STUDY OF AGROTECHNICAL RESPONSE IN SUNFLOWER (HELIANTHUS ANNUUS L.) PRODUCTION

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Abstract

Today, cropyears with extreme weather conditions are becoming more and more frequent and increase the risk of sunflower production. The objective of researches into plant production is to minimize these effects as much as possible. In this sense, the optimization of agrotechnological factors is of high importance. Therefore, appropriate cropping technologies (sowing time, crop density) and optimized, rational crop protection are highly important especially in highly sensitive sunflower cultures. The effect of sowing time, crop density, and fungicide treatments on the yield of sunflower hybrid (NK Kondi) was analysed in 2010. In each case, disease infection, lodging and head blight rates were highest with the early sowing time and the highest crop density level (65000 ha^{-1}). When only one fungicide treatment was applied, the rate of infection decreased compared to the control treatment.

Te yield difference between the optimal and minimal crop density levels was higher in the fungicide treatments than in the control treatment (ontrol: 919 kg ha^{-1}; one treatment: 1024 kg ha^{-1}; two treatments: 1030 kg ha^{-1}). The highest yield was obtained with the third, late sowing time in each fungicide treatment.

Key words: sunflower, plant density, sowing time, fungicide

INTRODUCTION

In Hungary, sunflower has very significant role in the production of vegetable oil, therefore sunflower was converted into one of the most important field crop.

The agrotechnical factors all influence the product yield of sunflower hybrids. Climatic factors are given, however, their effect can significantly be reduced by sound agrotechnology. Using the right cropping technology and crop protection methods suitable for the hybrid, land area and crop year we can decrease yield loss caused by diseases, increase crop yield and improve quality. The critical factor of sunflower production is the excessive vulnerability of hybrids to fungal diseases. The negative effect of stalk and head infections caused by different diseases was lower in draughty years than in humid years. Even today, the climatic conditions of the crop year cannot be predicted; however, infection rate and yield loss caused by the unfavourable weather can significantly be reduced by adequate and well-timed crop protection technologies. Recently, the crop yields have significantly been varying, weather extremes (uneven distribution of precipitation during the crop year, draughty periods, low temperature) were rather frequent and increased the risk of production.

Crop density is a mayor agrotechnical factor in sunflower production. Optimal plant spacing allows of utilizing the yield capacity of the hybrids.

Increasing crop density (above 50-55 thousand/ha) increases costs and decreases crop yield (Pepó et al. 2002). Besides climatic conditions, crop yields and yield safety are also influenced by the water supply and water management of the soil (Birkás et al., 2006). Within the interval of biological optimum, productivity of the hybrids was significantly influenced by sowing time and crop density level (Zsombik, 2007).

The yield capacity of sunflower hybrids is highly influenced by agrotechnical and climatic factors in the crop years (for e.g. crop density, sowing time, etc.) (Borbélyné et al. 2007, Zsombik 2006).

Pepó and Szabó (2005) analysed the effects of agrotechnological factors at different crop density levels in sunflower. The results showed that in humid, cold crop years the yield was lower due to the higher degree of infection by stalk and head diseases. The optimal crop density level varied with the hybrids proving that in humid, cold years the optimal crop density level is determined by the resistance of the plant against stalk and head diseases. In dry years, as the spread of diseases is slower, the infection rate was lower, which was reflected in the yields and the oil yield as well.

Agroclimatic factors had the most significant influence on crop yield, while the effect of the hybrid selection was moderate. The emergence and intensity of diseases is significantly influenced by the hybrid choice, as well as the agroclimatic factors in the crop year (temperature, distribution and amount of precipitation) (Branimir et al., 2008).

