	-	0,25
D	10,74	21,11	31,11	32,00	-	-	-	-	-	0,75
E	10,99	20,86	28,03	35,33	-	-	-	-	-	0,49
F	11,36	21,85	30,25	31,46	-	-	-	-	-	-
G	11,11	22,72	32,22	28,66	-	0,37	-	-	-	-

- Designation of variants are described in chapter Material and methods
  a - the last leaves (flag), b - the second leaves, c - the third leaves downward, BÚ - biological efficacy of fungicides

The infection gone over the ultimate leaves in all variants. In other leaves the infection increased too, because of up-grade infection, especially in case of *B. graminis*. All fungicides retarded this translocation of pathogens. Just this ultimate leaf is most important for creating of future yield. The best influence on health of ultimate leaves the fungicides reached in following downward order: epoxiconazole + tridemorph (0,8 $l.ha^{-1}$), epoxiconazole + tridemorph (0,6 $l.ha^{-1}$), flusilazole + carbendazim (1,0 $l.ha^{-1}$), epoxiconazole + carbendazim (1,0 $l.ha^{-1}$), epoxiconazole + fenpropimorph (1,5 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (0,8 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (1,0 $l.ha^{-1}$). In case of average biological efficacy (all of evaluated leaves) was the order following: flusilazole + carbendazim (1,0 $l.ha^{-1}$), epoxiconazole + tridemorph (0,8 $l.ha^{-1}$), epoxiconazole + tridemorph (0,6 $l.ha^{-1}$), epoxiconazole + fenpropimorph (1,5 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (0,8 $l.ha^{-1}$), epoxiconazole + carbendazim (1,0 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (1,0 $l.ha^{-1}$).
The finally efect - harvested yield is most interesting for agricultural practice (Tab. 3).

Table 3 Influence of fungicides application on yield characteristic, Malanta 1999

Variant	Number of fertile tillers	Length of ears	Number of grains per ear	Weight of ear grains	Weight of thousand seeds	Yield
	(pc)	(mm)	(pc)	(g)	(g)	(g)
K	395	57,4	22	1,01	48,31	388,95
A	515	63,8	23	1,19	51,58	529,23
B	525	63,8	24	1,17	49,18	536,99
C	393	65,6	24	1,17	49,74	448,61
D	558	62,1	23	1,11	47,86	441,57
E	529	62,9	24	1,23	51,93	516,31
F	485	63,3	24	1,21	50,49	541,53
G	554	63,1	24	1,24	51,09	528,73

- Designation of variants are described in chapter Material and methods (pc) - pieces

The highest increasing of yield was observed in following downward order: epoxiconazole + fenpropimorph (1,5 $l.ha^{-1}$), kresoxim-methyl + epoxiconazole (0,8 $l.ha^{-1}$ and 1,0 $l.ha^{-1}$), epoxiconazole + carbendazim (1,0 $l.ha^{-1}$), flusilazole + carbendazim (1,0 $l.ha^{-1}$), and epoxiconazole + tridemorph (0,8 $l.ha^{-1}$ and 0,6 $l.ha^{-1}$). The most notable differences are in case of epoxiconazole + tridemorph, which was the best in biological efficacy, but the yield was not the highest. Other way round the kresoxim-methyl + epoxiconazole had not the best efficacy, but the increasing of yield was evident. This situation was caused by so-called "green effect", which is well known by this fungicide and other strobilurins (GERHARD et al., 1999). The positive effect of all fungicides on yield increasing was observed in all variants. It comes to this, that transmission of pathogen to ultimate leaves markedly decreased the yield (Lockley et al., 1998). In case of kresoxim-methyl + epoxiconazole application was observed interesting phenomenon, the sprayed plants was lighter in growth stage full ripe, because of less *Cladosporium* spp. and *Alternaria* spp. infection than in other variants.
Laboratory analysis of grains: In all fungicide variants the decreasing of *S. nodorum* ears attack was observed in comparison to the control (Tab. 4). The best influence was recorded by using of epoxiconazole + tridemorph, according to the highest biological efficacy in previous evaluation.

Table 4 Infestation of barley ears and grains, DC 93, Malanta 1999

	K	A	B	C	D	E	F	G
Number of evaluated ears	395	515	525	393	558	529	485	554
S. nodorum attack (%)	4,55	1,62	2,54	3,64	0,30	2,22	2,41	0,78
Germinate capacity of seeds (%)	78,0	92,0	91,0	86,0	87,0	90,0	90,0	79,0
Fusarium attack (%)	26	18	17	20	27	6	21	24

- Designation of variants are described in chapter Material and methods

Occurrence of *Fusarium* species on ears and grains is dangerous as potential for direct damages and mycotoxins contamination (MIROCHA et al., 1977). The more markedly decreasing of *Fusarium* grains attack was observed by flusilasole + carbendazim. Other differences have trivial meaning, because of smaller differences and early application. The more effective application is considered in latest period, in the beginning or during flowering (SUTY et al., 1977).

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INFLUENCE OF DIFFERENT SYSTEMS OF CEREALS GROWING (BI-, TRI-, TETRA-CULTURE) ON THE ANIMAL PESTS OCCURRENCE

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Summary

Effect of different systems of cereal growing (bi-, tri-, tetra-culture) on the occurrence of animal pests and their natural regulators was investigated on the experimental basis at Nitra-Malanta. Spring barley grown in bi- and tetra-culture was more infested by animal pests than winter wheat grown under tri- and tetra-culture. System of soil cultivation and fertilization showed significantly different effect on the crop infestation by pests.

Key words: spring barley, winter wheat, pests, system of bi-, tri-and tetra-culture

Introduction

Occurrence and extension of animal pests on cereals is not homogeneous and depends on climatic, agroecological, anthropogenic and other factors which hardly can be characterised with a simple definition (Fadejev, Novožilov, 1986). Up to now there was devoted only little attention to the research of this field under the conditions of Slovak Republic (Gallo, Pekár, 1999). Most of the authors were focused to the investigation and evaluation of the most spread species as once time were for instance leaf miners *(Agromyzidae)* which are mentioned in the works of Dušek (1980), Kocourek et al. (1990), and Gallo (1990, 1994). Further such a species are represented by frit fly – *Oscinella frit* L. (Perutík, 1977), thrips spp. – *Thysanoptera* (Grenčík, 1981), aphids spp. – *Aphididae* (Praslička, 1996), lema beetles – *Oulema* spp. (Hayer, 1982; Ramson et al., 1980; Tummala et al., 1975; Sawyer et al., 1978; McPherson, 1983; Kocourek et al., 1995), straw fly – *Chlorops pumilionis* Bjerk. (Derron et al., 1990) and others. The whole spectrum of animal pests on cereals was investigated from the point of view of their occurrance and harmfulness only by a few authors (Markovec, Gorbunová, 1951; Šedivý, Kodys, 1985; Wetzel et al., 1986; Gallo, Pekár, 1999). Effect of "new" farming sytems on the pests and regulators started to be investigated only recently (Khamraev, 1990; Pfiffner, 1990; Booij – Noorlander, 1992; Xie et al., 1995). These systems include different methods of soil cultivation: ploughing (Samsonova, 1991), loosening (Lewis, 1980) and application of various fertilisers (Sokolov – Nikitina, 1991). Effect of previous crop and cultivation methods on the occurrence of animal pests in winter wheat covers are researched in the works of Lacko-Bartošová et al. (1997) and Gallo (1996).
In this contribution we focused on the evaluation of the influence of different growing systems of cereals (bi-, tri-, tetra-) and on the effect of ploughing and previous crop on the species spectrum of animal pests and their regulators in spring barley and winter wheat covers.

Material and methods

Occurrence of animal pests on cereals was investigated at the Slovak Agricultural University in Nitra within the polyfactorial experiments of the Department of Agricultural Systems, part of which is separated for special purposes of this research within so called "monitoring" at Nitra-Malanta.
Agrotechnical conditions of trial establishment:
Crops: spring barley, winter wheat
Previous crops: pea, maize for silage
Biological material: grain of spring barley, variety JUBILANT; grain of winter wheat, variety VLADA
System of soil cultivation: 1) B1 – ploughing into the depth of 0,2 m + surface soil levelling
2) B3 – combined soil tillage machine
Fertilizing: O – zero treatment without fertilising
PZ – rational fertilising (on the balance basis) calculated for average crop yielding
Growing system: bi - crop rotation as follows: maize, spring barley
tri - crop rotation as follows: pea, winter wheat, maize
tetra – crop rotation as follows: pea, winter wheat, maize, spring barley
Collecting of animal pests and other insect was performed by means of entomological net on the investigated stands. Collecting was carried out in determined time intervals (once a week, since the first observed occurrence) on the experimental plots (15 m^2) in five replications. The results are stated in pieces (pcs) per 5m^2. Statistical testing methods for nominal scalar variables were used for statistical evaluation of the results based on testing the differences between two independent data sets (Clauss, Ebner, 1988). Species spectrum has been found by theirs determination. The results achieved during the years 1996-2000 are presented in the contribution.

Results and discussion

Insect was collected since the 30th of April to the 18th of June 1996 in the cover of winter wheat totally 9 times and since the 7th of May to the 4th of July 1996 in the cover of spring barley totally 8 times. The next period of collection was from the 2nd of May to the 25th of June 1997-9 times in wheat and 11 times in spring barley in total. The third collecting interval lasted from the 6th of May to the 10th of June 1998 totally 6 and 6 times both for wheat and barley. During the year 1999 collection interval was realised from the 21st of April to the 16th of June totally 9 and 9 times for wheat and barley, respectively; and from the 18th of April to the 27th of June 2000 ten and 9 times in total for wheat and barley, respectively.

By investigation of animal pest invasion in cereals of experimental plots during 5 years, we have found in all systems of growing, cultivation and fertilizing totally 7278 pieces of animal pests per $5m^2$ and 3275 pieces of natural regulators per $5m^2$.

Spring barley grown in bi- and tetra-culture was more infested by animal pests (bi- 1905 and tetra- 1873 $pcs.5m^{-2}$) than winter wheat which was grown in tri- and tetra-culture (tri-1726 and tetra- 1774 $pcs.5m^{-2}$). This fact was caused by system of growing and it is in correlation with some partial results of some authors (Fadejev, Novožilov, 1986; Lacko-Bartošová et al., 1997; Gallo, 1996).

