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THE EFFECT OF NUTRIENT SUPPLY AND PLANT PROTECTION IN YIELD AND OIL CONTENT OF SUNFLOWER *(Helianthus annuus L.)*

Sunflower is the most important oil crop in Hungary which is grown on the biggest area of all the oil crops. The area of producing sunflowers was changing to 400–520 thousand hectares in the past decade in comparison with approximately 100 thousand hectares in the 1970's. During the examination different sunflower hybrids were examined. The doses of chemical fertilizers were the following in 2010: 0-30-90-150 Kg/ha N, 0-50-90-90 Kg/ha P_2O_5 and 0-70-110-110 Kg/ha K_2O. Three different treatments of plant protection were used in the experiment to protect them from fungal infections. A rise in the dosage of nitrogen resulted in increasing infectious diseases. The biggest fungal infection was identified in 150 Kg/ha N, 90 Kg/ha P_2O_5 and 110 Kg/ha K_2O treatment. Average yield was changing between 1.96–2.67 t/ha in 2010. The examination was also directed at analysing the impact of different treatments on the profitability of sunflower production.

Keywords: *sunflower, nutrient supply, yields, plant protection*

Introduction. Sunflower is the most important oil crop in Hungary. When deciding on the amount of nitrogen a special attention must be paid to the fact that overdosing may lead to the plant's increased susceptibility to fungal infections, reduced oil content but, at the same time, the lack of it can result in reaching the yield targeted. Phosphorus increases both piling up dry matter and oil content. Potassium increases resistance to diseases and tolerance to drought (Ivány, 1994).

Nitrogen decreases the oil content of the achene but, on the other hand, it increases yield per hectare. Phosphorus increases both piling up dry matter and oil content. However, potassium increases the plant's resistance to the environment, improves its drought tolerance, resistance to diseases and even decreases the effect of nitrogen overdose (Radics, 2003). The optimal N dose of sunflower hybrids with different genotypes is also different That is why using hybrid specific N fertilising techniques is very important in the case of new sunflower genotypes (Pepó – Zsombik, 2003).

Futó (2008) concluded that a significantly greater infection is generated on higher number of stems. The steamier microclimate formed in the case of more stems provides favourable conditions for generating Diaporthe leaf and stem infections as well as Scleroitinia stem and disc florets infections. Sunflower is susceptible to some fungal infections but today there are such existing hybrids that show a significant resistance or tolerance on arable land. Vear and Tourvieille (1984) note it with a regret that the oil content of several resistant genotypes is low so resistance is inversely related to yield or earliness.

Materials and methods. Despite the abundant rainfall in 2010 record yields were not produced and only average yields or even below the average were produced on many areas. The abundance of rain even continued at the end of the production season, which resulted in serious infections in sunflower on many production areas. *(Table 1).*

1. Precipitation data between January 2010 and September 2010, Kompolt

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Total
precipitation (mm)	53	60.3	18.8	70.7	158	91	161	76	98	786.8
30 year-average	30.6	31.4	28.9	41.9	62.9	71.4	74.4	59.6	42.8	443.9

The experiment was carried out on non-carbonate chernozem brown forest soil where topsoil had acid reaction (pH_{KCl} 4.59) *Table 2.* The cultivated topsoil is of clay and adobe with slight acid reaction (the value of hydrolyte acidity is slight and replacement acidity can be ignored). Its humus content is a bit higher than average and its total salt content is low. The entire soil section is free from carbonates. Acidity gradually and slightly decreases in parallel with depth.

