www.nsseme.com/journal.html

Phytopathology / Fitopatologija

Ratar. Povrt. / Field Veg. Crop Res. 48 (2011) 353-358
original research article / originalni naučni rad

Sclerotinia Wilt Occurrence on Sunflower in Vojvodina, Serbia

Sonja Tančić • Boško Dedić • Siniša Jocić • Igor Balalić • Nada Lačok • Dragana Miladinović • Vladimir Miklič

received / primljeno: 29.03.2011. accepted / prihvaćeno: 27.05.2011.

Summary: *Sclerotinia sclerotiorim* is a facultative parasite that can cause diseases on more than 400 plant species. Sclerotinia wilt presence was observed in Vojvodina during the period 2007-2009 at seven sites (Bečej, Kikinda, Kula, Pančevo, Sombor, Vršac and Zrenjanin). Assessment was done on 8 hybrids (Baća, Bačvanin, Branko, Duško, NS-H-111, Sremac, Šumadinac and Velja). Disease intensity was calculated according to McKinney's formula. AMMI analysis was used in order to estimate stability of hybrid tolerance to Sclerotinia wilt in different environments. Average Sclerotinia wilt occurrence on sunflower was the lowest in 2007 and the highest in 2009. Sclerotinia wilt was not observed in Zrenjanin and Vršac in 2007, nor in Pančevo in 2008. The lowest average Sclerotinia wilt occurrence during 3-year period was in Sombor and Pančevo. Hybrids Duško, NS-H-111, Sremac and Velja can be recommended for future growing on sites where Sclerotinia wilt of sunflower occurs.
Key words: AMMI analysis, ocurrence, Sclerotinia wilt, sunflower, Vojvodina

Introduction

Sclerotinia sclerotiorim (Lib.) de Bary is a facultative parasite that can cause diseases on more than 400 plant species, including a large number of important crops such as sunflower, soybean, oilseed rape, edible dry bean, chickpea, peanut, dry pea, lentils and various vegetables (Bolton et al. 2006). Occurrence of diseases caused by *S. sclerotiorum* on sunflower is influenced by genotype and weather conditions. This fungus favours moist and cold weather conditions prevailing in temperate climate regions where the sunflower is frequently cultivated. Symptoms of diseases caused by *S. sclerotiorum* can appear during the whole sunflower growing season. This pathogen can cause three different forms of the sunflower disease – Sclerotinia wilt, middle stalk rot and head rot. The infection comes from the infected overwintered plant debris and overwintered sclerotia in the soil or from infected seed. After the infection, fungus spreads and develops fast in the infected tissue. The pathogen has the ability to produce proteolytic enzymes which cause degradation and rotting of the infected tissue. Infected parts of the plant are covered with white mycelium and black irregular shaped structures for overwintering – sclerotia. Sclerotia may conserve their viability in the soil for more than 10 years (Aćimović 1998). Yield loss depends on the sunflower development stage in which the disease occurs. If infection occurs in early sunflower development stage, the yield loss will be approximately equal to the disease occurrence percentage. Disease occurrence percentage and yield losses caused by sclerotinia wilt can even reach 100% because it causes whole plant devastation (Aćimović 1998, Lamey et al. 2000). Sunflower plants infected at the beginning of flowering stage can lose up to 98% of their potential yield, while plants infected eight weeks after flowering can lose only 12% of their potential yield (Maširević & Gulya 1992).

In the USA, annual losses on all crops caused by *S. sclerotiorum* exceed $ 200 million, while in 1999 Sclerotinia head rot epidemic on sunflower caused crop loss valued at $100 million (Bolton et al. 2006). In Serbia, Sclerotinia wilt is the most common form of Sclerotinia disease, and appears in sunflower crop more frequently than other two forms. Its average frequency in Serbia is about 15-20%, but in some years the frequency can reach even around 50% (Marić et al. 1988).

S. Tančić (✉) • B. Dedić • S. Jocić • I. Balalić • N. Lačok • D. Miladinović • V. Miklič
Institute of Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia
e-mail: sonja.tancic@ifvcns.ns.ac.rs

As Sclerotinia wilt causes economically important yield loss in Vojvodina, Serbia, tolerance of NS commercial hybrids to this disease is regularly estimated under the commercial growing conditions. Sclerotinia wilt occurrence and intensity in at seven sites Vojvodina and tolerance of eight commercial NS hybrids during three-year period were observed in this paper by using McKinney's formula and AMMI analysis.

