# INVESTIGATION OF SOWING TECHNOLOGY IN SUNFLOWER (Helianthus annuus L.)

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**Abstract**

*The yield and maximal leaf area index of three sunflower hybrids (P64LC09, Paraiso 1000, ES Tektonic) were studied in two crop protection models with different input levels (extensive=without fungicide treatments, mid-tech= two fungicide treatments) on chernozem soil in two different years (2012 and 2013). A field experiment was set up at the experimental farm of the University of Debrecen, at Látókép on calcareous chernozem soil. The highest LAI values were measured in the beginning of July for all the three hybrids in the case of both cropyears. During our investigation, the yield results of the cropyear 2012 (1828-3602 kg ha$^{-1}$) were significantly below those of the cropyear of 2013 (4292-5902 kg ha$^{-1}$). With respect to the yield amount, the higher plant density (55000 plant ha$^{-1}$) were optimal.*

**Key words:** fungicid treatment, leaf area index, plant density sunflower, yield

## INTRODUCTION

Besides straw cereals and corn, sunflower has the largest cropland in Hungary (Lehoczky és Sárkány, 2007). Aside from smaller changes, today it varies between 520,000 to 560,000 hectares. Sound knowledge of agroecological conditions and adequate application of recent hybrids and its arogtechnical elements are crucial to enhance the efficiency of sunflower production (Pepó, 2011). Nowadays, the extreme weather conditions are increasing the risk of sunflower production. (Mijić et al, 2012). Adequately applied planting technologies (i.e. planting time and plant density) and optimized, reasonable pest control have an outstanding role in decreasing risk factors of sunflower production (Szabó, 2012). The determination of plant density is essential and possible under given production circumstances (Frank 1999). The plant number significantly influences the productivity within the biological optimum (Allam et al., 2003). The effect of plant density was more expressed in a wet crop year, than in a drought one (Harmati, 1990). According to the research of Szabó and Pepó (2004), the optimal plant number was 65000 plant ha$^{-1}$ during dry cropyears, while during average ones, it varied between 45000 and 55000 plant ha$^{-1}$. In the average of different crop years and genotypes the most favourable yield amount on a chernozem soil could be produced in case of a plant number of 40000 ha$^{-1}$ (Pepó, 2001). Yankov et al. (2002) specified the optimal plant number as 55000 plant ha$^{-1}$.

## MATERIAL AND METHOD

A field experiment was set up at the experimental farm of the University of Debrecen, at Látókép on calcareous chernozem soil. The experimental site is located in Eastern-Hungary, 15 km from Debrecen along the main road No. 33 in the loess region of Hajdúság (N 47$^{o}$33’, E 21$^{o}$27’). The experimental soil is of good culture-state, medium-hard loam. The soil has good water management characteristics, it has a good water conducting and water-holding capacity.

Parcells of the research were set up in four repetitions. Previous crops were winter wheat in 2012, maize in 2013. We applied a 95000 ha$^{-1}$ seeding rate on 10 April 2012 and 20 April 2013 then adjusted plant density to 35000 plant ha$^{-1}$ and 55000 plant ha$^{-1}$. The hybrids were treated with the agrotechnique generally applied in the practice. We applied a two-level fungicide treatment (control: non-treated; double-treated). We applied fungicide Pictor two times in the double-treated stand (agents: boscalid and dimoxistrobin) in a dose of 0.5 l ha$^{-1}$. Harvesting took place on 10 September 2012 and 16 September 2013. We used a SunScan Canopy Analysis Systems (SS1) mobile indicator to determine the leaf area. We standardized the yield results to an 8% moister content.

The weather of 2012 was unfavourable for the sunflower’s early vegetative and generative development and its yield production. Due to dry April (20.7 mm rainfall compared to the long term average of 42.4 mm), the initiative development of the sunflower plants lagged behind the average. Besides significant rainfalls in May (71.9 mm) and June (91.7 mm), temperature above the average (June: 20.9 °C, July: 23.3 °C) was also favourable. Average precipitation in July (65.3 mm compared to the long term average of 65.7 mm) could only partially satisfy the water demand of the huge vegetative stands. Sunflower stands could only partially tolerate the unfavourable and warm flowering and fertilization period. Extremely dry (4.1 mm) and hot (22.5 °C) August weather had an adverse effect on achene filling processes. 2013 weather conditions significantly challenged the adaptation capability of sunflower hybrids. April and May weather conditions – apart from some short periods – were ideal for the vegetative development of stocks. Sunflower plants with excellent stages of development and significant vegetative sink were able to tolerate the dry (June: 30.8 mm, July: 15.6 mm, August: 32.2 mm) and hot (June: 19.6 °C, July: 21.2 °C, August: 21.5 °C) period from the middle of June till the end of August. The flowering and fertilization of stocks as well as the development and filling of achenes were sufficient. Smaller, but continuous rainfalls prior to the harvesting period set the stock back from drying and hindered harvest (Table 1.).