Three nutrient levels were created on the experimental area by adding a control plot receiving no chemical fertilizer treatments. On the basis of these points the nutrient levels were the following:

-nutrient treatment ’A’: 0 kg/ha N, 0 kg/ha P_2O_5 and 0 kg K_2O active substance

-nutrient treatment ’B’: 30 kg/ha N, 50 kg/ha P_2O_5 and 70 kg K_2O active substance

-nutrient treatment ’C’: 90 kg/ha N, 90 kg/ha P_2O_5 and 110 kg K_2O active substance

-nutrient treatment ’D’: 150 kg/ha N, 90 kg/ha P_2O_5 and 110 kg K_2O active substance

The possibilities of technological improvement of three fungicide combinations were examined in the experiment by adding a control plot without being treated with a fungicide treatment. The basic fungicide in the examination was boscalide 200 g/l + dimoxystrobine 200 g/l (with 0.3–0.5 l/ha dosage) mixed with two technological development combination partners with code numbers before their licensing phase, which acted as a new active agent in the experiment. The first treatment were received by the sunflowers in the state of having 8–10 leaves (BBCH 18–19.) while the second ones were applied when sunflowers developed a before of flowering (BBCH 57–59.). Treatments were as follows:

2: The main characteristics of soil on the experimental area

Level	depth (cm)	KA	pH (H_2O)	pH (KCl)	$CaCO_3$ %	y_1	y_2	Humus %
A_{sz}	0-30	42	6.27	4.59	0	8.71	0.40	2.69
A_2	30-45	58	6.13	4.42	0	8.30	0.61	1.90
B_1	45-60	67	6.22	4.52	0.12	6.28	0.81	1.47
B_2	60-80	68	6.41	4.64	0	4.25	0.30	1.14
C_1	80-135	71	6.74	4.93	0	3.85	0.30	0.79

- Control: (plots without fungicide technology)

- ’A’ Plant protection: 100 g/ha boscalide + 100 g/ha dimoxystrobin (BBCH 18–19.) + 100 g/ha boscalide + 100 g/ha dimoxystrobin (BBCH 57–59.)

-’B’ Plant protection: Combination partner I. (BBCH 18–19.) + 100 g/ha boscalide + 100 g/ha dimoxystrobin (BBCH 57–59.)

- ’C’ Plant protection: Combination partner I. (BBCH 18–19.) + Combination partner II. (BBCH 57–59.)

The sunflower hybrid taking part in the experiment was NK Tristan and the number of stems was 55 thousand germs/ha. The experiment was conducted on small randomised plots repeated four times. Plant pathological infection, average yield and oil content were analysed in the experiment. The results were examined by means of variance analysis and correlation examination by using SPSS 9.0 for Windows programme.

Results and discussion. Changes in the pathological infection of sunflower. Sunflower has an endless number of pathogenic agents, which can cause serious yield losses in average yields either by reducing photosynthetically active leaf surface or damaging the stem or dick. During the experiment we could track down the values of the two most frequent pathogenic agents of sunflower, i.e. the leaf infection value (%) of Diaporthe helianthi and stem-and disc infection value (%) of Sclerotinia sclerotiorum. In the case of Diaporthe helianthi infection there was a significant difference between the infection results of the treated and not treated (control) plots from which it can be seen that the infection of the plots not treated by plant protection treatments (36.5-41.25 %) exceeded the infection of plots treated by plant protection treatments (9.5–10.5 %) many times *(Figure 1)*.

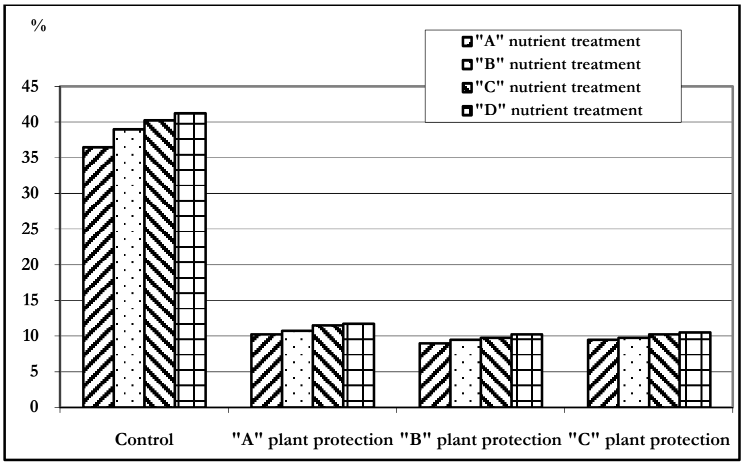

Figure 1. Changes in the infection with Diaporthe helianthi 2010.