Materials and Methods

Sunflower natural infestation by *S. sclerotiorum* and Sclerotinia wilt occurrence under field conditions were observed for three years (2007-2009) in Vojvodina at seven sites (Bečej, Kikinda, Kula, Pančevo, Sombor, Vršac and Zrenjanin). These sites were selected as representative for different sunflower growing environments in Vojvodina. Eight NS commercial hybrids usually grown in Vojvodina were included in the assessment (Baća, Bačvanin, Branko, Duško, NS-H-111, Sremac, Šumadinac and Velja). Growing conditions for these hybrids were the same as the conditions in the usual commercial cultivation – row spacing was 70 cm while spacing between plants was 25 cm. Eight rows of each hybrid were sown next to each other at all sites. Crop rotation was taken into account at every location, and sunflower had not been grown for at least three years on the observed fields.

Disease assessment was done during R9 growth stage of plant maturity (Schneiter & Miller 1981) by visual observation of typical water-soaked lesions symptoms, white mycelium and sclerotia in the stem pith. Estimation was done on 300 plants per hybrid per site. In order to avoid border row effect, plants from border rows and plants growing within 10 meters from the field border were not included in the disease assessment.

Degree of plants susceptibility to disease was registered according to 1-5 scale (Aćimović 1979):

1- mycelium at soil surface,
2- ring-like necrosis above ground,
3- stem base necrosis,
4- ¾ of stem covered with ring-like necrosis,
5- completely wilt plant.

Sclerotinia wilt intensity was calculated according to McKinney's formula, and average disease occurrence was calculated as a number of diseased plants in a total number of estimated plants.

The obtained results were also analysed using AMMI analysis in order to estimate stability of hybrid tolerance to Sclerotinia wilt in different environments (Abamu et al. 1998).

Results and Discussion

According to the obtained results, the highest Sclerotinia wilt occurrence was observed in 2007 in Kikinda, while it was not registered in Zrenjanin nor in Vršac (Tab. 1). Low occurrence of Sclerotinia wilt was observed in 2007 in Sombor and Pančevo (0.05% and 0.09%, respectively). This was probably caused by unfavourable agroecological conditions for the wilt development - spring of 2007 was extremely hot and June saw total amount of rainfall much lower than average. During summer, average monthly temperatures were higher than long-term average by 2.4°C - 5.7°C, while precipitation was lower (Hydrometeorological Institute of Serbia 2008).

In 2008, Sclerotinia wilt occurrence was not registered in Pančevo, while its highest occurrence was in Kula (Tab. 1). Low average disease occurrence was registered in Sombor and Bečej (0.21% and 0.29%, respectively). Dry conditions were prevalent during growing season of 2008 with two extreme drought periods – from May 26th till June 3rd and from 20th till 27th of June (Hydrometeorological Institute of Serbia 2009). These were the periods when sunflower plants were most susceptible to disease development (R3 and R4 growth stage), which can explain the lower Sclerotinia wilt occurrence during 2008.

Table 1. Sclerotinia wilt occurrence on 8 sunflower hybrids at seven sites in Vojvodina (2007-2009)
Tabela 1. Prosečna zastupljenost bele truleži korena suncokreta na sedam lokaliteta u Vojvodini (2007-2009)

%	Kikinda	Kula	Zrenjanin	Vršac	Pančevo	Bečej	Sombor	Average
2007	**2.81**	0.28	0.00	0.00	0.09	0.62	0.05	0.55
2008	2.35	**3.50**	1.25	0.92	0.00	0.29	0.21	1.22
2009	4.42	**6.75**	3.08	2.50	0.95	3.42	0.25	3.05
Average	3.19	**3.51**	1.44	1.14	0.35	1.44	0.17	1.61

Table 2. Sclerotinia wilt intensity* on 8 sunflower hybrids at seven sites in Vojvodina (2007-2009)
Tabela 2. Intenzitet napada* bele truleži korena na 8 hibrida suncokreta u sedam lokaliteta u Vojvodini (2007-2009)

%	Kikinda	Kula	Zrenjanin	Vršac	Pančevo	Bečej	Sombor	Average
2007	**1.63**	0.15	0.00	0.00	0.05	0.38	0.03	0.32
2008	1.38	**2.07**	0.75	0.53	0.00	0.18	0.13	0.72
2009	2.60	**3.92**	1.77	1.48	0.53	2.03	0.15	1.78
Average	1.87	**2.05**	0.84	0.67	0.19	0.86	0.10	0.94