The precipitation in the vegetation period is a mayor determining factor of the emergence of diseases and the crop yield. If soil conditions are favourable, sunflower can utilize the precipitation accumulated before the vegetation period, the highest yield can be obtained in dry crop years (Borbélyné et al., 2007). Today, the most critical factor in the production technology is crop protection. Not only weed control measures but also the prevention of diseases needs wide-range expertise. Today, the success of production lies in prevention and in integrated application of chemical and agrotechnological methods. Besides the use of effective pesticides, other factors such as crop rotation, optimal nutrient supply, sound soil cultivation, optimal sowing time and crop density, cutting weeds and voluntary crops, cultivation of plant residues in the soil are of equal importance for weed-free and healthy sunflower stands. Out of the various infections of sunflower the most dangerous diseases are powdery mildew (Plasmophara halstedii), the more and more frequent Diaporthe helianthi, the well-known sunflower white rot (Sclerotinia sclerotiorum) and grey mould (Botrytis cinerea). The origin of these diseases is the infected soil and plant residues, and disease development is conduced by temperate or high temperature together with humid weather conditions (Goór és Kissné, 1999).

MATERIAL AND METHOD

The experiment was carried out at the Látókép Plant Cultivation Research Site of the Debrecen University. The site is about 15 km from Debrecen, near Route 33 on the loess ridge of the Hajdúság region. According to its physical characteristicsm, the soil belongs to the semi-compacted clay category, its plasticity index according to Arany (KA) is 43.

The water management features of the soil are favourable, as it is typical of chernozem soils. According to the classification of Várallyay, it is ranked in category IV, i.e. it has good water management and water storing capacity.

Crop spacing was accomplished manually after the emergence of young plants. Harvesting was done by Sampo parcel harvester applied with a special adapter. The raw yield and moisture content was measured at harvesting. The crop yields were standardized at 8 % moisture content. In experiment NK Kondi hybrid was investigated.

The design of the experiment was random-block in 4 repetitions. The hybrids were sown at three different times (Table 1) and at four different crop density levels (35000-65000 crop ha^{-1}) with 10000 crop ha^{-1} steps. Fungicide treatment was applied in the 8-leaf stage on plots where fungicide treatment was applied once, and in the 8-leaf and in the flowering stages on plots where fungicide treatment was applied twice. The applied pesticides was Pictor (0.5 l ha^{-1}) in the first treatment, and Trezor (0.4 kg ha^{-1}) was applied in the second treatment. We have reported the fenological, fenometrical, agronomical and pathological features of hybrids in four repetitions.

Table 1.

Sowing time in the examined cropyears (Debrecen-Látókép, 2010)

1. sowing time	***2. sowing time***	***3. sowing time***
march 26.	april 9.	may 3.

In 2010 the weather was rather exterme. The total precipitation in the vegetation period was 491.7 mm, which is 184.6 mm higher than the 30-year average. In the first three months of the vegetation period the precipitation was 296 mm, moreover, there was significant rainfall at the end of the vegetation period (195.5 mm). The precipitation exceeded 80 mm in each month, which is remarkable compared to the values of the previous year. Prior to the vegetation period (from October to March) the precipitation was also higher than the 30-year average (334.3 mm) (table 2-3.).

Table 2.

Precipitation values in the examined cropyears
(Debrecen-Látókép, 2010)

<table>
<tr><th colspan="12">2009-2010 (mm)</th></tr>
<tr><th>Okt.</th><th>Nov.</th><th>Dec.</th><th>Jan.</th><th>Febr.</th><th>March.</th><th>Apr.</th><th>May.</th><th>Jun.</th><th>July.</th><th>Aug.</th><th>Summary</th></tr>
<tr><td>79,3</td><td>78,3</td><td>54,9</td><td>48,8</td><td>58,6</td><td>14,4</td><td>83,9</td><td>111,4</td><td>100,9</td><td>97,2</td><td>98,3</td><td rowspan="3">826,0</td></tr>
<tr><td colspan="6" rowspan="2">334,3</td><td colspan="5">491,7</td></tr>
<tr><td colspan="3">296,2</td><td colspan="2">195,5</td></tr>
</table>

Table 3.