*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 | 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 | 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 |

**RESULTS AND DISSCUSIONS**

We determined the leaf area per 1m$^2$ by using a leaf area indicator. The highest LAI values were measured in the beginning of July for all the three hybrids in the case of both cropyears. The maximal LAI values varied between 3.7 m$^{-2}$ m$^{-2}$ and 6.7 m$^{-2}$ m$^{-2}$, depending on the hybrid, the plant number and the fungicide treatment (Table 2).

*Table 2*

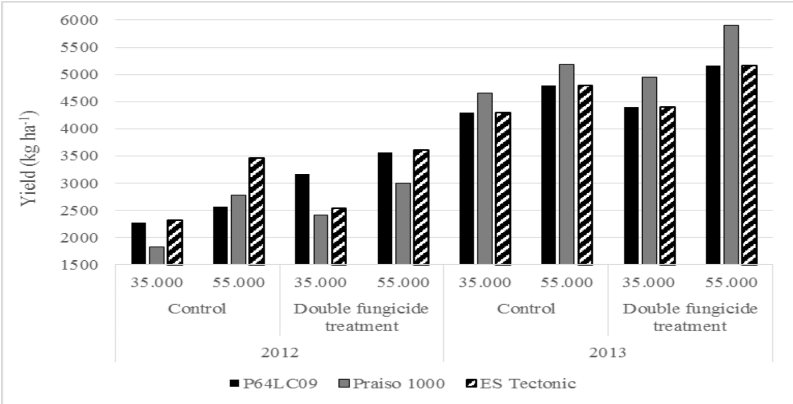
The maximal LAI values in the examined crop years (Debrecen, 2012-2013)

| Crop year | | 2012 | | 2013 | |
|---|---|---|---|---|---|
| Hybrid | Fungicide treatment | Plant density (plant ha$^{-1}$) | | | |
| | | 35000 | 55000 | 35000 | 55000 |
| | | Maximal leaf area index (m$^{-2}$ m$^{-2}$) | | | |
| P64LC09 | Control | 3.9 | 4.2 | 4.9 | 5.7 |
| | Double fungicide treatment | 3.7 | 4.6 | 5.7 | 5.3 |
| | *$LSD_{5\%}$ plant density* | *0.9* | | *1.2* | |
| | *$LSD_{5\%}$ fungicide treatment* | *0.4* | | *0.7* | |
| Paraiso 1000 | Control | 4.9 | 5.4 | 5.3 | 6.1 |
| | Double fungicide treatment | 4.8 | 4.8 | 6.7 | 5.5 |
| | *$LSD_{5\%}$ plant density* | *1.9* | | *1.8* | |
| | *$LSD_{5\%}$ fungicide treatment* | *0.6* | | *0.8* | |
| ES Tektonic | Control | 4.4 | 4.8 | 4.7 | 5.5 |
| | Double fungicide treatment | 4.7 | 5.3 | 5.6 | 4.9 |
| | *$LSD_{5\%}$ plant density* | *0.6* | | *1.1* | |
| | *$LSD_{5\%}$ fungicide treatment* | *0.3* | | *0.5* | |

The maximal LAI values of the crop year 2012 were below those of the crop year of 2013 (except of hybrid ES Tektonic on the double treated plots: 2012: 5.3 m$^{-2}$ m$^{-2}$, 2013: 4.9 m$^{-2}$ m$^{-2}$). The highest LAI values were produced by Paraiso 1000 (except on the double treated plots in 2012). In the cropyear of 2012, the weakest LAI values were measured in the case of P64LC09, while in 2013 in case of ES Tectonic. Due to enhanced plant density, hybrids produced highest LAI values (except of hybrids P64LC09 and ES Tektonic on the double treated plots in 2012; Paraiso 1000 on the double treated plots in 2012 and 2013). These increases were significant in case of P64LC09 in 2012 and Paraiso 1000 in 2013 on the double treated plots. On the double treated plots, in case of ES Tektonic, we have measured significantly higher LAI values in each case, than on the control plots (expect: 55.000 plant $ha^{-1}$ in 2013). We measured significantly higher LAI values in case of P64LC09 and Paraiso 1000 at the lower plant number (35000 plant $ha^{-1}$) in 2013; in case of P64LC09 at the higher plant number (55000 plant $ha^{-1}$) in 2012. In contrast, in 2012, the fungicide treatment significantly decreased the maximal LAI values in case of t Paraiso 1000 at the higher plant number.