Spring barley grown in biculture under the cultivation B1 was statistically highly significantly more infected by edificators in fertilising (PZ) variants (76 $pcs.5m^{-2}$) than in unfertilised (O) variants (60 $pcs.5m^{-2}$). However, under the cultivation B3 the achieved results were opposite. We have found statistically highly significantly higher infestation (83 $pcs.5m^{-2}$) in unfertilised variants (O) as compared with fertilised ones (PZ) amounting 71 $pcs.5m^{-2}$. Our results differ from the findings of some other authors who have concluded that neither soil cultivation nor fertilization showed more substantial effect on pest occurrence (Sokolov et al., 1991; Samsonova, 1991) and partially are in accordance with the results of Levine (1993), Gallo, Pekár (1999). Occurrence of natural regulators in spring barley that was grown in biculture was in contrast position to the occurrence of edificators. Their statistically significant occurrence was on B1 in unfertilised (O) variants (37 $pcs.5m^{-2}$) and under the cultivation B3 in fertilized (PZ) variants (35 $pcs.5m^{-2}$). Klingenberg (1994) achieved similar results with oil rape.

Winter wheat was statistically highly significantly more infected by edificators only in triculture under the soil cultivation B3 in unfertilized (O) variants (68 $pcs.5m^{-2}$). Regardless the fertilisation, we have found in winter wheat grown in tetraculture statistically significant difference in increased infestation by edificators in variants under the B3 cultivation (80 $pcs.5m^{-2}$) comparing with B1 cultivation (56 $pcs.5m^{-2}$). These results are in harmony with the findings of Samsonov (1991) and Sokolov, Nikitina (1991). Occurrence of natural regulators in wheat grown in tetraculture was significantly higher in unfertilised (O) variants (58 $pcs.5m^{-2}$) than in fertilised (PZ) variants (48 $pcs.5m^{-2}$).

During experimental years there were investigated several pest species as edificators: In spring barley they were represented mainly by thrips ssp. *(Thysanoptera)*, brassy flea beetle (*Chaetocnema concinna* Marshall), straw fly (*Clorops pumilionis* Bjerkander) and frit fly (*Oscinella frit* Linnaeus). In winter wheat the main observed edificators were as follows: Thrips spp. *(Thysanoptera)*, brassy flea beetle (*Chaetocnema concinna* Marshall), lema blue cereal beetle (*Lema lichenis* Linnaeus), lema black cereal beetle (*Lema melanopus* Linnaeus) and wheat bulb fly (*Hylemyia coarctata* Fallén). Natural regulators of pests in cereals stated in this contribution were represented by species of the following families: *Nabidae, Cantharidae, Braconidae, Chalcididae, Ichneumonidae, Pteromalidae* and *Syrphidae.*

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INFLUENCE OF INSECTICIDES TO *BEAUVERIA BASSIANA* (BALSAMO) VUILLEMIN

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Summary

Four insecticides, permethrin, deltamethrin, alfacypermethrin and cypermethrin, were tested for their influence to *B. bassiana*. When isolates of *Beauveria bassiana* (Balsamo) Vuillemin were placed into agars containing insecticides, they average daily growth of mycelium was significantly smaller than that of control variants. After mixing suspension of fungal spores with insecticides in the concentration recommended by producer against European corn borer, *Ostrinia nubilalis* Hbn., fungus did not create any colonies on artificial medium. Results show that during the application of chemical insecticides it is possible to use biopesticides containing the fungus *B. bassiana*, but they can not be mixed together with chemical insecticides.

***Key words*: *Beauveria bassiana,* pesticides, pyrethroids, *Ostrinia nubilalis*, mycelial growth**

Introduction

Combination of *Beauveria bassiana* (Balsamo) Vuillemin, or *Beauveria brongniartii* with insecticides should increase the efficiency of the fungi. Thus, there was an increase in incidence of *B. brongniartii* on *Melolontha melolontha* larvae in the presence of low doses of organochlorides or organophosphates (Ferron, 1971). Combinations of *B. bassiana* with insecticides abamectin, triflumuron, thuringiensin or carbaryl were consistently more toxic than *B. bassiana* alone (Anderson et al., 1989). When carbofuran was added to plants treated with *B. bassiana*, there was increased mortality of the European corn borer, *Ostrinia nubilalis* Hbn. (Lewis et al., 1996). Synergism only occurred at concentrations of chemical insecticide (Quintela, McCoy, 1997).
Growth inhibition of entomopathogenic fungi is an useful criterion for testing compatibility of fungi with pesticides used in plant protection systems (Loria et al., 1983).
Cadatal and Gabriel (1970) found that mycelial growth of *B. bassiana* was inhibited by carbaryl in vitro conditions. Permethrin did not inhibit *B. bassiana* at all, and its growth curve was very similar to that of the control (Clark et al., 1982).
The most efficient insecticides in the experiments with chemical control of *O. nubilalis* in Slovakia were pyrethroids (Cagáň, 1993). The aim of this work was to evaluate how pyrethroids influence biological properties of fungus *B. bassiana.*

Material and methods

Four isolates of *B. bassiana* (SK 67, SK 78, SK 99 and SK 100) isolated from *O. nubilalis* larvae and maintained on Sabouraud-dextrose agar (SDA) were used in the experiment. Four insecticides, permethrin (0.8 ml/1l SDA), deltamethrin (0.8 ml/1l SDA), alfacypermethrin (0.4 ml/1l SDA) and cypermethrin (0.8 ml/1l SDA), were tested for their influence to *B. bassiana*.
In the first experiment, application rates of insecticides were added to the cooled medium (SDA) and treated medium was infused into Petri dishes. *B. bassiana* isolates were placed on insecticide Petri plates and every 24 hours mycelial growth was evaluated during one week according to the formula $r = r_a - r_b$ where "r" was radial growth, "a" was actual time of measurement and "b" was time of measurement 24 hours ago.
In the second experiment, suspension of *B. bassiana* spores was mixed together with insecticide solution (concentration was as recommended for spaying of maize for control of *O. nubilalis*). Mixture was added on SDA and mycelial growth was evaluated during one week.
Each experiment was repeated four times.

Results and discussion

The effect of insecticide on mycelial growth of *B. bassiana* is shown in Fig. 1, 2, 3 and 4. The isolates grew when they were placed into agars containing insecticides. But average daily growth increase of any of tested isolates had not been higher than that of control variants (Fig. 1-4). The highest inhibiting effect to each of four isolates was found after application of Decis 2,5 EC. The fattest growth of isolates was observed on agars containing Vaztac 10 EC. There are many similar results from literature. From insecticides, carbaryl inhibited in vitro *B. bassiana* mycelial growth (Gardner et al., 1979), or was absolutely not dangerous to fungus *Verticillium lecanii* (Halla, 1981). Carbofuran showed moderate inhibition to *B. bassiana* (Clark et al., 1982). Permethrin did not inhibit the fungus (Halla, 1981; Clark et al., 1982; Samšiňáková, Kalalová, 1983), but another pyrethroid fenvalerate produced significant inhibition of *B. bassiana* germination and growth. As indicated by Landa (1983), cypermethrin showed only weak inhibition of *V. lecanii* similarly as permethrin, formothion, mevinfos, oxamyl, pirimicarb and pirimiphos-methyl.

In the second experiment, after mixing suspension of spores with insecticides in the concentration recommended by producer against corn borer, fungus did not create any colonies on artificial medium. Similarly, toxicity of many fungicides (including maneb, mancozeb, metiram, zineb) to entomogenous fungi was detected (Lorio et al., 1983; Landa, 1983; Samšiňáková, Kalalová, 1983).

From our results we can assume that during the application of chemical insecticides it is possible to use biopesticides containing the fungus *B. bassiana*, but they can not be mixed together with chemical insecticides.

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Fig. 1: The effect of insecticides on mycelial growth of Beauveria bassiana isolate SK 67.

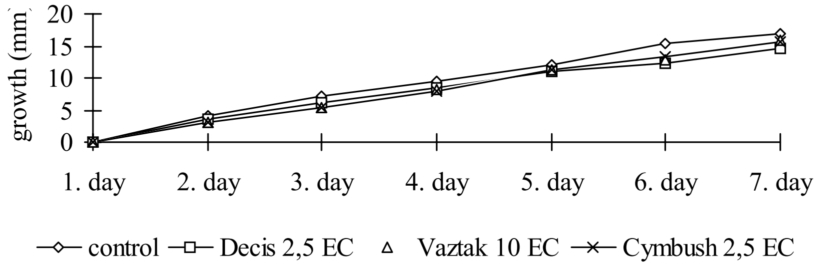


Fig. 2: The effect of insecticides on mycelial growth of *Beauveria bassiana* isolate SK 78.

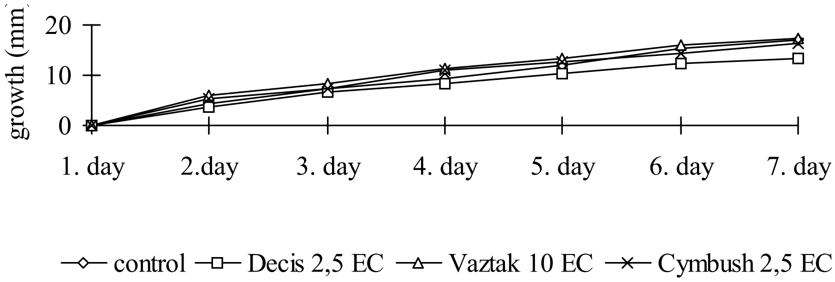


Fig. 3: The effect of insecticides on mycelial growth of *Beauveria bassiana* isolate SK 99.

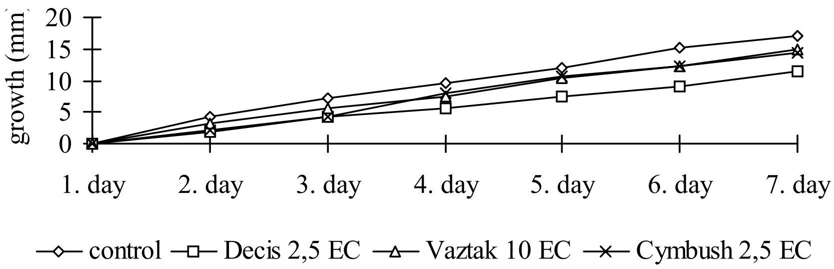
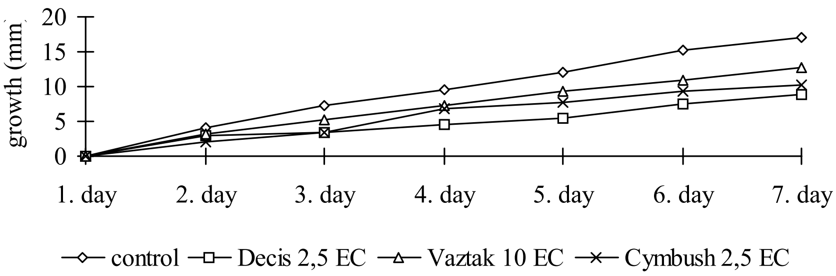


Fig. 4: The effect of insecticides on mycelial growth of *Beauveria bassiana* isolate SK 100.