Temperature values in the examined cropyears
(Debrecen-Látókép, (2010)

<table>
<tr><th>Apr.</th><th>May.</th><th>June.</th><th>July.</th><th>Aug.</th><th>Average</th></tr>
<tr><td>11,6</td><td>16,6</td><td>19,7</td><td>22</td><td>19</td><td rowspan="3">17,8</td></tr>
<tr><td colspan="5">17,8</td></tr>
<tr><td colspan="3">14,1</td><td colspan="2">20,5</td></tr>
</table>

RESULTS AND DISSCUSIONS

Stalk strenght parameters (lodging, head blight) have significant influence on sunflower productivity. Through influencing the infection rates, stalk strength is primarily determined by three parametes (weather in the vegetation period, sowing technology, crop protection). Climatic factors are given but their effect can significantly be reduced by sound agrotechnology.

The weather in the examined year significantly influenced the efficiency of fungicide treatments and the optimal crop density levels as well.

The rate of lodging and head blight infection decreased with later sowing times, lower crop density levels and more frequent fungicide treatments, and vice versa. However, there was significant difference between the rate of lodged and infected plants on plots.

In the extremely humid year of 2010 the rates of lodging (29.1 % - 70.1 % ; 32.4 % - 69.3 %) and head blight (7.7 % - 45.8 % ; 14.5 % - 38.8 %) was wery high.

In 2010, the high amount of precipitation favoured the spread of diseases, therefore, the rate of lodging and head blight increased. The average rate of lodging was 57.1 % and it stayed above 42% even after the second fungicide treatment on the contol plots. In the examined year head blight was less severe than lodging, and it was higher both in the control and fungicide treatments (34.4 %, 29.7 %, 19.1 %) (Table 4.).

Table 4.

Stalk strength parameters with different crop protection and cultivation models on the average of sunflower hybrids in 2010
(Debrecen-Látókép, 2010)

	Lodging (%)				Stalk bending (%)			
	Control	**1 treatment**	**2 treatment**	**Average**	**Control**	**1 treatment**	**2 treatment**	**Average**
1. sowing time	70,1	66,7	54,4	**63,7**	45,8	40,1	30,9	**38,9**
2. sowing time	58,6	54,5	43,3	**52,1**	38,4	31,7	18,5	**29,5**
3. sowing time	42,7	41,2	29,1	**37,7**	19,0	17,3	7,7	**14,7**
Average	**57,1**	**54,1**	**42,3**	**51,2**	**34,4**	**29,7**	**19,1**	**27,7**
LSD 5%	**12,8**	**10,6**	**8,2**		**9,2**	**8,7**	**5,9**	
plant ha^{-1}								
35000	43,1	40,9	32,4	**38,8**	26,3	22,4	14,5	**21,1**
45000	53,5	50,0	38,2	**47,2**	31,0	27,1	17,5	**25,2**
55000	62,6	63,1	47,1	**57,6**	41,2	34,0	19,9	**31,7**
65000	69,3	62,4	51,5	**61,1**	38,8	35,1	24,3	**32,7**
Average	**57,1**	**54,1**	**42,3**	**51,2**	**34,4**	**29,7**	**19,1**	**27,7**
LSD 5%	**12,8**	**10,6**	**8,2**		**9,2**	**8,7**	**5,9**	

Our results showed that fungicide treatments had a significant influence in each sowing time and at each crop density level, as it is reflected by the decreased rates of lodging and head blight. In order to mitigate the harmful effects of inappropriate agrotechnology, crop protection with fungicides is also important. In each case in the experiment the difference of lodging and head blight rates between the optimal and most unfavourable sowing times and crop density levels was lower in the fungicide treatments (one and two applications) than on the control plots .

The effect of sowing time, crop density and different fungicide treatments on the infection and yield of sunflower hybrids was also examined.

In each case, the infection by head diseases, Diaporthe and Slerotinia was highest with the 1st sowing time and with the highest crop denstiy level. The infection rates decreased with the 2nd and 3rd sowing times.