* calculated according to McKinney's formula; data are expressed in percentage
* računat prema McKinney-evoj formuli i izražen u procentu

Regarding growing season of 2009, Sclerotinia wilt occurrence was lowest in Sombor and Pančevo like in 2007. The highest average occurrence of Sclerotinia wilt was in Kula (Tab. 1). Similarly to 2008, high temperatures characterized the summer of 2009 and caused low Sclerotinia wilt occurrence. However, unlike previous years, daily rainfall in June and total amount of summer rainfall were above average (Hydrometeorological Institute of Serbia 2010), which caused somewhat higher Sclerotinia wilt occurrence in 2009 than in the previous two years.

According to estimations of 2,400 plants of eight hybrids per site, Sclerotinia wilt average occurrence was the lowest in 2007 (0.55%), middle in 2008 (1.22%), and the highest in 2009 (3.05%). Sclerotinia wilt average occurrence for the three-year period was 1.61% (Tab. 1). Similar occurrences of Sclerotinia wilt were registered in the neighbouring Croatia with similar agroecological conditions, where variant treated with fungicide had 2.5-7.5% diseased plants, while in untreated control it varied from 0-10% (Ćosić et al. 2005). These authors also indicated that Sclerotinia wilt was sporadically present in Croatia during 2002 and 2003. In France, estimated yield loss caused by Scerotinia diseases could be up to 50% in some years (CETIOM 2007) as Marić et al. (1998) noticed in Serbia, too. Under the agroecological conditions of 2007, Sclerotinia wilt was sporadically noticed in France (CETIOM, 2007) which is similar to its occurrence in Vojvodina in 2007. According to Marić et al. (1988), Sclerotinia wilt frequency in the range of 15-20% is considered to be a higher disease frequency in Serbia. Sclerotinia wilt presence in Vojvodina in the earlier periods indicates that number of infected plants was 10% or less for the period 1961-1964 and 10-20% for the period 1970-1974 (Aćimović 1983, cit. Stojanović 2004). Weather conditions in 2005 in Vojvodina were especially favourable for *S. sclerotiorum* diseases development, resulting in 30% infected sunflower plants on average (Maširević & Dedić 2006).

According to our research, Sclerotinia wilt average intensity in Vojvodina was 0.32% in 2007, 0.72% in 2008, and 1.78% in 2009 (Tab. 2). Maximum intensity of Sclerotinia wilt was observed in Kikinda in 2007, and in Kula in both 2008 and 2009 (Tab. 2). Sclerotinia wilt intensity for the period 2007-2009 in Vojvodina was lower than its occurrence, because disease was mostly manifested as spots near the stem base while plants with highest disease intensity were rarely detected. Its average value for the three-year period was 0.94% (Tab. 2).

Sclerotinia wilt intensity during the period 2007-2009 was highest in 2009 in all investigated sites. Contrary to other sites, Sclerotinia wilt intensity was higher in 2007 than in 2008 in Kikinda, Pančevo and Bečej.

According to AMMI analysis, the genotype NS-H-111 had the highest number of healthy plants in Pančevo and at sites with disease occurrence higher than average – Kikinda and Kula (Tab. 3). In Sombor and Zrenjanin, Šumadinac was the genotype with the highest number of healthy plants, while the same were Velja in Bečej and Baća in Vršac. Velja had the highest average number of healthy plants at all seven sites in three years (Tab. 3).

The main effects of the AMMI analysis, genotype and environment, are 65.75% of total trial variation, of which 43.34% belongs to environment and 22.41% to genotype. Non-additive source of variation, interaction between genotype and environment, showed high statistic significance and accounted for 34.24% in square sum of a trial. First PCA axis makes the most of total variability with 46.81% of interaction, while second PCA axis makes 39.57% of interaction and both have high statistic significance.

Based on AMMI biplot GxE interaction, it can be observed that genotypes with a higher

number of healthy plants than average were Duško, NS-H-111, Sremac and Velja. Duško showed the highest stability in its tolerance to Sclerotinia wilt which makes the most suitable hybrid for cultivation in the sites where Sclerotinia inoculum is already present in soil (Fig. 1). Higher than average, disease occurrence was registered in Kula and Kikinda, while the highest variation in a disease occurrence during three years period was observed in Kula and Zrenjanin (Fig. 1).