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FLEA BEETLES SPECIES ASSOCIATED WITH *AMARANTHUS* SPP. AND SURROUNDED CULTIVATED AND WILD PLANT SPECIES

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Summary

Sweep net collection of the *Alticinae* flea beetle from various cultivated and wild plant species revealed that the most common genus was *Chaetocnema* spp. To the predominant species was *Chaetocnema tibialis* (Ill.). Another two *Chaetocnema* species, *C. concinna* (Marsh) and *C. laevicollis* Thoms., did not overcome more than one percent of *C. tibialis* population on *Amaranthus* spp., *Chenopodium* spp. and *Beta vulgaris* L. Their share on *Medicago sativa* L. was 14%, on *Zea mays* L. and *Urtica dioica* L. 11%. Next six flea beetles species – *Altica oleracea* (L.), *Longitarsus pellucidus* Foudras, *Phyllotreta atra* (F.), *P. cruciferae* (Goeze), *P. nigripes* (F.) and *P. vittula* (Redt.), were swept on *Amaranthus* spp. *P. cruciferae* was not present in sweep net collection of *B. vulgaris* and *Chenopodium* spp., *P. nigripes* on *M. sativa*, *A. oleracea* on *Z. mays* and *Altica oleracea, L. pellucidus, Phyllotreta nigripes* on *U. dioica*.

Key words: crop plants, weeds, species composition, flea beetles, Alticinae

Introduction

Alticinae are highly specialized and phytophagous insects. Both the adults and larval stages feed on stems, leaves and roots of almost all of higher plants families. The majority of the flea beetles are oligophagous, more rarely polyphagous, and only a few species are unequivocally monophagous (Warchałowski, 1978).
Flea beetles occur virtually everywhere, in almost all type of habitats, even in deserts and arctic environs, but the majority of genera and species occur in the tropical regions of South America, Africa and Asia. The palearctic fauna is relatively poor. Here, the richest flea beetle communities occur in open spaces near forests or scrubland, often associated with rivers or lakes, and various kind of meadows (Konstantinov & Vandenberg, 1996).
The aim of our study was to compare species composition of *Alticinae* flea beetles occurring on *Amaranthus* spp. with surrounding cultivated and wild plant species in Slovak conditions.

Methods

Occurrence of *Alticinae* flea beetles on various cultivated and wild plant species was observed during July and August 1996 at Dolná Malanta 14 kilometres eastern from Nitra. The locality is characterised according to Konček (1980) as a warm and temperate dry. Insects were collected by net sweeping (3x100 sweepings). One sweeping on *Beta vulgaris* L. (Chenopodiaceae), *Medicago sativa* L. (Fabaceae), *Urtica dioica* L. (Urticaceae) and *Zea mays* L. (Poaceae) was about 1m long. One sweeping in case of weed *Amaranthus* spp. (Amaranthaceae) and *Chenopodium* spp. (Chenopodiaceae) corresponded to one plant. Each swept plant was approximately same sized, with a stem length of about 1m. Collected insects were put to death, sorted and identified.

Results

Sweep net collection of the *Alticinae* flea beetle from various cultivated and wild plant species revealed, that the most common genus, especially on *Amaranthus* spp. *Amaranthaceae*), sugar beet (*Chenopodiaceae*) and particularly on *Chenopodium* spp. (*Chenopodiaceae*) was *Chaetocnema*. To the predominant species belonged *C. tibialis* (Ill.), another two *Chaetocnema* species, *C. concinna* (Marsh.) and *C. laevicollis* Thoms., did not overcome more than one percent of *C. tibialis* population. Next six flea beetles species – *Altica oleracea* (L.), *Longitarsus pellucidus* Foudras, *Phyllotreta atra* (F.), *P. cruciferae* (Goeze), *P. nigripes* (F.) and *P. vittula* (Redt.), were swept on *Amaranthus* spp. The same flea beetles were found on sugar beet and *Chenopodium* spp., except of *P. cruciferae*.
Chaetocnema spp. created 94-97,70% of the flea beetles found on *Amaranthus* plants. The rest portion was represented by the remained six flea beetle species, from which *P. vittula* was the most abundant (2,52%). Similar situation was observed on sugar beet, where *C. tibialis* created 95,20-96% of all *Alticinae* flea beetles. Different result was obtained from the plants of the same family as sugar beet – *Chenopodium* spp. On this weed species, *Chaetocnema spp.* number formed 6,25% flea beetle population in July to 89,5% flea beetle population in August. From the remained flea beetles species observed on plants from the family *Chenopodiaceae*, *P. vittula* was the most abundant again, sharing maximum 4,20% on sugar beet, but more than 56% on *Chenopodium* spp.

The numbers of *Chaetocnema* species on sugar beet at the end of July and August were comparable, while on *Chenopodium* their number till August increased and on *Amaranthus* decreased.
On *Z. mays* the same flea beetles species, were found as those on *Chenopodiaceae*, excluding *A. oleracea*. Among the *Alticinae* species collected by net sweeping on maize, *P. vittula* shared 18-65,71%. Portion of *Chaetocnema* spp. was 34,29-56%, from which *C. concinna* and *C. laevicollis* created 11%.
Another two plant species - *M. sativa* and *U. dioica*, were swept in August. The predominant *Chaetocnema* species represented 68,5 and 89,8%, respectively. On these plants were observed higher numbers of *C. concinna* and *C. laevicollis*. Their share on *M. sativa* was 14%, and on *U. dioica* 11%. Share of *P. vittula* was from 6,12 to 22%.
A. oleracea, L. pellucidus, P. nigripes was not present in sweep net collection of *U. dioica*. and *P. nigripes* on *M. sativa.*

Discussion

The observed plant species serve as a host for 9 *Alticinae* flea beetle at locality Dolná Malanta, while during 1995-1997 was 13 species identified at 10 localities throughout Slovakia on *Amaranthus* spp. (Cagáň et al. 2000). Among the absenting species belonged *Longitarsus longipennis* Kutsch., *L. melanocephalus* Deg., *L. nasturtii* (F.) and *Psylliodes chrysocephala*.
C. tibialis and *C. concinna* are important pests of sugar beet (Warchalowski, 1978). Except of *Chenopodiaceae*, another host plants for *C. tibialis* are *Amaranthus* spp. (Nonveiler 1960, 1978, Praslička 1996), *Z. mays* (Naibo, 1974), *Hordeum vulgare* L. (Sevagina, 1991; Sobakar & Timoghina, 1991) Host plants for *C. concinna* are the plants from family *Polygonaceae* (Warchalowski, 1978), but also *M. sativa* (Mostovaya 1994). The occurrence of *C. concinna* at locality Dolná Malanta was higher on *M. sativa* (14% of *Chaetocnema* population) and *U. dioica* (11% of *Chaetocnema* population) than on sugar beet or *Amaranthus* spp. (1% of *Chaetocnema* population). However, *U. dioica* is not mentioned as a host plant in the literature.
Phylotretta species found on swept plants are mostly the pests of the family *Brassicaceae* (Warchalowski, 1978), but *P. vittula* is also pest of cereals (Poaceae) (Naibo, 1974; Warchalowski, 1978). In our observations it was found on each plant species, with highest abundance on maize.
From four *Longitarsus* species found on *Amaranthus* plants throughout Slovakia only *L. pellucidus* was present at locality Dolná Malanta. The species is known on *Convolvulus arvensis* L. (Warchalowski, 1978).

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POPULATION DYNAMICS OF GREEN PEACH APHID, *MYZUS PERSICAE* (SULZ.) (HOMOPTERA, APHIDIDAE) ON PEACH TREE (*PERSICA VULGARIS* MILL.) AND PEPPER (*CAPSICUM ANNUM* L.)

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Summary

During 1998-2000, population dynamics of the green peach aphid, *Myzus persicae* (Sulzer) was studied on peach trees and pepper in Nitra, south-western Slovakia. Population dynamics was observed weekly during the vegetation period. During 1998 and 1999, the first alatae gynoparae on peach were observed in the middle of September. In 2000 it was in the middle of October. The peak of *M. persicae* population was recorded in the first decade of October (in 1998 and 1999), or at the end of October (in 2000). The last aphid individuals were observed in the second decade of December (in 1998) or in the second decade of November (in 1999 and 2000). The first fundatrices were found on April 26 in 1999 and on April 13 in 2000. In 1999, the highest population density of *M. persicae* was found at the end of May. In 2000 it was on June 15. The highest number of migrates alatae was observed on May 24 in 1999 and on June 1 in 2000. After maximum, population of *M. persicae* on peach trees decreased. In 1999, the first individuals of *M. persicae* on pepper were recorded on June 10. The population density increased until the first decade of July and decreased again until the end of August. The second maximum was found in the first decade of September. From that time, the number of *M. persicae* went down until frost destroyed pepper plants. In 2000, the first individuals of *M. persicae* on pepper were recorded on July 27, and maximum of density was found on September 28.

Key words: Peach aphid, *Myzus persicae*, *Capsicum annuum*, *Persica vulgaris*

Introduction

The green peach aphid, *Myzus persicae* (Sulzer) (Homoptera, Aphididae) is of high economic importance with a wide geographic distribution and a wide host range (Emden et al., 1969). Among plant species seriously attacked is pepper in commercial greenhouses where *M. persicae* causes not only direct feeding damage but it is also a prominent vector of cucumber mosaic virus, potato virus Y and alfalfa mosaic virus (Somos, 1984).
In the present study the population dynamics of the green peach aphid was studied on primary host peach tree and secondary host pepper.

Materials and methods

The experiment was conducted at the experimental area of the Slovak Agricultural University in Nitra, Slovakia in 1998-2000. The population dynamics of *M. persicae* was observed on 3 peach trees (varieties Sunhaven, Elberta and Redhaven). At each tree, 20 randomly chosen sprouts were selected. Peach trees were investigated at 7-day intervals. In spring, the period of larval hatching and period of aphid migration from trees were investigated. In autumn, the occurrence of first aphids and their maximum occurrence on peach trees were determined.
The experiment with pepper was carried out in unheated greenhouse situated 30 m near peach trees. Three varieties of pepper (Andrea, Slovakia and PCR) were included to experiment. The population of *M. persicae* on pepper was determined on 3x5 plants of each variety at 7-day intervals.