Intensive nutrient supply, especially increased N dose, results in loosening plant tissues, which is favourable for pathogenic agents. This fact was also justified by means of the variance analysis which proved that plant protection and nutrient supply can cause a significant difference in the values of infection levels *(Table 3)*.

3. The variance table of Diaporthe helianthi infection values

Factor	SO	FG	MO	F	Significance
Treatment	19565.016	1	19565.016	16845.215	***
nutrient supply	40.672	3	13.557	11.673	***
plant protection	10124.297	3	3374.766	2905.628	***
nutrient * Plant protection	21.266	9	2.363	2.034	n. a.
Error	55.750	48	1.161		
Total	29807.000	64			

***: significant on 0.01 reliability level, R^2 = 0.995 (adjusted R^2= 0.993)

In examining Sclerotinia sclerotiorum the disc infection values of the fungus were monitored. The extent of disc infection has an extraordinary impact on average yields as it is able to destroy a decisive part of the yield.

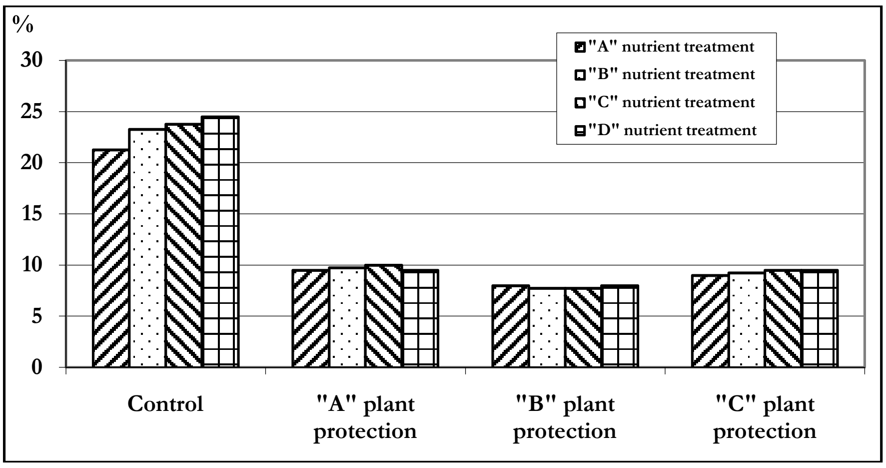

Figure 2. Changes in Sclerotinia sclerotiorum disc infection 2010

Experiments showed that the infection of 20-27 % of the control plot decreased below 7-12 % under the conditions of being treated, which is very favourable. The most favourable values were gained in the fungicide combination of ‘B’ plant protection treatment (Figure 3). Between the plant protection treatments (‘A’-‘B’-‘C’ treatments) no significant differences could be experienced and infection levels were ranging from 7.75 to 9.5 %.

The biggest difference was experienced between the untreated control plots and the plots treated by plant protection treatments, which exceeded significant difference. The statistical analysis of the above-mentioned infection values also supported the fact that only plant protection could influence the level of disc sclerotiny significantly and in a statistically justifiable way. The combined impacts of nutrient supply as well as nutrient supply and *plant protection did not reach a significant level.