According to the obtained results, we can conclude that the main cause for Sclerotinia wilt low occurrence in Vojvodina during the estimated period (2007-2009) was unfavourable weather conditions for pathogen and disease development. Additionally, high tolerance of NS hybrids to Sclerotinia wilt also proved contributing. Duško showed the highest stability in its tolerance to Sclerotinia wilt, which makes it advantageous for future growing in Vojvodina, especially on sites with higher disease occurrence. Hybrid NS-H-111 is a well known sunflower hybrid that once again confirmed its tolerance to Sclerotinia wilt. Evaluated NS sunflower hybrids during the years of estimation also achieved high average yields (3.14 to 3.51 t ha^{-1}) (Miklič 2008, Miklič 2009).

Table 3. Means of healthy plants of eight sunflower hybrids at seven sites and values of the first two variation sources

Tabela 3. Srednje vrednosti zdravih biljaka osam hibrida u sedam lokaliteta i vrednosti prva dva izvora varijacije

Genotype	E1	E2	E3	E4	E5	E6	E7	$\overline{X}$	IPCAg1	IPCAg2
Baća (G1)	85.23*	76.96	79.25	84.92	87.15	**90.44**	80.13	83.44	-0.17	2.24
Bačvanin (G2)	79.42	78.57	78.55	85.81	86.06	78.69	88.58	82.24	1.03	-2.13
NS-H-111 (G3)	86.63	**83.13**	**89.89**	**90.11**	89.73	86.03	88.17	87.67	-1.31	-1.11
Branko (G4)	85.17	80.28	77.81	88.25	90.41	88.91	88.16	85.57	1.57	0.58
Sremac (G5)	88.17	82.49	88.71	89.78	90.27	89.73	86.03	87.88	-1.27	0.29
Duško (G6)	85.68	81.60	84.61	88.97	89.64	86.86	87.77	86.44	-0.14	-0.41
Šumadinac (G7)	84.79	80.31	77.17	88.28	**90.45**	88.39	**88.79**	85.45	1.82	0.39
Velja (G8)	**88.19**	82.66	89.67	89.87	90.12	89.36	85.98	**87.98**	-1.52	0.13
$\overline{X}$	85.41	80.75	83.21	88.25	**89.23**	87.30	86.70	85.83	-	-
σ^2	29,84	19,71	74,33	8,50	4,98	32,03	39,62	-	-	-
IPCAe(1)	-0.34	0.09	-2.92	0.31	0.84	0.27	1.73	-	-	-
IPCAe(2)	0.96	-0.62	-0.92	-0.39	0.21	2.49	-1.73	-	-	-

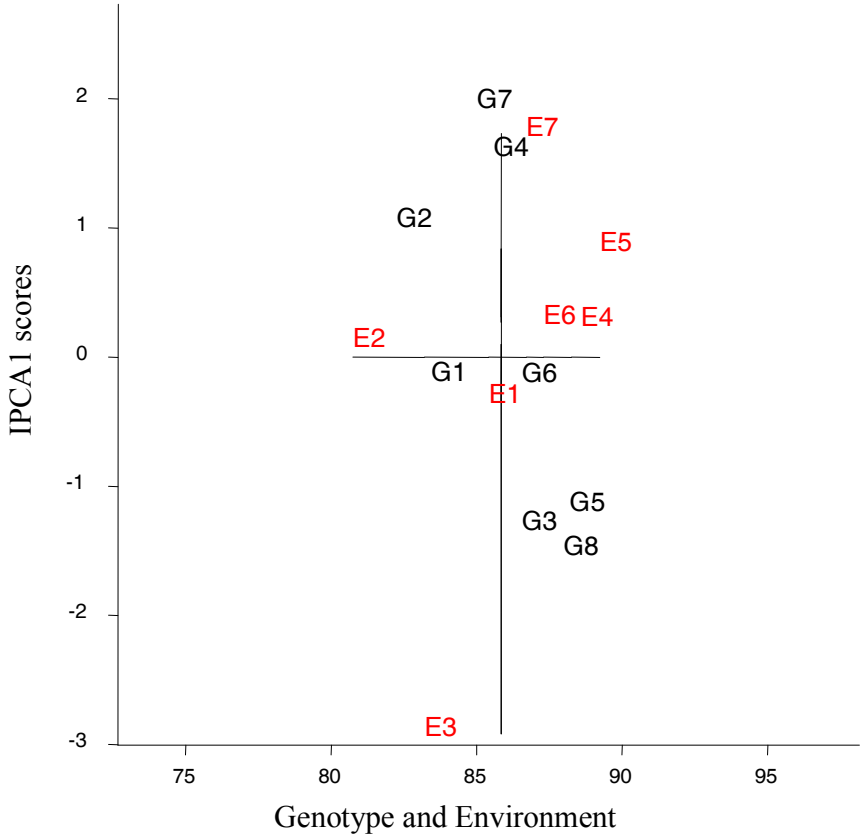
Percentage values of healthy plants were transformed in arcsin