Results and discussion

In autumn, the first alatae gynoparae on peach were observed in the middle of September (September 18, 1998; September 9, 1999). In 2000, they were observed in the middle of October (October 12) (Tab. 1). Similarly, Prasličk‌a (1972) found first alatae gynoparae in Nitra In the second decade of September. In Poznan, Poland, alate gynoparae were observed from the end of September (Wilkaniec, Karczewska, 1993). The peak of *M. persicae* population was recorded in the first decade of October (in 1998 and 1999), or at the end of October (in 2000). The last aphid individuals were observed in the second decade of December (in 1998) or in the second decade of November (in 1999 and 2000).
In our results, the first individuals of the fundatrix generation were found on April 26, 1999 and on April 13, 2000 (Tab 1.). Prasličk‌a (1972) found the first adult fundatrix at Nitra locality from March 24 to April 13. Similar results were recorded at Poznan, Poland, where the first larvae of the fundatrix generation hatched from over-wintering eggs at the beginning of April (Wilkaniec, Karczewska, 1993). In 1999, the highest population density of *M. persicae* was found at the end of May. In 2000

it was on June 15. The highest number of migrates alatae was observed on May 24 in 1999 and on June 1 in 2000. After maximum, population of *M. persicae* on peach trees decreased.
In 1999 (Fig. 1), the first individuals of *M. persicae* on pepper were recorded on June 10. The population density increased until the first decade of July and decreased again until the end of August. The second maximum was found in the first decade of September. From that time, the number of *M. persicae* went down until frost destroyed pepper plants. In 2000 (Fig. 2), the first individuals of *M. persicae* on pepper were recorded on July 27, and maximum of density was found on September 28. Praslička (1972) found the maximum of *M. persicae* population on pepper in the middle of July.
In 1999, the last aphid individuals on pepper were observed in the second decade of November. In 2000 it was at the end of November (variety Slovakia – November 16; variety PCR-November 23; variety Andrea – November 30). According to Praslička (1972), high occurrence of *M. persicae* was found at Nitra locality from the beginning of June till the middle of August.
During 1999-2000, the highest infestation by *M. persicae* was observed on the pepper variety Andrea and the lowest infestation on variety PCR (Fig.1. and 2.).

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Table 1 Population dynamics of the green peach aphid, *Myzus persicae* (Sulzer) on *Persica vulgaris* L. at the locality Nitra during the years 1998-2000

		1998	1999	2000
Autumn	The first occurrence alatae gynoparae	September 18	September 8	October12
	The maximum of population density	October 8	October 8	October 26
	The maximum of migrantes alatae population	October 15	October 8	October 26
	The last individuals	December 17	November 19	November 16
Spring	The first occurrence of adults		April 26	April 19
	The maximum of population		May 31	June 28
	Date of migration from the primary host		1. decade July	1. decade July

Table 2 Population dynamics of the green peach aphid, *Myzus persicae* (Sulzer) on *Capsicum annuum* L. at the locality Nitra during the years 1999-2000

	1999	2000
The first occurence	June 10	July 24
The maximum of population	July 1 and September 9	September 28
The maximum population of migrates alatae	October 14	October 5

Fig. 1 Population dynamics of green peach aphid, *Myzus persicae* (Sulz.) on three varieties of *Capsicum annuum* L. in 1999

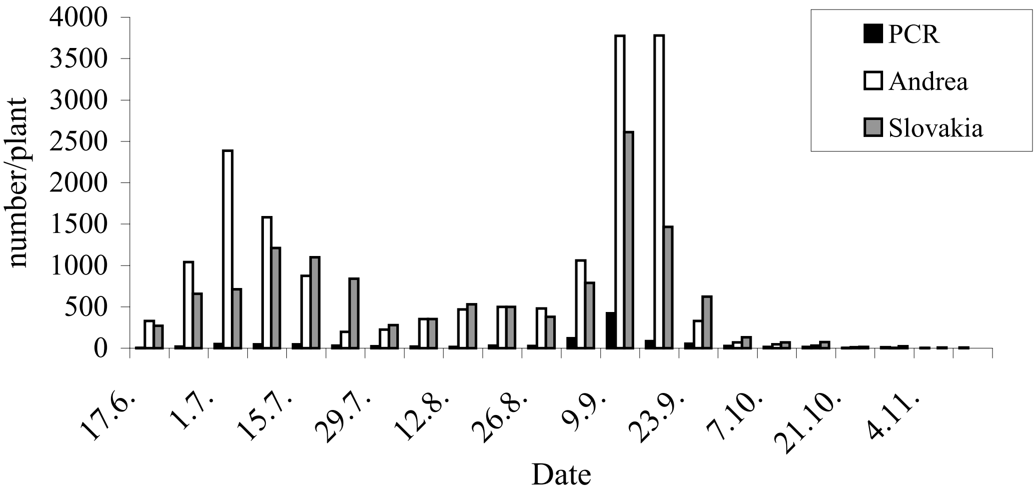
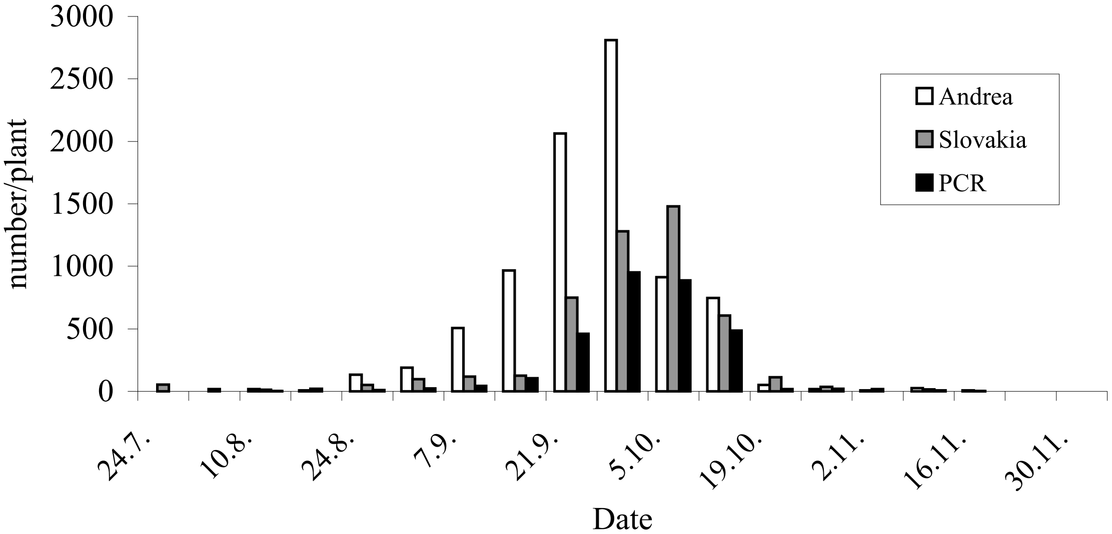


Fig. 2 Population dynamics of green peach aphid, *Myzus persicae* (Sulz.) on three varieties of *Capsicum annuum* L. in 2000



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BIONOMICS OF *SPERMOPHAGUS SERICEUS* (GEOFFROY) (COLEOPTERA: BRUCHIDAE) - A POTENTIAL BIOLOGICAL CONTROL AGENT OF *CONVOLVULUS ARVENSIS* L.

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Summary

During 1997-1998, field surveys were conducted to determine the incidence of seed beetles associated with field bindweed (*Convolvulus arvensis* L.) in Slovakia. The only insect species frequently associated with *C. arvensis* seeds was *Spermophagus sericeus* (Goeffroy) (Coleoptera: Bruchidae). This species was usual in the warmest regions in the south of Slovakia and less widespread in the temperate regions. *S. sericeus* adults were recorded during the whole growing season (May-September), with maximum from May 20 to June 30. Only a few individuals were found during July and August. In September, the small blurred peak of occurrence was observed. *S. sericeus* lays its eggs externally on the pod. Egg laying started in the beginning of June. Freshly hatched larvae burrowed through the pod wall and entered the seed from mid June. Larvae remained within the seed for pupation. *S. sericeus* could be significant for the biological control of field bindweed.

***Key words**: Spermophagus sericeus*, seed beetles, field bindweed, Bruchidae

Introduction

Bruchidae can be found in every continent except of Antarctica. The largest number of species live in the tropical regions (Southgate, 1979). Many species have economic importance because they breed on grain legumes and consume valuable proteins (Lamprey et al., 1974). Intense destruction of seeds reduces the numbers of seedlings.
The larvae of Bruchidae feed and develop only in seeds. The majority of species (84%) feed within family Fabaceae. Remaining (16%) species feed on plants from 32 different families. Thence, species recorded on Convolvulaceae represent 4.5% (Borowiec, 1988). There are approximately 90 species of *Spermophagus* that have been described in the Old World. Twenty-four species of *Spermophagus* have been reported to feed in species of Convolvulaceae (Romero & Johnson 2000). In Europe, *Spermophagus sericeus* (Geoffroy, 1785) is only known species to breed on seeds of *Convolvulus arvensis* L. (Southgate 1979).
C. arvensis is very successful weed in agriculture. It is deep-rooted perennial and thus can escape many chemical and mechanical weed control methods. In this context, biocontrol appears as a promising alternative against bindweeds. Rodgers & Garrison (1975) have already suggested Bruchids for use in this way as an agent of biological control. As for any biological control program, the basic need is to study all aspects of the life of the selected species, especially information about population dynamics as well as host range. It was also the main aim of this research in connection with *S. sericeus*.

Material and methods

In 1997-1998, population dynamics and biology of seed beetle *S. sericeus* associated with *C. arvensis* L. plants was studied at locality Kamenica nad Hronom (48°19´N 18°09´E; 117 a. s. l.) and Vráble (48°15´N 18°19´E; 142 a. s. l.) in south-western Slovakia.
Insects were collected every week from mid May to end of September by sweeping/catching (3 x 50 sweepings) in the areas infested by field bindweed. Collected insects were put to death, sorted and identified. Furthermore, population density and behaviour of *S. sericeus* was observed under natural conditions at Kamenica nad Hronom. Surveys were based on 30 randomly selected flowers.

