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SUSCEPTIBILITY OF SOME EXPERIMENTAL SUNFLOWER HYBRIDS TO WHITE ROT (*Sclerotinia sclerotiorum*) AND BROOMRAPE (*Orobanche cumana*)

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SUMMARY

The susceptibility of 10 experimental sunflower hybrids to the causal agent of white rot (*S. sclerotiorum*) and broomrape (*O. cumana*) was tested at two localities (Bečej and Svetozar Miletić) in naturally highly infested fields in 2009. There are significant differences between hybrid susceptibility to white rot and broomrape. The basal stalk rot was absolute dominant type of disease and was evident on 16,7 % of plants in Bečej. In Svetozar Miletić fungus attack did not noticed in any tested hybrid. Broomrape attack was noticed on six tested hybrids at both localities. It can be observed that hybrids in Bečej had significantly higher yields compared to those achieved in Svetozar Miletić. Genetic capacity of the hybrids and favorable conditions for sunflower growth had the most important influence of achieved seed yield. Negative influence of white rot attack on seed yield was lower because it appeared in root and stalk form. Although on certain plants broomrape attack was of high intensity generally it was not so sever and therefore harmfulness of this parasitic plant could not manifest significant influence on seed yield.

Key words: sunflower, seed yield, white rot, broomrape, hybrid

INTRODUCTION

White rot and broomrape are the most important problems on sunflower in the agroecological conditions of Serbia. The causal agent of white rot (*Sclerotinia sclerotiorum* (Lib.) de Bary) is world wide spread plant pathogen and it attacks sunflower in all regions (3). In our country white rot appears on sunflower almost every year and can cause great damage under favourable conditions (4).

Broomrapes (*Orobanche* spp.) are native primarily to the Mediterranean region and western Asia, where they cause significant crop damage (7). In Serbia, it has been appearing with varying intensity almost every year but since the 1990s broomrape has been causing significant damage in susceptible sunflower hybrids (5). Yield losses depend on intensity of attack and they can range from 5 to 100 % (6).

For these pathogens soil is one of the most significant source of inoculum. Seed of the broomrape as well as sclerotia remains viable in soil for 8-12 years. Preservation of broomrape seed and sclerotia vitality and accumulation of the inoculum in the soil due to repeated sowing of sunflower or other host plants create favorable conditions for high disease attacks. Therefore it is very important to test susceptibility of sunflower genotypes in our agroecological conditions in the areas which are known as highly infested.

MATERIAL AND METHOD

The susceptibility of ten experimental sunflower hybrids to the causal agent of white rot (*Sclerotinia scelotiorum*) and broomrape (*Orobanche cumana*) was tested at two localities in Vojvodina province in naturally highly infested fields: Bečej and Svetozar Miletić in 2009. The first region (Bečej region) is known as soybean cultivation region and Svetozar Miletić which is know as one of the main focus of hazard to broomrape infection. The experimental hybrids which were included in trails were from two groups. In the first group of the hybrids were hybrids which are resistant to the broomrape (NORH-28, NORH-29, NORH-30, NORH-33, NORH-34), and in the second were high-oleic sunflower hybrids (HO-B-2, HO-B-3, HO-B-4, HO-B-5, HO-08). The standard hybrids were NK-Kondi and NK-Dolby in Bečej and NS-H-111 in Svetozar Miletić. Experimental hybrids were sown by randomized block system in 4 rows (22 plants per row) in three replicates. Differential lines for determination of broomrape races were also sown in the experimental field. Sowing was done on 24th of April in Bečej and on 10th of May in Svetozar Miletić.

The first presence of the white rot in Bečej was noticed at the beginning of June (June 6, 2009). After that time the evaluation of disease intensity was done every 7 days. Evaluation of disease presence was done on the basis of plants with symptoms. The final evaluation was done on September, 23, 2009.

Appereance of broomrape was evaluated three times during the vegetation period- first time at the beginning of flowering, than in full flowering and before harvest. Broomrape attack was evaluated as a frequency (F) intensity (I)

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and attacking rate (AR) based on Pustovoit method. Frequency is percent of sunflower plants with *Orobanche*. Intensity is the number of *Orobanche* per one infested plant and attacking rate is the number of *Orobanche* in one plant in the row.

Susceptibility of sunflower genotypes to these pathogens was followed until the harvest. For seed yield estimation two medium rows of every genotype were harvested. Obtained results were analyzed by ANOVA.