**Key: E1-Bečej; E2- Kikinda; E3-Kula; E4-Pančevo; E5-Sombor; E6-Vršac; E7-Zrenjanin

Table 4. AMMI analysis of variance of healthy plants of eight sunflower hybrids at seven sites

Tabela 4. AMMI analiza varijanse zdravih biljaka osam hibrida suncokreta u sedam lokaliteta

Variation Source	df	SS	MS	F	F-tablica	
					0.05	0.01
Total	503	18707	37.2	*		
Treatments	55	8834	160.6	7,09**	1.00	1.00
Genotypes	7	1980	282.8	12,51**	2.01	2.64
Environments	6	3828	638.1	247,71**	2.09	2.80
Block	14	36	2.6	0,11**	1.75	2.18
Interactions	42	3025	72.0	3,17**	1.35	1.52
IPCA 1	12	1416	118.0	5,18**	1.75	2.18
IPCA 2	10	1197	119.7	5,29**	1.83	2.32
Residuals	20	412	20.6	0,91**	1.57	1.87
Error	434	9838	22.7	*		



*Legend: G1-Baća; G2-Bačvanin; G3-NS-H-111; G4-Branko; G5-Sremac; G6-Duško; G7-Šumadinac; G8-Velja; E1-Bečej; E2-Kikinda; E3-Kula; E4-Pančevo; E5-Sombor; E6-Vršac; E7-Zrenjanin

Figure 1. Biplot of Genotype and Environment scores versus means of healthy plants sunflower hybrids at seven sites
Slika 1. Biplot vrednosti Genotipa i Sredine naspram srednjih vrednosti zdravih biljaka hibrida suncokreta na sedam lokaliteta

Conclusions

Average Sclerotinia wilt occurrence on sunflower in the period 2007-2009 was the lowest in 2007, while it was the highest under weather conditions of 2009. During the estimated period, average Sclerotinia wilt occurrence was the lowest in Sombor and Pančevo, and the highest in Kula and Kikinda. Data obtained in our research showed NS hybrids tolerance to Sclerotinia wilt under commercial growing conditions in Vojvodina region where these hybrids are usually grown. NS hybrids Duško, NS-H-111, Sremac and Velja can be recommended for future growing at sites where Sclerotinia wilt of sunflower occurs.

References

Abamu FJ, Akinsola EA, Alluri K (1998): Applying the AMMI models to understand genotype-by-environment (G x E) interactions rice reaction to blast disease in Africa. International J. Pest Manag. 44: 239-245

Aćimović M (1979): Evaluation procedures for the intensity of disease occurrence in sunflower. Helia 2: 55-57

Aćimović M (1998): Bela trulež / White rot. In: M Ćirović (ed.), Sunflower diseases. Naučni institut za ratarstvo i povrtarstvo, Novi Sad, 444-507

Bolton DM, Thomma BPHJ, Nelson BD (2006): Sclerotinia sclerotiorum (Lib.) de Bary: biology and molecular traits of a cosmopolitan pathogen. Mol. Plant Pathol. 7: 1-16

CETIOM (2007): Tournesol 2007: Bilan de campagne & Synthèse variétale [electronic source]. [4th pg] available at http://www.cetiom.fr/index.php?id=6569#c38893 (cited on 01.03.2011)

Ćosić J, Jurković D, Vrandečić K, Duvnjak T (2005): Sunflower stem disease occurrence in East Croatia. Agric. 11: 11-16