Results

S. sericeus was only species reared from seeds of *C. arvensis* in the laboratory. The species were the most frequent in warm and dry climatic regions (locality Kamenica nad Hronom) and much less widespread in the temperate (locality Vráble) and cold regions of Slovakia. It was also documented by 464 adults of *S. sericeus* collected in total by sweeping (May - September) at Kamenica nad Hronom in comparison with 54 adults from Vráble.
Some *S. sericeus* adults were seen during the whole growing season, with exception of July at Vráble. However, they were most common from May 20 to June 30. Number of adults achieved in this period average of 16.7±3.8 adults per 50 sweepings at Kamenica nad Hronom on May 27 in 1998 and 2.3±1.5 at Vráble on June 15 in 1997. Only a very few individuals were found during July and August. In September, the small blurred peak of occurrence was observed.
In 1998, population density of adults per single flower was also evaluated at Kamenica nad Hronom. The highest occurrence was again from end of May to end of June and varied from 0.3-0.7 adults per flower in average.

S. sericeus lay its eggs externally on the pod. Egg laying started in the beginning of June. Freshly hatched larvae burrow through the pod wall and enter the first available seed from mid June. Larvae that remain within the seed to pupate prepare for adult emergence by cutting as close to the surface as possible. No natural enemy has been recorded in laboratory.

Discussion

The only insect taxon frequently associated with *C. arvensis* seeds was *S. sericeus* (Bruchidae) in Slovakia. This verified the fact, that genus *Spermophagus* is associated with Convolvulaceae worldwide (Jolivet 1967). In Palearctic region five species of *Spermophagus*, *S. sericeus*, *S. calystegiae*, *S. kuesteri, S. variolosopunctatus* (Decelle 1983) and *S. rufiventris* (Ishikawa et al., 1994) were reared from *C. arvensis* seeds. Notwithstanding that, *Megacerus discoidus* (Wang & Kok 1986) and *M. impiger* (Schlising 1980) were reported as native North American seed feeders of *Calystegia sepium*. In Europe, the most common one was *S. sericeus*. It has been confirmed also in Slovakia. Usually only a small percentage of seeds were attacked, but 50 percent infestation was found at Kamenica nad Hronom. Similarly as in Slovakia, 40 percent infestation, was found at Rome (Italy), and 65 percent of the seeds collected near Venice were infested (Rosenthal & Buckingham 1982). *Megacerus discoidus* destroyed about 63% of the viable seeds of *C. sepium* at Belleville (Canada) (Mohyuddin, 1969). As indicate our observations, the population density of *S. sericeus* was considerably higher in warm localities (Kamenica nad Hronom) in contrast with localities with temperate climate (Vráble). The most numerous numbers were recorded in the beginning of June. But, even one adult per flower or 17 adults per one replication of sweeping were found the infestation of seeds did not achieve high level. It seems that mainly the egg stage is very vulnerable for parasitoids, because eggs are laid on the surface of the ripening pod. For example, Bridwell (1918) noted that when the trichogrammatid egg parasite *Uscana semifumipennis* Girault was present, only six larvae reached maturity from 3000 eggs of *Caryedon serratus* (Bruchidae). Similar species, *Uscana spermophagi* (Chalcidoidea: Trichogrammatidae) was found as parasite of *S. sericeus* (Viggiani 1979). The hymenopterous parasitoids *Bruchophagus sp.* (Hymenoptera: Eurytomidae), *Dinarmus acutus* Thomson (Hymenoptera: Pteromalidae) of *S. sericeus* were also reported in Italy (Rosenthal & Buckingham 1982).
Because high potencial of seed destruction reduces the numbers of seedlings, *S. sericeus* was selected as promising candidate for biological control programs of *C. arvensis*.

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RELATION BETWEEN APHID AND LADYBIRD POPULATIONS IN THE MAIZE FIELD

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Summary

During 1987-1995, population dynamics of aphids and coccinellids was observed at Nitra-Janíkovce locality in south-western Slovakia. From three aphid species, *Metopolophium dirhodum* (Walk) was the most numerous during all years of study. More than 90% of ladybird beetle population was formed by two ladybird species. They were *Coccinella septempunctata* Linneus and *Propylea quatuordecimpunctata* Linneus. When relationship between aphid populations and ladybirds was calculated (all calculations were made between *M. dirhodum* – the most numerous aphid and ladybirds), it was found that it was significant between the number of aphids and ladybird larvae (r = 0.818 P = 0.007), and also significant between number of aphids and number of ladybird adults (*C. septempunctata* r = 0.711, P = 0.032; *P. quatuordecimpunctata* r = 0.859, P = 0.003). In 1990, when more than 900 aphids per one maize plant were found, together 73 ladybird adults were found on the maize plants. In 1993, when maximum was only 6 aphids per one maize plant, the maximum of 6 ladybird beetles per 100 plants was observed.

Introduction

According to Cagáň et al. (1998) the first aphids on the maize plants in south-western Slovakia can be found at the beginning of June and the number of aphids grew until the end of June. In Europe, maximum of aphid population depends on locality. In Spain it is in the first quarter of June (Pons et al., 1989), in Poland on July 11 (Kot a Bilewicz-Pawinska, 1989), in western France at the end of July (Henry and Dedryver, 1989).
The most usual cereal aphid predators are ladybirds (*Coccinellidae*). The analysis of intestinal tract of *Coccinella septempunctata* L., showed that 76,9-91,7 % of its content was formed by aphids (Triltsch, 1997a). Except of *C. septempunctata*, a very important aphid predator was *Propylea quattourdecimpunctata* L., which was the most important aphid in Upper Hessen (Germany) (Storck-Weyhermuller, 1988).
During 9 years, a population dynamics of aphids and ladybirds was observed at Nitra-Janíkovce in Slovakia. The aim of this work was to explain how coccinellid populations in maize depend on the populations of aphids

Material and methods

During 1987-1995, population dynamics of aphids and coccinellids was observed at Nitra-Janíkovce locality in south-western Slovakia. Aphids and coccinelids were counted on 100 maize plants that were randomly selected at 10 maize field sites (at each site 10 plants). Maximum of population density of aphids was related to maximum of coccinellid population density and correlation coefficient was calculated between aphids and coccinellid larvae and adults.

Results and discussion

Table 1 shows numbers of aphids and the numbers of ladybirds on the maize plants at the locality Nitra-Janíkovce during nine years. From three aphid species, *Metopolophium dirhodum* (Walk) was the most numerous during all years of study. Numbers of *Rhopalosiphon padi* (Linneus) and *Sitobion avenae* (Fabricius) created nearly 10% of aphid population. During nine years, more than 90% of ladybird beetle population was formed by two ladybird species. They were *Coccinella septempunctata* Linneus and *Propylea quatuordecimpunctata* Linneus. Similar ladybird populations were observed by Attia (1985) and Reh (1985) in Germany. In Poland, *C. septempunctata* dominated in the maize fields. *P. quattourdecimpunctata* formed only 16.5 % of ladybird population (Plewka and Pankanin-Franczyk, 1989).
Tale 1 shows that maximum number of ladybird beetle larvae can achieve very various values. In 1990 it was 285 larvae per 100 maize plants. In 1993 and 1995 it was only 3 larvae per 100 plants.
When relationship between aphid populations and ladybirds was calculated (all calculations were made between *M. dirhodum* – the most numerous aphid and ladybirds), it was found that it was significant between the number of aphids and ladybird larvae (r = 0.818 P = 0.007), and also significant between number of aphids and number of ladybird adults (*C. septempunctata* r = 0.711, P = 0.032; *P. quatuordecimpunctata* r = 0.859, P = 0.003). In 1990, when more than 900 aphids per one maize plant were found, together 73 ladybird adults were found on the maize plants. In 1993, when maximum was only 6 aphids per one maize plant, the maximum of 6 ladybird beetles per 100 plants was observed. Rautapää (1976), Basedow (1982) and Poehling (1988) found positive correlation between the population density of *C. septempunctata* and aphids on cereals. No correlation was found between *C. septempunctata* and aphid density in Germany (Triltsch, 1997b).
The occurrence of predators depends on many factors. In the vicinity of pea and sugar beet fields adults and larvae of *P.*

quatuordecimpunctata and *C. septempunctata* were the most numerous predators in wheat. Syrphid larvae dominated in the wheat field when potato was in their vicinity (Freier et al., 1997).

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Table 1
Maximum number of aphids and ladybird beetles at the locality Nitra-Janíkovce (Slovakia) during 1987-1995. Numbers of aphids was calculated as an average per one plant (from 100 plants). Number of ladybird beetles and larvae is a result of 100 maize plants observation.
MD – *Metopolophium dirhodum*, SA – *Sitobion avenae*, RP – *Rhopalosiphon padi*, C7 – *Coccinella 7-punctata*, P14 - *Propylea 14-punctata*, Clarvae – larvae of ladybirds

Year	Maximum MD	Maximum SA	Maximum RP	Maximum C7	Maximum P14	Maximum C larvae
1987	366	11	24	20	26	10
1988	351	11	12	13	7	24
1989	404	12	26	28	13	53
1990	891	10	19	27	45	285
1991	165	5	12	8	18	47
1992	435	6	26	3	15	11
1993	4	1	1	2	4	3
1994	20	1	1	3	3	12
1995	4	1	0	10	8	3

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FIELD PATOGENICITY OF *FUSARIUM CULMORUM*, *FUSARIUM EQUISETI* AND *MICRODOCHIUM NIVALE* ON TRITICALE

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Summary

The pathogenicity of *M. nivale* (Fr.) Samuels et Hallet, *F. culmorum* (W. G. Sm.) Sacc. and *F. equiseti* (Corda) Sacc. (*Deuteromycotina, Hyphomycetes*) was tested in the field. The inoculation was carried out by application of inoculated substrates before sawing. The evaluations were realised in growth stages DC9, DC 26, DC 61-69, DC 93. There were the differences between *Fusarium* species pathogenicity observed. *M. nivale* was the most important pathogen. It caused reduction of germinated and overwintered plants. It increased infestation in all evaluating growth stages, especially in first two. The reduction of yield was similarly the highest. *F. culmorum* and F. *equiseti* was less important, they caused increasing of infested plants in warmer period, in growth stage flowering. The yield reduction was lower than *M. nivale*. Higher damaging of *Fusarium* was observed in year with more rainfall during winter and followed vegetation period.