Due to the fact that the weather of 2012 had an unfavorable effect on the vegetative and generative development and the yield formation of sunflower, we received average yield results. The yield results of the crop year 2012 (1828-3602 kg $ha^{-1}$) were below those of the crop year of 2013 (4292-5902 kg $ha^{-1}$). The fungicide treatments resulted in enhanced yields in the case of all three hybrids, both plant density and both cropyear set ups compared to the control parcels. These increases were not significant in each instance. In the average of the hybrids and the plant density, the yield enhancing effect of the fungicide treatments was 508 kg $ha^{-1}$ (which is an 20.0% increase) in 2012 and 331 kg $ha^{-1}$ (which is an 6.9% increase) in 2013 compared to the control parcels (Figure 1). In our studies, with the increase of plant number, yield increased in every case, however the increase was not significant in each instance. The yield enhancing effect of the plant density set up were 30.6% (2012) and 18.0% (2013) in the average of the hybrids and the treatments. Due to enhanced plant density, hybrid Paraiso 1000 produced the highest yield increase in the case of the control parcels (52.6%) in 2012. The optimum plant density in respect of the yield were the 55 000 plant $ha^{-1}$ set up in the case of all the three hybrids, both fungicide treatments and both crop year.

We applied Pearson's correlation to determine the value and direction of the relationships between agrotechnical factors (plant density, fungicide treatment), maximal LAI and yield. As shown in Table 3., values of correlations below 0.3 were considered small, values between 0.3 - 0.5 were medium, values between 0.5 - 0.7 were strong and correlations above 0.7 were considered very strong. The plant number increase resulted in yield increase (0.820**, 0.650**) in both crop year. In addition, in the cropyear of 2012, we have found positive medium correlation between the plant number and the maximal LAI too (0.300*).




| | *2012* | | | *2013* | | |
|---|---|---|---|---|---|---|
| | *P64LC09* | *Paraiso 1000* | *ES Tektonic* | *P64LC09* | *Paraiso 1000* | *ES Tektonic* |
| *$LSD_{5\%}$ Plant density* | *427* | *625* | *403* | *1036* | *1380* | *932* |
| *$LSD_{5\%}$ Fungicide treatment* | *164* | *193* | *229* | *589* | *415* | *530* |

Fig. 1 The amount of yield in the examined crop years (Debrecen, 2012-2013)

*Table 3*

Correlation between the analysed parameters (Debrecen, 2012-2013)

| Crop year | Analysed parameters | Max LAI | Yield |
|---|---|---|---|
| 2012 | Plant density | 0,300(*) | 0,820(**) |
| | Fungicide treatment | 0,065 | 0,272 |
| | Maximal LAI | 1 | 0,203 |
| 2013 | Plant density | 0,000 | 0,650(**) |
| | Fungicide treatment | 0,139 | 0,264 |
| | Maximal LAI | 1 | -0,005 |

* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level

**CONCLUSIONS**

During our studies, the maximal LAI values varied between 3.7 and 6.7 $m^{-2}$ $m^{-2}$, depending on the hybrid, the plant number and the fungicide treatment. The highest LAI values were measured in the beginning of July for all the three hybrids in the case of both cropyears.

During our investigation, the yield results of the cropyear 2012 (1828-3602 kg $ha^{-1}$) were significantly below those of the cropyear of 2013 (4292-5902 kg $ha^{-1}$). The fungicide treatments resulted in enhanced yields, but these increases were not significant in each instance. In the average of the hybrids and the plant density, the yield enhancing effect of the fungicide treatments was higher (20.0%) in 2012 than in 2013 (6.9%). In our studies, with the increase of plant number, yield increased in every case, however the increase was not significant in each instance. Similarly to the findings of Yankov et al. (2002) with respect to the yield amount, the higher plant density (55000 plant $ha^{-1}$) were optimal.

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