EFFECT OF ECOLOGICAL AND AGROTECHNICAL FACTORS ON THE PHYTOPATHOLOGICAL PROPERTIES OF SUNFLOWER (Helianthus annuus L.)

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Abstract

The research work has been carried out at the Látókép Research Site of the University of Debrecen, Centre for Agricultural Sciences, Farm and Regional Research Institute on calcareous chernozem soil in. We examined the effects of sowing times and the fungicide treatments on the phytopathogenic characteristics phytopathological properties of sunflower hybrids. In order to characterize the phytopathological properties of sunflower hybrids in a complex way infection index (Ii) has been elaborated.

*The infection of sunflower populations by fungal phytopathogenes was mainly determined by the weather conditions of the crop year. The development of infection indexes depended mainly on the sowing time in the studied crop years (r=-0.806**, r=-0.755**). Fungicide application had significant contribution to the moderation of the unfavourable effect of sowing time in both years and thus it decreased the infection index of sunflower populations (r=-0.464**, r=-0.578**). Plant phytopathogenes resulted in significant yield loss in sunflower populations only in the crop year of 2012 that was characterized by heavy infection.*

Key words: infection, ungicide treatment, phytopathogenics, sowing time, sunflower

INTRODUCTION

Arable land use structure has simplified in Hungary in the last three decades. Cereals (small grains and maize) have ~67% and oil crops have ~19% of arable land. The most important oil crop is the sunflower in Hungary. In the past decade the country average yield dinamically increased (~2500 kg ha-1) but the yield fluctuation remained on the high level (~52%) (Pepó and Vad 2011). When the weather is cold and wet, lower yields can be expected due to the higher infection by stem and head diseases (Borbély et al. 2007), as the yield of sunflower is strongly influenced by the fungal diseases (Mukhtar, 2009). Fungal infection impairing the crop does not appear in drought, while besides average precipitation it appears only to a small extent, therefore the role of the primary determinant of yield – the disease – becomes negligible (Ruzsányi and Csajbók 2001). Climatic factors are given, however, their effect can significantly be reduced by sound agrotechnology (Szabó 2011a). The yield stability and the agronomic and economic efficiency of sunflower cultivation depend on the influence of genotype, the level of applied technology (date of sowing, number of plants), and the presence of an important number of diseases caused by the attack of parasitic fungi (Csép 2007, Szabó 2013). In respect of the amount of yield, earlier sowing turned out to be the optimal, however, the degree of infection was the largest at that period as well. In dry, droughty years average sowing time (April) is the optimal, while in years with regular rainfalls, when the presence of stem and flower diseases is more enhanced, late sowing should be considered (Szabó 2011b). Stands planted too early are more exposed to Diaporthe helianthi, Phoma macdonaldii and Alternaria species. When sowing too late, rot diseases (Sclerotinia) may damage stands due to late harvesting (Békési 2012).

MATERIAL AND METHOD

The research work has been carried out at the Látókép Research Site of the University of Debrecen, Centre for Agricultural Sciences, Farm and Regional Research Institute on calcareous chernozem soil in.

The carefully designed experiment was carried out between March 2012 and September 2013. Each experimental plot was set up in four replications, randomized. One of the studied agrotechnical factors was sowing time. Early (end of March), average (middle of April), just as late (beginning of May) sowing times were applied. The other studied agrotechnical factor was fungicide plant protection of which three different application models were set up. There was no fungicide treatment in the control treatment, while in case of the 1-time fungicide treatment model fungicides (dimoxistrobin + boscalid) were applied once (in the plant development state of 8-10 pairs of leaves) and in case of the 2-times fungicide treatment model twice (in the plant development state of 8-10 pairs of leaves and in the flowering state resp.). Sunflower hybrids of 7 different genotypes were involved into the experiment (NK Neoma, P63LE13, NK Ferti, Tutti, SY Revelio, P64HE39, PR64H42).