Key words: tritikale, pathogenicity, *Fusarium* species

Triticosecale Witt. (tritikale) is grain crop, which is well-known as a yield stabile and disease resistant one (Petr et al., 1991; Diblíková et al., 1989; Fencík et al., 1980). In other hand some authors (Ivašenko et al., 1997; Lacicowa, 1989; Pavlov, 1983) regard tritikale as sensitive for *Fusarium* diseases especially. The *Fusarium* diseases are important problem of the grain crops (Šrobárová, 1987). Recently their second main importance has been considered as mycotoxins contamination of products, especially kernels (Mirocha et al., 1977; Lew, 1993). The aim of work was field testing of different *Fusarium* species pathogenicity to tritikale.

Material and methods

During years 1997-99, the field trials were realised on Slovak agricultural university (SAU) experimental base - SBaER Dolná Malanta, near Nitra. Tested cultivar of triticale was "Presto". In the experiments, the following strains of pathogen were used: *M. nivale* - in 1998 strain 227, separated from triticale stem. In year 1999 strain K44, isolated from triticale tiller. *F. culmorum* - strain 1/3-5, isolated from intratissue of triticale stem. *F. equiseti* - strain K61, isolated from the same location as *F. culmorum*. The *Fusarium* strains were storaged in Collection of fungi in Department of plant protection, SAU. The inoculation was realised across application of infested substrate to soil, before sawing. Each infested substrate was inoculated by relevant *Fusarium* species. The evaluations were realised in following growth stages: DC 9 - number of germinated plants, length of leaves, root number. DC 26 and DC 61-69 - plants and tillers number, percentage of *Fusarium* attacking plants. DC 93 - ear number and harvest per m^2.

Results and discussion

Inoculation of *M. nivale* significantly caused number of germinated plants reduction only in 1999 (Table 1). The same situation was observed in cases of *F. culmorum* and *F. equiseti*, because of better weather condition for infection during winter, in year 1999 (Fig. 1 and 2). The reduction level was the highest by *M. nivale*. Pathogenicity of *F. culmorum* and *F. equiseti* were markedly lower and were not very important in comparison to *M. nivale*. The significant influence of inoculation to reduction of root number and length of leaves was not observed. In this growth stage the damage of *Fusarium* species was showed only as a reduction of germinated plants.

In growth stage tillers forming (DC 26) the reduction of overwintered plants was significant only by *M. nivale.* According to Alton (1987) results, only *M. nivale* and *F. culmorum* are able to grow by temperature -1 to +3 °C. *M. nivale* is well-known as psychrotolerant one, and thus it was the primary pathogen during the winter (Šrobárová, Eged, 1992). The reduction of plants was in the same condition in general way 2,45 - 36,12 % (Michalíková et al., 1991). In year 1999 in control it was higher (39,68 %), because of good conditions for natural infection of plants. By *M. nivale* inoculation, the reduction was 2,17 times higher then control. Similar damage of *M. nivale* observed Šrobárová and Eged (1993) on winter wheat. The reduction was observed in cases of *F. culmorum* and *F. equiseti* too, but it was not significant and by *F. culmorum* not important in comparison to control. In this phase the tiller forming is very important for future yield (Petr et al., 1987). Just in this growth stage the plants are very sensitive for attacking of *Fusarium* spp. (Michalíková, 1988). The tillers are extra sensitive, because of intercellular growing of *Fusarium* hyphae to forming tillers (Hutcheon, Jordan, 1992). But no significant influence of inoculation was observed to reduction of tillers. *M. nivale* significantly increased the infestation of plants only. The attacking percentage was not important in case of others both *Fusarium*.

In growth stage flowering (DC 61-69) the inoculated *Fusarium* species did not influence the number of plants. In case of number of tillers any significant differences were observed too, but inoculation of *M. nivale* increased tillers forming imaginary in year 1999. The effect was caused by the high reduction of plants number, because almost solitary plants loosed the competitive ones (Karabínová, 1991). In this growth stage all of *Fusarium* species caused increasing of plant attacking significantly. The attack increasing of *M. nivale* was lower in year 1999, because of damping off the infested plants in the past. In this way the infection potential was lower during flowering.
In the last evaluating growth stage - full rape (DC 93), the reduction of ear number was observed by all of *Fusarium*, but significant was only the *M. nivale* one. Many *Fusarium* species caused usually decreasing of yield (Ellen and Langerak, 1987). In our trials, the higher harvest reduction was observed by *M. nivale*, followed *F. culmorum* and *F. equiseti*.

Table 1: Evaluated markers on triticale, Nitra 1997-1999

	Control		*M. nivale*		*F. culmorum*	F. equiseti
	1997/98	1998/99	1997/98	1998/99	1998/99	1998/99
DC 9						
Number of germinated plants	51,00 *a	38,00 a	51,67 a	8,67 b	35,67 cd	37,33 cd
Root number	4,43 a	5,58 a	4,96 a	5,48 a	5,54 a	5,59 a
Lenght of leaves	67,52 a	63,04 a	69,29 a	69,09 a	74,44 a	88,21 a
DC 26						
Number of plants	42,00 a	34,33 ab	47,67 a	14,67 b	32 ab	23,67 ab
Number of tillers	4,82 a	4,6 a	5,07 a	6,10 a	3,60 a	4,77 a
% of *Fusarium* attacking plants	18,76 a	16,14 a	41,26 b	39,35 b	11,33 a	16,04 a
DC 61-69						
Number of plants	20 a	21 a	19,2 a	14,67 a	16,33 a	20,33 a
Number of tillers	2,23 a	2,2 abc	2,57 a	3,08 abc	2,17 abc	1,92 ab
% of *Fusarium* attacking plants	52,95 a	15,86 a	63,07 b	16,33 b	34,72 b	31,14 b
DC 93						
Ear number	88,00 a	62,00 a	86,33 a	39,33 b	49,67 a	54,33 a
Grains weight	1267,93a	1076,32a	1447,29 a	682,83 b	877,21 b	943,23 b

* Differences between values (intro-lines and years) signed the same letter are not significant (Analysis of variance, Tukey test, P = 0,05)

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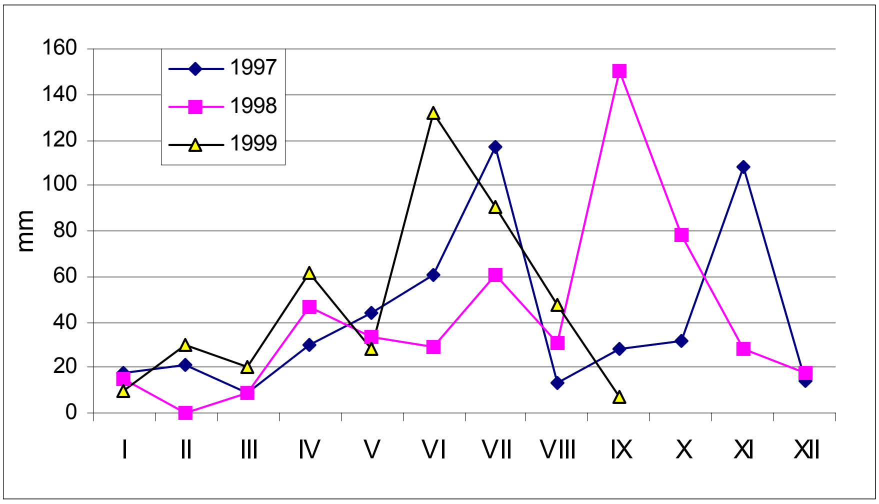
Figure 1: Average rainfall during 1997-1999 (Weather-station SAU in Nitra)



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BIOLOGICAL AND CHEMICAL CONTROL OF *SCLEROTINIA SCLEROTIORUM* ON DIFFERENT SUNFLOWER HYBRIDS

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Summary

Chemical and biological treatment from the seeds six commercial sunflower hybrids was evaluated for their reaction to *Sclerotinia sclerotiorum* (Lib.) de Bary. The artificial inoculation was realised before bud growth stage under field conditions. The number of infected plants, some biological and yield quality was examined. All hybrids were susceptible to the infection by *S. sclerotiorum*. The number of infected sunflower plants fluctuated from 35% to 92.5 %. Treatment of seeds by *T. harzianum* and seeds protection by chemical compounds influenced the infection elimination by fungus *S. sclerotiorum* only in hybrids Bambo, Opera and Apetil. The hybrids Bambo, Opera, Pixel showed statistically not significant increase of yield quality after seeds treatment by *T. harzianum* .

Key words: *Helianthus annuus, Sclerotinia sclerotiorum, Trichoderma harzianum*, biological control, chemical control, kernel weight, kernel density

Introduction

Sclerotinia sclerotiorum (Lib.) De Bary is one of important pathogens that can markedly reduce yield and quality of sunflower (Masirevic, Gulya, 1992). This facultative parasite is able to attack all plant parts: roots, stem, leaves, terminal bud, and capitulum (Zimmer, Hoes, 1978). Soil moisture and climatic conditions in production areas influenced part of the plant which was most commonly attacked (Huang, Dueck, 1980). In Slovakia stem attack, followed by plant wilting and breakdown is considered as potential danger for the sunflower crop. Fungicides can protect the heads from airborne infection, however, the use of fungicides to protect the roots from soilborne infections is not possible from the economical reasons. Biological control with hyperparasites proved to be effective in destroying sclerotia in soil (Huang 1980), but its effectiveness and the economical feasibility will further investigation (Hoes, Huang 1985).
The fungicides can prevent carpogenic germination of sclerotia (Philips 1987) and eliminate pathogen from infected sunflower seeds (Herd, Philips 1988). However, disease control by conventional methods has generally been disappointing (Steadman 1979) and control by hyperparasitic fungi has been suggested (Huang 1980). More than 30 different fungi and bacteria have been implicated as an antagonist or colonisers of *Sclerotinia* species, but only a few have been proven to be hyperparasitic (Campell 1947, Adams, Ayers 1981).
Isolates of *Trichoderma harzianum* have been reported as antagonists of mycelia or sclerotia of several soil born patogens (Steadman, 1979, Lewis, Papavizas 1987). *T. harzianum* formulated in alginate pellets (Lewis, Papavizas 1987) colonized sclerotia of *S. sclerotiorum* under laboratory and field conditions (Knudsen et al. 1991).
The aim of this study was to find out effect of biological seed treatment by *Trichoderma harzianum* and to compare this method with classical chemical seed treatment.