The weather of 2010 was most suitable for the spread of fungal diseases. The infection with Diaporthe, Sclerotinia and head diseases ranged between 10 % - 82 %, 12 % - 1.2 %, and 55.5 % - 14.8 %, respectively. The average infection rate with Diaporthe and head diseases ranged between 8 % and 69.2 % on the control plots. Sclerotinia infection was lower (8.7 %). Fungicide treatments decreased the infection rates. In plant stands where fungicide treatments were applied twice, the infection rates with Diaporthe, Sclerotinia and head diseases decreased by 14.9 %, 4.3 % and 18.5 %, respectively. On the average of the treatments, the infection with Diaporthe, Sclerotinia and head diseases was 36.1 %, 6.8 % and 60.9 %, respectively. (Table 5).

Table 5.

Infection rates with different crop protection and cultivation models in 2010 (Debrecen-Látókép, 2010)

Fungicide treatment	Sowing time	Head diseases (%)	Sclerotinia (stalk) (%)	Diaporthe (stalk) (%)
Control	**1. sowing time**	55,5	11,3	82
	2. sowing time	45,3	10,0	78
	3. sowing time	27,5	4,9	48
	Average	**42,8**	**8,7**	**69,2**
	LSD 5%	9,6	3,9	14
1 treatment	**1. sowing time**	44,2	9,2	74
	2. sowing time	41,9	9,0	73
	3. sowing time	26,4	3,6	42
	Average	**37,5**	**7,3**	**62,9**
	LSD 5%	*8,6*	*2,9*	*10*
2 treatment	**1. sowing time**	39,4	6,1	65
	2. sowing time	29,5	6,0	53
	3. sowing time	14,8	1,2	35
	Average	**27,9**	**4,4**	**50,7**
	LSD 5%	*5,9*	*1,8*	*12*
Fungicide treatment	**Plant density**	**Head diseases (%)**	**Sclerotinia (stalk) (%)**	**Diaporthe (stalk) (%)**
Control	**35000 plant ha^{-1}**	33,6	5,6	60
	45000 plant ha^{-1}	39,2	7,0	67
	55000 plant ha^{-1}	48,3	10,3	75
	65000 plant ha^{-1}	49,9	12,0	75
	Average	**42,8**	**8,7**	**69,2**
	LSD 5%	9,6	3,9	14
1 treatment	**35000 plant ha^{-1}**	30,2	4,4	57
	45000 plant ha^{-1}	33,1	6,2	59
	55000 plant ha^{-1}	40,1	9,0	65
	65000 plant ha^{-1}	46,5	9,5	71
	Average	**37,5**	**7,3**	**62,9**
	LSD 5%	*8,6*	*2,9*	*10*
2 treatment	**35000 plant ha^{-1}**	22,1	2,4	43
	45000 plant ha^{-1}	25,5	3,4	46
	55000 plant ha^{-1}	31,8	5,9	56
	65000 plant ha^{-1}	32,3	5,9	58
	Average	**27,9**	**4,4**	**50,7**
	LSD 5%	*5,9*	*1,8*	*12*
Average of treatments		***36,1***	6,8	60,9

Agrotechnological and crop protection technologies, as well as crop year significantly influenced the crop yield and yield safety.

The humid weather was unfavourable for sunflower and favourable for fungal pathogens, therefore, the crop yields were lower then other years. The crop yield was 2742 kg ha^{-1} on the average of the treatments. On the average of the crop densities and fungicide treatments, the highest cropyield was obtained with the third (late) sowing time (3296 kg ha^{-1}). The crop yield was lowest with the first sowing time in all cases. The highest crop yield

(2651 kg ha^{-1}, 3269 kg ha^{-1}, 3968 kg ha^{-1}) was obtained with the third sowing time in each fungicide treatment. The application of fungicides allowed of higher crop density levels. The highest crop yields were obtained with 35000 ha^{-1} crop density level in the control treatment and with 45000 ha^{-1} in the fungicide treatments (both one and two application of fungicides) on the average of the sowing times. In the third (late) sowing time, the optimal crop density was 55000 ha^{-1} due to the second fungicide treatment. Fungicide treatments increased the crop yield both on the average of crop densities and sowing times. The crop yield of the control treatment was 2308 kg ha^{-1}. The yield increase of the first fungicide treatments was 409 kg ha^{-1}, while the second fungicide treatment further increased the yield by 484 kg ha^{-1} (Table 6).