Hydrometeorological Institute of Serbia (2008): Main climatic characteristics of the period January-December of 2007 at Serbian territory. [electronic source]. [11th pg] available at http://www.hidmet.gov.rs/podaci/meteorologija/ciril/2007.pdf (cited on 15.11.2010)

Hydrometeorological Institute of Serbia (2009): Significant climatic changes at Serbian territory in 2008. [electronic source]. [7th pg] available at http://www.hidmet.gov.rs/podaci/meteorologija/ciril/2008.pdf (cited on 15.11.2010)

Hydrometeorological Institute of Serbia (2010): Significant climatic changes at Serbian territory in 2009. [electronic source]. [10th pg] available at http://www.hidmet.gov.rs/podaci/meteorologija/ciril/2009.pdf (cited on 15.11.2010)

Lamey A, Knodel J, Endres G, Gregoire T, Ashley R (2000): 2000 Sunflower Disease and Midge Survey [electronic source]. [1 p] available at http://www.ag.ndsu.nodak.edu/aginfo/ndipm/sunflower.htm (cited on 15.11.2010). NDSU Extension Service, North Dakota.

Marić A, Čamprag D, Maširević S (1988): White rot (Sclerotinia sclerotiorum). In: S Milošević (ed.) Diseases and pests of sunflower and their control. Nolit, Belgrade, 69-83

Maširević S, Gulya T.J (1992): Sclerotinia and Phomopsis – two devastating sunflower pathogens. Field Crop. Res. 30: 271-300

Maširević S, Dedić B (2006): Mass occurrence of Sclerotinia sunflower head rot (Sclerotinia sclerotiorum) and the effect on yield in 2005. Zbornik radova Instituta za ratarstvo i povrtarstvo Novi Sad 42: 87-98

Miklič V, Balalić I, Jocić S, Marinković R, Hladni N, Gvozdenović S, Stojšin V (2009): Productivity of sunflower NS hybrids and assortment recomendation for sowing in 2009. Zbornik radova Instituta za ratarstvo i povrtarstvo Novi Sad 46: 293-310

Miklič V, Hladni N, Jocić S, Marinković D, Dušanić N, Gvozdenović S (2008): Sunflower cultivation in the Institute of field and vegetable crops. Zbornik radova Instituta za ratarstvo i povrtarstvo Novi Sad 45: 31-63

Schneither AA, Miller JF (1981): Description of Sunflower Growth Stages. Crop Sci. 21: 901-903

Stojanović D (2004): Diseases of cultivated plants. In: Z Dragutinović (ed.) Agricultural Phytopathology. Srpsko biološko društvo "Stevan Jakovljević", Kragujevac, 394-397

Pojava bele truleži korena suncokreta u Vojvodini

Sonja Tančić • Boško Dedić • Siniša Jocić • Igor Balalić • Nada Lačok • Dragana Miladinović • Vladimir Miklič

Institut za ratarstvo i povrtarstvo, Maksima Gorkog 30, 21000 Novi Sad, Srbija

Izvod: Fakultativni parazit *Sclerotinia sclerotiorum* izaziva bolesti na više od 400 biljnih vrsta. Pojava bele truleži korena suncokreta na teritoriji Vojvodine je praćena tokom trogodišnjeg perioda (2007-2009) u sedam lokaliteta (Bečej, Kikinda, Kula, Pančevo, Sombor, Vršac i Zrenjanin), a u svakom lokalitetu je bilo ocenjeno osam hibrida (Baća, Bačvanin, Branko, Duško, NS-H-111, Sremac, Šumadinac i Velja). Stepen osetljivosti biljaka je izračunat po McKinney formuli. AMMI analizom je vršena procena stabilnosti hibrida na tolerantnost prema beloj truleži korena u različitim lokalitetima. Prosečna zastupljenost ovog oboljenja u 2007. godini je bila najniža, a u 2009. godini najviša. Bela trulež korena suncokreta u 2007. godini nije registrovana u Zrenjaninu i Vršcu, a u 2008. godini u Vršcu i Pančevu. Najniža prosečna pojava ove bolesti u trogodišnjem periodu je bila u Somboru i Pančevu. Na osnovu dobijenih rezultata hibridi Duško, NS-H-111, Sremac i Velja se mogu preporučiti za gajenje u lokalitetima na kojima se javlja bela trulež korena suncokreta.

Ključne reči: AMMI analiza, bela trulež korena, pojava, suncokret, Vojvodina