Material and methods

Preparation of *Sclerotinia sclerotiorum* inoculum
Sclerotinia sclerotiorum isolates (152, 154, 155) were obtained from sclerotia originated from locations Malanta, Chorvátsky Grob and Nové Zámky. Sclerotia were originally harvested from sunflower plants after natural infection. The mixture all isolates in equal relation was used for inoculation. Inoculum was prepared according to Sedun and Brown (1989). *S. sclerotiorum* was grown 14 days at 25°C on sterilised wheat grain (press100kPa and temperature 120°C). Wheat grain was inoculated by seven days old cultures *S. clerotiorum*, which was cultivated in dark at 25°C on PGA in in 10-cm diameter Petri dishes.
Infection of plants under field conditions
Field trials were carried out at Experimental base of Slovak Agricultural University in Dolná Malanta, near Nitra, as a complete randomised block design with four replications. In field trials were used six sunflower hybrids Bambo, S–277, Opera, Pixel, Arena and Apetil. The sunflower hybrids were sown manually April 29, 1999 in six variants.

1. Seeds non-treated- Control
2. Seeds non-treated and inoculation by *S. sclerotiorum*
3. Seeds treated by *Trichoderma harzianum*, B_1
4. Seeds treated by *T. harzianum*, B_1 and inoculation by *S. sclerotiorum*
5. Seeds treated by chemicals
6. Seeds treated by chemicals and inoculation by *S. sclerotiorum*

Seeds were treatment by *T. harzianum*, B_1 a concentration 4 g . 1000g^{-1} seeds.
The seeds were treated by fungicides metalaxyl, carbendazin and quinolate.
Inter row spacing was 0.75 m, and the spacing between plants was 0.2 m. The plants were inoculated in June 1999, they had developed 4-6 pair of leaves, before bud growth stages. The plants were inoculated with 5 g of inoculum, inserted into a hole of the soil located 50 mm from the base of each stem, about 10 mm deep. The sunflower heads were harvested during September.
The number of infected plants was recorded, plant height and flower bud diameters was measured at the beginning of flower growth stage (F 3.4).
The number of health plants and number of plants infected by *S. sclerotiorum* was counted before yield of sunflower heads (F 5.1.2). Heads diameter, number of kernel in the heads, kernel weight from the heads and one thousand seeds weight were also measured and compared across several hybrids. Acquired data were analysed by analysis of variance.

Results and discussion

Sunflower inoculation was successful in all variants and number of infected sunflower plants fluctuated from 35 % to 92.5 % (Table 1). All hybrids were susceptible to the infection by *S. sclerotiorum*. Seeds treatment by T*. harzianum* influenced elimination infection by fungus *S. slerotiorum* only in hybrids Bambo, Opera and Apetil, bud differences between biological treatment and not treated seeds was not significant (Table 1). Seed protection by chemical compounds was similarly insufficient as a biological control. Inoculation of sunflower plants was made after seed treatment and systemic fungicides to show soft protection level.
The level of natural infection was very low. Only one occurrence was recorded in hybrid S-277, where natural infection achieved 3 % (Table 1). Low natural infections was due to growing only non-hosts crops for *S. sclerotiorum*, especially cereals on the soil.
T. harzianum increased yield factors (kernel weight from the heads and one thousand seeds weight) in hybrid Bambo, Opera, Pixel, but differences between variant 1 (Control) and variant 3 (Seeds treatment by *T. harzianum*, B_1) was not significant (Table 1). Growth stimulation of plants through treatment by fungus *Trichoderma* species was observed by other authors (Chet 1990, Windham et al., 1989, Krivoščenkova, Miščenko, 1990).
In variant with inoculation sunflower plants by *S. sclerotiorum* and biological treatment seeds was all yield factors (number of kernel in the heads, kernel weight from the heads and one thousand seeds weight) lower. Analysis of variance did not showed significantly differences (Table 1).
Similarly no significantly differences between variant 1 (Control) and variant 6 (seed treatment by chemicals and inoculation by *S. sclerotiorum*) was detected. Values was lower in variant 6.
Chemical and biological control seems to be not equally effective, if the level of infection in the soil is very high. Thus the agronomic methods (especially crop rotation) may influenced reduction of primary soil infection level and health of sunflower plants.

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Table 1. Effect of chemical and biological (by *Trichoderma harzianum*) treatment of seeds on some yield characteristic in various variants. SS - percentage of wilted sunflower after inoculation by *Sclerotinia sclerotiorum,* ^{abcdef} - values followed by the same letter in each column are not significantly different from each to other at the significant level 0.05 (Tuckey´s test)

Variant	SS [%]	Plant height [cm]	Head diameter		Number of kernel in the heads [pcs]	Kernel weight from the heads [g]	One thousand seeds weight [g]
			Flowering [mm]	Harvest [mm]			
Hybrid Bambo							
1	0^{a}	104.4^{abcdef}	52.8^{ab}	180.5^{bcdef}	1660^{abcd}	106.7^{bcde}	63.1^{abcd}
2	80^{bc}	90.2^{abc}	45.6^{ab}	148.0^{abc}	1330^{abcd}	66.5^{abc}	50.9^{abcd}
3	0^{a}	111.8^{abcdef}	62.8^{ab}	184.8^{bcdef}	1860^{bcd}	119.8^{cde}	64.5^{cd}
4	72.5^{bc}	97.8^{abcde}	48.8^{ab}	130.8^{ab}	1387^{abcd}	52.8^{ab}	37.3^{a}
5	0^{a}	126.9^{bcdef}	68.4^{ab}	187.3^{bcdef}	1706^{abcd}	91.9^{abcde}	53.5^{abcd}
6	62.5^{abc}	97.3^{abcde}	59.9^{ab}	146.0^{abc}	1442^{abcd}	66.5^{abc}	47.6^{abcd}
Hybrid S-277							
1	0^{a}	122.5^{abcdef}	51.3^{ab}	168.0^{bcdef}	1936^{bcd}	95.0^{abcde}	49.3^{abcd}
2	35^{abc}	108.1^{abcdef}	50.0^{ab}	157.0^{abcd}	1647^{abcd}	74.0^{abcd}	44.5^{abc}
3	3^{ab}	111.3^{abcdef}	44.9^{ab}	170.5^{bcdef}	1799^{bcd}	85.2^{abcde}	47.1^{abcd}
4	43^{abc}	113.8^{abcdef}	56.6^{ab}	177.0^{bcde}	1725^{abcd}	74.8^{abcd}	43.7^{abc}
5	0^{a}	130.4^{abcdef}	73.1^{ab}	168.5^{bcde}	1585^{abcd}	69.8^{abcd}	43.6^{abc}
6	65^{abc}	115.7^{abcdef}	71.7^{ab}	201.0^{cdef}	1676^{abcd}	68.9^{abc}	41.0^{ab}
Hybrid Opera							
1	0^{a}	129.2^{bcdef}	64.0^{ab}	189.8^{bcdef}	1862^{bcd}	112.2^{bcde}	59.7^{abcd}
2	55^{abc}	122.2^{abcdef}	61.5^{ab}	166.8^{bcdef}	1676^{abcd}	78.2^{abcde}	46.8^{abcd}
3	0^{a}	137.3^{def}	77.3^{ab}	195.3^{cdef}	1893^{bcd}	118.6^{bcde}	63.6^{cd}
4	50^{abc}	127.2^{bcdef}	69.4^{ab}	149.8^{abc}	1415^{abcd}	65.6^{abcde}	44.2^{abc}
5	0^{a}	149.9^{f}	76.5^{ab}	192.0^{bcdef}	1855^{bcd}	114.0^{bcde}	61.0^{bcd}
6	48^{abc}	136.0^{cdef}	72.8^{ab}	173.5^{bcdef}	1611^{abcd}	85.4^{abcde}	53.0^{abcd}
Hybrid Pixel							
1	0^{a}	116.4^{abcdef}	59.1^{ab}	166.3^{bcde}	1578^{abcd}	84.9^{abcde}	55.4^{abcd}
2	75^{c}	114.2^{abcdef}	43.0^{ab}	190.0^{bcdef}	1384^{abcd}	91.3^{abcde}	67.7^{de}
3	0^{a}	128.0^{bcdef}	71.4^{ab}	157.5^{abcd}	1570^{abcd}	92.4^{abcde}	58.8^{abcd}
4	90^{c}	82.5^{a}	40.0^{ab}	178.3^{bcdef}	1105^{ab}	64.7^{abc}	58.5^{abcd}
5	0^{a}	131.9^{bcdef}	76.3^{ab}	170.0^{bcdef}	1671^{abcd}	83.5^{abcde}	49.2^{abcd}
6	75^{c}	100.7^{abcde}	63.3^{ab}	100.0^{a}	944^{a}	34.5^{a}	36.9^{a}
Hybrid Arena							
1	0^{a}	122.6^{abcdef}	63.7^{ab}	189.0^{bcdef}	2008^{cd}	107.3^{bcde}	54.1^{abcd}
2	73^{bc}	95.2^{abcde}	51.6^{ab}	176.8^{bcdef}	1824^{bcd}	87.0^{abcde}	47.2^{abc}
3	0^{a}	133.0^{bcdef}	76.0^{ab}	184.0^{bcdef}	1917^{bcd}	98.5^{abcde}	50.4^{abcd}
4	98c	88.4^{ab}	43.1^{ab}	140.0^{abc}	1020^{ab}	57.2^{abc}	55.1^{abcd}
5	0^{a}	140.7^{ef}	72.8^{ab}	179.5^{bcdef}	2104^{d}	106.4^{bcde}	50.4^{abcd}
6	92.5^{c}	85.5^{ab}	47.5^{ab}	155.0^{abcd}	1267^{abcd}	57.7^{abc}	45.5^{abcd}
Hybrid Apetil							
1	0^{a}	108.3^{abcdef}	62.2^{ab}	218.5^{def}	1427^{abcd}	142.1^{e}	99.1^{f}
2	70^{abc}	87.7^{abcd}	51.4^{ab}	221.0^{def}	1376^{abcd}	142.6^{de}	101.3^{f}
3	0^{a}	120.8^{abcdef}	81.3^{ab}	214.3^{def}	1353^{abcd}	126.4^{cde}	92.1^{f}
4	65^{abc}	109.9^{abcdef}	83.3^{ab}	227.7^{f}	1210^{ab}	103.6^{bcde}	86.1^{ef}
5	0^{a}	119.9^{abcdef}	78.2^{ab}	201.8c^{def}	1133^{ab}	109.5^{bcde}	95.8^{f}
6	45^{abc}	99.7^{abcde}	74.0^{ab}	223.3^{ef}	1299^{abc}	125.7^{cde}	87.9^{ef}

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RESISTANCE OF SUNFLOWER HYBRIDS (*HELIANTHUS ANNUS* L) TO *SCLEROTINIA SCLEROTIORUM* (LIB.) DE BARY

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Summary

Commercial used sunflower hybrids were evaluated for their reaction to *Sclerotinia sclerotiorum* (Lib.) de Bary after artificial inoculation. The inoculation was realised before bud growth stage under field condition. In all hybrids used in trials germination fluctuated in interval 86 % to 100 %. Pathogen *Alternaria* spp. was obtained from non germinated seeds. Maximum infected seeds was recorded in hybrids S-277 and minimum in hybrid Pixel. Only 35 % plants infected by *S. sclerotiorum* were observed in hybrid S-277. Maximum of infected plants were in hybrid Bambo (80 %). The incidence of *Diaporthe helianthi* ranged from 80 to 95 %. Hybrids Apetil and Pixel show the ability to increase of same yield characteristics after inoculation by *S. sclerotiorum*.