Trends of weather factors are shown in *Table 1*. The weather was totally different in the two years, the effect of which was manifested both in the phytopathological characteristics and in the yield in the studied genotypes. The amount of precipitation (253.7 mm) in the vegetation period of 2012 was favorable, but its distribution was unfavourable (71.9 mm in May, 91.7 mm in June, 65.3 mm in July). The precipitation from May until the end of June created favourable microclimate conditions for the relatively early occurrence of the leaf, stem and head diseases of sunflower and for the development of a significant infection. The weather and phytopathological conditions of 2013 and the preceding period were totally different from those of 2012. The amount of precipitation (195.3 mm) in the vegetation period of 2013 (April-August) was considerably lower than in 2012.

Consequently, the sunflower diseases occurred later in 2013 and their spread was moderate in the stands.

Table 1.

The amount of meteorological parameters in the examined crop years (Debrecen, 2012-2013)

	Months	April	May	June	July	August	Total/Average
Precipitation (mm)	30 year's average	42.4	58.8	79.5	65.7	60.7	307.1
	2012	20.7	71.9	91.7	65.3	4.1	253.7
	Difference	-21.7	13.1	12.2	-0.4	-56.6	-53.4
	2013	48.0	68.7	30.8	15.6	32.2	141.9
	Difference	5.6	9.9	-48.7	-50.1	-28.5	-165.2
Temperature (°C)	30 year's average	10.7	15.8	18.8	20.3	19.6	17.0
	2012	11.7	16.4	20.9	23.3	22.5	19.0
	Difference	1.0	0.6	2.1	3.0	2.9	1.9
	2013	12.0	16.6	19.6	21.2	21.5	18.2
	Difference	1.3	0.8	0.8	0.9	1.9	1.2

During the researches we determined the degree of infections for the most important phytopathogenics (Diaporthe helianthi, Phoma macdonaldii, Alternaria helianthi, head diseases). In order to characterize the overall phytopathological state, i.e. total infection of studied crop years infection index (a value without dimension) has been used. For the calculation of the infection index first the rates of infection of monitored phytopathogenes (Diaporthe, Phoma, Alternaria, head diseases) were drawn up (in the average of hybrids) on a radial diagram for both crop years. After that the size of the surface area demarcated by the phytopathogenes has been determined. The area bounded by the phytopathogenes was divided to four right triangles in order to execute the calculation. The area of each triangle was determined, and then by the addition of the part-areas the infection index (Ii) could be calculated. Accordingly, infection index is calculated upon the following formula:

$$\mathrm{Ii} = \left[\frac{D*T}{2} + \frac{D*P}{2} + \frac{A*T}{2} + \frac{A*P}{2}\right]/100$$

The abbreviations in the formula cover following parameters:
Ii =Infection index
D = Diaporthe infection
T = Head diseases infection
P = Phoma infection
A = Alternaria infection

Computer programmes Microsoft Excel 2013 and SPSS for Windows 13.0 were used for data processing and statistical evaluation. For the determination of the relationship between the studied factors Pearson correlation coefficients were calculated.

RESULTS AND DISSCUSIONS

Infection indexes that represented the studied crop years showed significant differences. While weather conditions in 2012 favoured the infection by pathogens, the monitored phytopathogenes occurred and damaged in a lower extent in the crop years of 2013. Consequently the infection index of 2012 was extremely high (in the average of sowing times and fungicide treatments: Ii=42.4). Infection index of sunflower populations lag significantly behind this value in 2013 (Ii=13.4). Depending on sowing times and fungicide treatments infection index values ranged in 2012 in a rather wide (Ii: 4.5-93.6), while in 2013 (Ii: 3.1-29.7) in a relevantly more narrow interval.

Infection indexes for different sowing times sowed significant differences in both studied crop years. In the average of fungicide treatments the highest infection index values were found in case of the early sowing time treatments (2012: Ii=67.6; 2013: Ii=20.5). The infection index of populations sown in May was relatively low in all three years (2012: Ii=8.1; 2013: Ii=5.4).