RESULTS AND DISCUSION

The first symptoms of white rot on tested sunflower hybrids in Bečej were noticed at the budding stage. The basal stalk rot was absolute dominant type of disease. Such high percent of infection with basal stalk rot indicates that there is source of inoculum in the soil and favorable condition for pathogen development. Presence of inoculum in the soil could be explained by frequent soybean cultivation in crop rotation in this region. According to (8) population of sclerotia do not change significantly if non-susceptible cultures are grown in three year period. Favorable weather conditions primarily amount of rainfall was one of the most important factors for disease development. Amount of rainfall from sowing (April, 24, 2009) to May 1, was 92.6 mm when short drought period came. In the third decade more than 50mm of precipitation was measured, while total amount of rainfall in May was 69.8 mm and it is over multiyear average. Wet weather continued in June and the first appearance of white rot symptoms was noticed in the budding stage. Such distribution of precipitations was favorable to disease development which can cause greater damage in conditions of wet, cool and specially variable weather (1).

During vegetation period constant increase of the number of diseased plants could be noticed. After the first heavy rain at the end of budding stage significant higher appearance of root form of white rot was observed. Rising trend of number of diseased plants was permanent further during vegetation period and significant increase was observed after second rainfall period. Until harvest it was 16.7% of diseased plants, Except short wet period in the middle of August the second part of vegetation period was characterized by warm and dry weather with periodically high temperatures. Such weather conditions influence on slower disease development and dispersal and its manifestation on other plant parts (middle and upper stalk part and head).As it was said previously, white rot appearance in the trial in Bečej was caused by inoculum potential of fungus in the soil. Soybean known as very important host plant for *S. sclerotiorum*, is also one of the major cultivated plants in the Bečej region. Soybean cultivation on great area in monoculture without crop rotation leads to accumulation of inoculum (sclerotia) in the soil.

All tested hybrids showed significant differences in susceptibility to *S. sclerotiorum*. Range of diseased plants depending of genotype varied from 9.3 to 30.1%. Significantly lower percent of diseased plants were noticed in hybrids NORH-29 (9.3%) and NORH-34 (9.5%), while significantly higher level of disease attack was noticed in NORH-28 (30.1%), NORH-30 (24.4%) and H-O-08 (23%).

Table 1 Number of plants with symptoms of white rot per hybrid

Hybrid	Number of diseased plants (%)	Level of significance
NORH-29	9.3	a
NORH-34	9.5	ab
H.O-B-3	10.7	abc
H.O-B-2	11.9	abcd
H.O-B-5	12.4	abcd
NK DOLBI	13.9	abcd
H.O-B-4	18.4	bcd
NK KONDI	19.7	bcd
NORH-33	20.2	bcd
H.O-08	23.0	cd
NORH-30	24.4	d
NORH-28	30.1	d
p for treatments	0.106*	

In Svetozar Miletić, fungus attack did not noticed in any tested hybrid. Weather conditions at both localities were similar so weather could not be decisive factor for white rot occurrence. Absence of white rot attack in Svetozar Miletić could be explained by absence of inoculum in the soil and soil structure. Soil structure is one of the important factors for disease attack intensity. At the trail in Svetozar Miletić the soil has light mechanical structure and it is dry and sandy. Such soils are not so favorable for white rot occurrence and dispersal. (Tu, 1997).

Broomrape attack in Bečej was noticed in six out of twelve tested hybrids. Broomrape attack was observed in four high-oleic hybrids, NORH-34 and NK Kondi. All tested hybrids showed low level of susceptibility (Table 2) including test hybrid NK Kondi. All hybrids except H.O-B-2 have percent of infected plants below 5%. There is a statistically significant difference in frequency of broomrape attack between H O-B-2 which has 17% and other hybrids at the locality.

Table 2 Susceptibility of tested sunflower hybrids to broomrape in Bečej and Svetozar Miletić

locality	Bečej			Svetozar Miletić		
Hybrid	Frequency- F (%)	Intensity- I	Number of broomrape per sunflower plant	Frequency- F (%)	Intensity- I	Number of broomrape per sunflower plant
HO-B-2	17 a	1,8	0,3	5,6 c	1,3	0,07
HO-B-3	2,2 b	0,6	0,03	5,5 c	1,3	0,07
H. O-B-4	4,5 b	0,8	0,1	2,6 c	1	0,02
HO-B-5	2,1 b	0,8	0,03	3,6 c	1,3	0,05
NORH-34	2,9 b	0,8	0,03	21,3 b	1,25	0,27
NK KONDI	0,4 b	0,3	0,01	-	-	-
NS-H-111	-	-	-	61,3 a	5,3	3,25
p treatments	0.0010***			0,0000***		

Broomrape attack in Svetozar Miletić was noticed on six out of 10 tested hybrids (Table 2). The highest broomrape attack was observed in standard broomrape susceptible hybrid NS-H-111 (61.3%). High oleic hybrids had lower broomrape attack and it was observed only on individual plants. In the group of broomrape resistant hybrids, broomrape attack was noticed only on NORH-34. with the 21.3% of infected plants.NORH-34 could be classified as a susceptible, because hybrids with frequency up to 20% are selected as tolerant (2). But the value of attacking rate in NORH-34 is 0.27 and according to (12) hybrids with attacking rate from 0-1 are accepted as resistant. It is very important to investigate further to evaluate the susceptibility of the hybrid in our agroecological conditions. Hybrid NORH-34 was also infected with *Orobanche* in Bečej. Lower intensity of attack in Bečej than in Svetozar Miletić could be explained by less amount of inoculum potential in the soil. Broomrape plants in fields with tested sunflower hybrids were noticed just before flowering period. The most significant differences in frequency of broomrape attack were observed between the beginning of flowering stage and full flowering. From the period of full flowering until harvest time the number of broomrape plants did not increase.