***Key words*: *Helianthus annus, Sclerotinia sclerotiorum*, kernel weight, kernel density**

Introduction

Sclerotinia sclerotiorum (Lib.) De Bary is an important pathogen causing most important sunflower disease called white rot (Huang, Dueck, 1980). *Sclerotinia sclerotiorum* can produce three distinctly different diseases on sunflower; a basal stalk rot, which can appear at any plant growth stages, a mid-stalk rot on older plants, and a head rot on mature plants (Nelson, Lamey 1984). Rapid drying of the leaves and development of lesions on the tap roots and basal portion of the stem caused infected plants to die within a few days after the onset of wilting. Seed yield was significantly reduced when wilting occurred at early stage of plant development (Dorrell, Huang 1978). Under relatively low soil moisture conditions the overwintering sclerotia produce mycelia which infect the roots and cause basal stalk rot plant wilt (Huang, Dueck 1980, Huang 1985). Under high soil moisture conditions, sclerotia produce apothecia and ascospores infected floral parts and stems causing head rot (Ju, Maric 1988).

The development of resistant hybrids appears the most effective and economical approach to control this disease (Putt 1958, Dueck, Campbell 1978, Vear, Tourvielle 1984, Gulya et al. 1989).

The aim of this study was to evaluate the reaction of the commercial sunflower hybrids to sclerotinia wilt, to determine effects of this disease on yield, and to identify resistant hybrids for the purpose of crop recommendation.

Material and methods

Evaluation of sunflower seeds germinative capacity used in field trials.

Non treated seeds were placed upon sterile cotton wool into Petri dishes. 100 seeds were used in two repetition. Germinative capacity power and germinative capacity of seeds were evaluated after three and seven days respectively. The number of germinate and non-germinate seeds were calculated, and health conditions of non-germinate seeds were determined. Infected seeds were placed on 2% PGA in 9-cm diameter Petri dishes to specify pathogens, which caused non-germinate seeds.

Preparation of Sclerotinia sclerotiorum inoculum

Sclerotinia sclerotiorum isolates (152, 154, 155) were obtained from sclerotia originated from locations Malanta, Chorvátsky Grob and Nové Zámky. *Sclerotinia* was originals harvested from sunflower plants after natural infection. The mixture all isolates in equal relation was used for inoculation. Inoculum was prepared according to Sedun and Brown (1989). *S. sclerotiorum* was grown 14 days at 25°C on sterilised wheat grain (press100 kPa and temperature 120°C). Wheat grain was inoculated by seven days old cultures *S. sclerotiorum*, which was cultivated in dark at 25°C on PGA in 10-cm diameter Petri dishes.

Infection of plants under field conditions

Field trials was carried out at Experimental base of Slovak Agricultural University in Dolná Malanta, near Nitra as a complete randomised block design with four replications. Six sunflower hybrids (Bambo, S – 277, Opera, Pixel, Arena and Apetil) were used in field trials. The sunflower hybrids were sown manually in April 1999 in two variants. The plants were inoculated in June, they had developed 4-6 pair of leaves, before bud growth stages. The plants were inoculated with 5 g of inoculum, inserted into a hole of the soil located 50 mm from the base of each stem, about 10 mm deep. The sunflower heads were harvested during September.

The number of infected plants were recorded, plant high and flower bud diameters were measured at beginning of flower growth stage (F 3.4). Before harvesting yield of sunflower (F 5.1.2) heads were counted number of health plants and number of plants infected by *S. sclerotiorum* and *Diaporte helianthi*. Heads diameter, number of kernel in the heads, kernel weight from the heads and one thousand seeds weight were also measured and compared among several hybrids. Acquired data were analysed by analysis of variance.

Results and discussion

The number of germinate seeds was the highest hybrid Pixel and achieved 100 % (Table 1). Germination in all hybrids fluctuated in interval 86 % to 100 %. Only *Alternaria* spp. was determinate as pathogen obtained from non germinated seeds. Grey and rich cover of mycelium was presented on infected seeds and after microscopic analyses was pathogen *Alternaria* spp determinate. Maximum infected seeds (6) was recorded on seeds in hybrids S-277 (Table 1). Another hand from seeds of hybrid Pixel did not obtained pathogen *Alternaria* spp. and germination of this hybrid was 100 %.
The incidences of *Sclerotinia* wilt after artificial inoculation sunflower plants by *S. sclerotiorum* shows table 1.

Table 1. Germination, number of seeds infected by *Alternaria* spp., percentage of wilted sunflower after inoculation by *Sclerotinia sclerotiorum* and percentage of infected sunflower plants after natural infection by *Diaporthe helianthi*.

Hybrid	Germination [%]	Seeds infected by *Alternaria* spp. [%]	*Sclerotinia sclerotiorum* [%]	*Diaporthe helianthi* [%]
S-277	86	6	35	92.5
Bambo	88	4	80	97.5
Opera	96	3	55	95
Pixel	100	-	75	92.5
Arena	97	3	73	80
Apetil	99	1	70	87.5

Only 35 % plants infected by *S. sclerotiorum* were observed in hybrid S-277. Similar Ziman and Šrobárová (1996) observed the lowest infection by *S. sclerotiorum* in hybrid S-277 from all evaluated hybrids. Maximum of infected plants were in hybrid Bambo (80 %). Other hybrids such Opera, Pixel, Arena and Apetil showed level of infection ranking from 55 to 75 %. These results demonstrate that none of the tested hybrids was highly resistant to the pathogen *S. sclerotiorum*.
The number of sunflower plants were observed before harvesting. The incidence of *Diaporthe helianthi* ranged from 80 to 95 %.

Table 2. Reaction of sunflower hybrids to *Sclerotinia sclerotiorum* and effects on plant hight, heads diameter, yield and one thousand seeds weight

Hybrid	Plant hight [cm]	Heads diameter		Number of kernel in the heads [ks]	Kernel Weight from the heads [g]	One thousand seeds weight [g]
		Flowering [mm]	Harvest [mm]			
S-277	108.1[a]	50.0 [a]	157.0[a]	1647 [a]	74.0[ab]	44.5[a]
Bambo	90.2[a]	45.6 [a]	148.0[a]	1330 [a]	66.5[a]	50.9[ab]
Opera	122.2[a]	61.5 [a]	166.8[ab]	1676 [a]	78.2[ab]	46.8[a]
Pixel	114.2[a]	43.0 [a]	190.0[ab]	1384 [a]	91.3[ab]	67.7[c]
Arena	95.2[a]	51.6 [a]	176.8[ab]	1824 [a]	87.0[ab]	47.2[ab]
Apetil	87.7[a]	51.4 [a]	221.0[b]	1376 [a]	142.6[b]	101.3[d]

[abcd] - values followed by the same letter in each column are not significantly different from each to other at the significant level 0.05 (Tuckey´s test)

The reduction in yield of sunflower on the infested fields (Table 2) was primarily due to the effect of *Sclerotinia* wilt in comparison with control variants (Table 3). Only hybrids Apetil and Pixel showed the ability to increase of same measured values after inoculation by *S. sclerotiorum*. The difference was detected after harvest in heads diameter, kernel weight from the heads and weights of one thousand seeds. The increase of one thousand seeds weights after inoculation by *S. sclerotiorum* also observed Rashid, Dedio (1992) and Ziman, Šrobárová (1996) at the same tested hybrids. It is possible to assume that some hybrids are able to reduce negative influence of pathogen enlarges size and weight of kernels.
The influence of infection by *S. sclerotiorum* on sunflower plants was not manifested in growth stage beginning of flower, where was acquired value of the plant high and diameter of head. The non-significant differences among the hybrids were found in the plant hight, heads diameter and number of kernel in the heads.
Variability was found for morphological and harvests characteristics. The largest heads were recorded in hybrid Apetil, 221 mm in diameter (Table 2) and on the other hand the smallest heads were recorded in the hybrid Bambo (148 mm) and S-277

(157 mm). There were observed significant differences among tested hybrids (Table 2). Similar results determinrd assessment of kernel weight from the heads.

Table 3. Control - Non infected variants.

Hybrid	Plant hight [cm]	Heads diameter		Number of kernel in the heads [ks]	Kernel Weight from the heads [g]	One thousand seeds weight [g]
		Flowering [mm]	Harvest [mm]			
S-277	122.5a	51.3a	168.0 a	1936 a	95.0 a	49.3 a
Bambo	104.4a	52.8a	180.5 a	1660 a	106.7 a	63.1 a
Opera	129.2a	64.0a	189.8 a	1862 a	112.2 a	59.7 a
Pixel	116.4a	59.1a	166.3 a	1578 a	84.9 a	55.4 a
Arena	122.6a	63.7 a	189.0 a	2008 a	107.3 a	54.1 a
Apetil	108.3a	62.2 a	218.5 a	1427 a	142.1 a	99.1 b

ab - values followed by the same letter in each column are not significantly different from each to other at the significant level 0.05 (Tuckey´s tets)

Significant differences among the hybrids were found as for as the weight of one thousand seeds (Table 2). The maximum of one thousand seeds weight was recorded by hybrid Apetil (101.3 g), followed by hybrid Pixel (67.7 g) and minimum weight was recorded by hybrid S-277 (77.5 g).

These results demonstrated that hybrids vary not only in their susceptibility to infection of *S. sclerotiorum*, but also in their ability to yield well under similar disease situation. The assessment of yielding ability under disease severity is essential for the identification of genotypes with tolerance (Buddenhagen 1981).

The hybrids Pixel, Arena, Apetil showed susceptibility to *Sclerotinia* on approximately equal level (70-75%) however only Apetil showed the ability to produce well under disease conditions and appeared to have tolerance to the disease. Tolerant hybrids could be recommended to complement crop rotation practices in areas where the disease is a limiting factor.

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