In contrast to the control plots treatments with 1-time or 2-times fungicide application were characterized by relevantly lower infection indexes. The greatest decrement of infection index value was found in case of the combination of late sowing time and the application of 2-times fungicide treatment. Infection index of populations sown at an early sowing time and treated with no fungicide application was relatively high in both crop years (2012: Ii=93.6; 2013: Ii=29.7). In contrast, the infection index of populations of late sowing time and 2-times fungicide application was minimal (2012: Ii=4.5; 2013: Ii=3.1) (*Table 2*).

We applied Pearson's correlation analysis (Table 1) to determine the relationship between the examined factors ($0,1<r<0,3$ = really small, $0,3<r<0,5$ = small, $0,5<r<0,7$ =medium, $0.7 <r$ = large). According to the results of the Pearson correlation analysis it can be stated that the development of infection indexes depended mainly on the sowing time in the studied crop years which was confirmed by the strong negative correlation between the two factors as well (r=-0.806**, r=-0.755**). Fungicide application had significant contribution to the moderation of the unfavourable effect of sowing time in both years and thus it decreased the infection index of sunflower populations (r=-0.464**, r=-0.578**). Infection index showed extreme high values only in the crop year of 2012. Consequently, great extent of infection resulted in relevant decrement of yields only it this particular crop year (r=-0.916**) (*Table 3*).

Table 2.

Effect of sowing time and fungicides treatment on the Infection index of sunflower (Debrecen, 2012-2013)

Crop year	Sowing time	Fungicide treatment	Diaporthe	Phoma	Alternaria	Head diseases	**Infection index**
2012	Early	Control	73	61.8	84.1	57.3	**93.6**
		1-time treated	61	51.1	70.8	51.4	**67.4**
		2-times treated	46	41.3	56.2	40.4	**41.9**
	Average	Control	64	53.5	76.4	50.1	**72.8**
		1-time treated	54	45.5	65.1	43.8	**53.2**
		2-times treated	38	34.0	48.7	30.8	**28.1**
	Late	Control	30	19.6	34.4	15.7	**11.3**
		1-time treated	24	17.5	29.1	13.9	**8.4**
		2-times treated	17	13.2	21.1	10.7	**4.5**
	$LSD_{5\%}$ sowing time		*7.4*				
	$LSD_{5\%}$ fungicide treatment		*5.8*				
	$LSDD_{5\%}$ interaction		*10.0*				
2013	Early	Control	46	33.4	42.3	33.5	**29.7**
		1-time treated	38	27.6	33.2	28.7	**20.1**
		2-times treated	30	19.4	26.1	22.5	**11.8**
	Average	Control	37	28.5	35.8	29.1	**20.8**
		1-time treated	29	22.4	29.1	24.9	**13.7**
		2-times treated	25	17.4	22.2	19.3	**8.6**
	Late	Control	25	15.7	25.9	15.3	**7.8**
		1-time treated	21	12.7	20.1	12.9	**5.2**
		2-times treated	16	10.2	15.3	9.3	**3.1**
	$LSD_{5\%}$ sowing time		*1.4*				
	$LSD_{5\%}$ fungicide treatment		*1.2*				
	$LSD_{5\%}$ interaction		*2.0*				

Table 3.

Relationship of sowing time, fungicide treatment, yield and Infection index with Pearson correlation analyses (Debrecen, 2012-2013)

Crop year	2012	2013
Examined factors	Infection index	Infection index
Sowing time	-0,806(**)	-0,755(**)
Fungicide treatment	-0,464(**)	-0,578(**)
Yield	-0,916(**)	$0{,}096^{NS}$

CONCLUSIONS

The infection of sunflower populations by fungal phytopathogenes was mainly determined by the weather conditions of the crop year. Delayed sowing time significantly decreased the infection rate of the studied phytopathogenes in both crop years. Beside the right choice of sowing time, fungicide application contributed to the decrease of the infection rate too.

Plant phytopathogenes resulted in significant yield loss in sunflower populations only in the crop year of 2012 that was characterized by heavy infection.

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