Table 6.

Crop yields with different crop protection and cultivation models on the average of sunflower hybrids in 2010
(Debrecen-Látókép, 2010)

Fungicide treatment	**Plant density**	**1. sowing time**	**2. sowing time**	**3. sowing time**	***Average***
Control	**35000**	2410	2673	2968	***2684***
	45000	2251	2370	2719	***2447***
	55000	2005	2341	2658	***2335***
	65000	1061	1976	2258	***1765***
Average		***1932***	***2340***	***2651***	***2308***
LSD 5%		***419***	***419***	***419***	
1 treatment	**35000**	2602	2758	3310	***2890***
	45000	2686	2990	3674	***3117***
	55000	2317	2752	3242	***2770***
	65000	1191	2236	2851	***2093***
Average		***2199***	***2684***	***3269***	***2717***
LSD 5%		***578***	***578***	***578***	
2 treatment	**35000**	2910	3017	3817	***3248***
	45000	3136	3412	4059	***3536***
	55000	2602	3568	4376	***3515***
	65000	1519	2381	3618	***2506***
Average		***2542***	***3095***	***3968***	***3201***
LSD 5%		***502***	***502***	***502***	
Average of treatments		***2224***	***2706***	***3296***	***2742***

CONCLUSIONS

Based on the average datas we found that crop year, crop density, sowing time and fungicide treatments are in interaction and thus strenghten or weaken the influence of one another reveals that in humid cropyear the maximum yield is obtained with lower crop density levels (35000-45000 ha^{-1}). Applying fungicides allow of the use of higher crop density levels. The yield of the control plots was highest at 35000 ha^{-1}, while in the single- or double treated plots it was highest at 45000-55000 ha^{-1}. In the experiment the difference between the yield of the optimal and minimal crop density levels was higher than in the control treatment (control: 919 kg ha^{-1}; one treatment: 1024 kg ha^{-1}; second treatment: 1030 kg ha^{-1}), on the average of the sowing times in the fungicide treatments. However, the efficiency of the fungicide treatments was different. The modifying effect of fungicide treatments on the yield varied with different sowing times as well. In the extreme cropyear of 2010, the yield increase of the first treatment was 409 kg ha^{-1} and the yield increase of the second treatment was even higher (484 kg ha^{-1}). In 2010, the yield maximum (3296 kg ha^{-1}) was obtained with the 3rd sowing time. Compared to the 3rd sowing time, the yield loss obtained with the 2nd and 1st sowing time was 509 kg ha^{-1}, and 1072 kg ha^{-1}, respectively (Figure 1.).

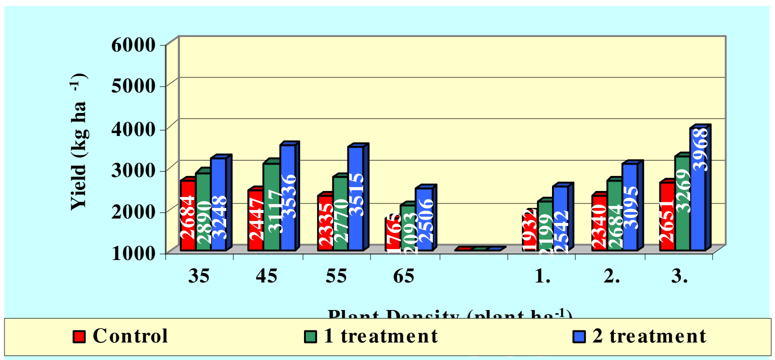

Figure1. Crop yields with different crop protection and cultivation models in 2010 (Debrecen-Látókép, 2010)

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