Seed yields of most hybrids were high (Table 3). These seed yields were achieved by high genetic potential favorable agroecological conditions and also by application of all cultivation measures. Average yields in Bečej were higher and ranged from 3250,2–4044,9kg/ha, and yields in Svetozar Miletic from 2039,6-3218,6kg/ha. Higher yields in Bečej were achieved because of longer vegetation period (10 days) and soil of higher fertility. Hybrids, NORH-33 and HO-08 had the best in Bečej, although hybrid NORH 33 showed the highest rate of susceptibility to white rot (34% diseased plants). HO-B-2, HO-B-4 and NORH 30 had relatively low yields related to other tested hybrids in Becej. Lower yield of these three hybrids can be explained by white rot and broomrape attack. Hybrids HO-B-2 and NORH 30 had good yields in Svetozar Miletic, but other hybrids had relatively small yield. (Table 3)

According to (9) NS sunflower hybrids achieved good yields in specific regions and with application of all needed agrotechnical measures. In many cases hybrids with lower yield potential which have wide range of resistance to diseases achieved high yields. The hybrids which were used in this paper should be tested in other localities and such results will contribute to right choice of hybrids in next years.

Table 3. Seed yield of tested sunflower hybrids and correlation between seed yield and disease attack on both localities

Hybrid	Bečej			Svetozar Miletic	
	Yield (kg/ha)	%of white rot diseased plants	%of broomrape diseased plants	Yield (kg/ha)	%of broomrape diseased plants
NORH 28	3939,8 ab	16,6 b	0 b	2450,1 b	0 d
NORH 29	3479,1 cd	7,2 b	0 b	2117,9 b	0 d
NORH 30	3250,2 d	11,0 b	0 b	3065,2 a	0 d
NORH 33	4044,8 a	34,1 a	0 b	2099,2 b	0 d
NORH 34	3754,3 b	9,6 b	0 b	2328,6 b	25.3 b
HO-B-2	3491,5 c	12,2 b	26,5 a	3218,6 a	2,8 cd
HO-B-3	3967,6 ab	10,2 b	3,6 b	2350,0 b	4,4 c
HO-B-4	3405,4 cd	7,2 b	10,6 b	2042,9 b	5,6 c
HO-B-5	3996,3 ab	5,9 b	2,9 b	2039,6 b	2,6 cd
HO-08	4028,0 a	3,4 b	0 b	2538,0 b	0 d
NK Kondi	3520,3 a	11,9 b	0 b	-	
NK Dolbi	3904.4 ab	15,6 b	0 b	-	
NS-H-111			-	2462,1 b	63.9 a
p	0,000***	0,143*	0,0002***	0.0006***	0,0000***

With application of all agrotechnical measures plants are in favourable growth conditions and lower level of disease occurrence could not be dominant factor which can influence on yield. This is confirmed also by results in our trials. In Bečej there is non significant correlation between seed yield and diseases (white rot and broomrape) (correlation coefficient -0,10898 ns). In Svetozar Miletic there is also non significant correlation between seed yield and broomrape attack (correlation coefficient -0,02319 ns) (Table 4.). The main reason for lower influence of white rot on seed yield is its appearance in root and stem form. In the favorable year for sunflower development, genetic capacity for yield has the highest influence on achieved seed yield. Although the broomrape attack had noticed on certain number of plants, generally it was attack of lower intensity. Consequently, harmfulness of this parasitic plant had not significant influence on seed yield.

Table 4 Coefficients of correlation of the observed parameters

Locality	Becej	Svetozar Miletic
	White rot and broomrape	broomrape
Seed yield	- 0,10898 ns	-0,02319 ns

CONCLUSION

Tested hybrids showed significant differences in achieved yield and in susceptibility to white rot and broomrape. White rot was noticed on all tested hybrids in Bacej. Intensity of disease per hybrid ranged from 9.3 - 30.1 % diseased plants. Fungus attack did not noticed in any tested hybrid in Svetozar Miletić. Broomrape attack was observed in the both localities and on 5 experimental and standard hybrids NS-H-111 i NK-KONDI. The most sever attack of the standard hybrid NS-H-111 (5,3 bromrape per sunflower plant). Seed yields in Becej in all tested hybrids were higher. Although negative correlation was observed between disease incidence and seed yield, it was not statistically significant and it indicates that other factors had stronger positive influence. Differences in susceptibility of tested hybrids to broomrape and white rot should be further investigated

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