4. The variance table of Sclerotinia sclerotorum infection values

Factor	SO	FG	MO	F	Significance
Treatament	1369.000	1	1369.000	1663.595	***
nutrient supply	1.625	3	.542	.658	n.sz.
plant protection	902.625	3	300.875	365.620	***
nutrient * plant protection	1.250	9	.139	.169	n.sz.
Error	39.500	48	.823		
Total	2314.000	64			

***: reliable on 0.01 reliability level, R^2 = 0. 958 (adjusted R^2= 0, 945)

The impact of treatments on the average yields of sunflower. When analysing the results we can see that chemical fertilizer treatment and fungicide treatment had a significant impact on average yields. It is also obvious that chemical treatments alone could increase the average yield of sunflower by almost 290 kg/ha, which could further be improved to 450–580 kg/ha if supplemented by fungicide treatments. In this way the yield of the plots treated against pesticides reached the average yield of 2.48–2.67 t/ha.

Of the yields it is striking that plots treated by ‘C’ nutrient treatment were able to produce an extraordinary average yield at all plant protection levels, their average yield was fluctuating between 2.32–2.54 t/ha depending on the treatment. Accordingly, we can state that ‘C’ and ‘D’ nutrient levels were approaching the optimal nutrient supply of sunflower; yields reached a high level.

During the statistical analysis we could conclude that both nutrient supply and plant protection treatments resulted in significant differences between yields. The SzD5% value of plant protection treatments is 0.26, on the basis of which the average yield of ‘C’ plant protection technology statistically exceeded the yield of the control plots that had not been given plant protection treatments.

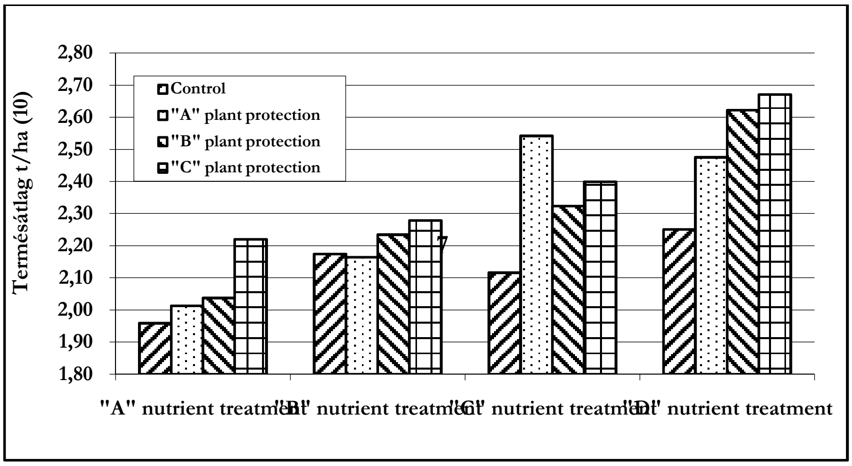

Figure 3: The impact of nutrient supply on the average yield of sunflower, Kompolt, 2010.

When analysing nutrient supply even stronger impacts were noted where the yield of the control plot without chemical fertilization was significantly increased by ‘C’ and ‘D’ nutrient treatments.

5. Average yields in different nutrient supplies and plant protection treatments and SzD5% values

Treatment	Average t/ha	SzD5 %	Treatment	Average t/ha	SzD5 %
Control	2.125	0.26	‘A’ nutrient supply	2.057	0.26
‘A’ plant protection	2.299		‘B’ nutrient supply	2.213	
‘B’ plant protection	2.304		‘C’ nutrient supply	2.345***	
‘C’ plant protection	2.392***		‘D’ nutrient supply	2.505***	

*** on 5 % reliability level significant difference

Oil level measured in sunflower treatments. In total, it reached 41.90-48.10 % during the treatments. There are no significant differences in oil content although the fact that the oil content of all the treated plots (except ‘B’ plant protection technology) exceeded the oil contents measured under control circumstances could be assessed as a trend. It can be seen from the data that in 2010 nutrient supply did not have a significant impact on the oil content of sunflower while the examined fungicides were more powerful in influencing the oil content of sunflower and the difference exceeded the significant difference.

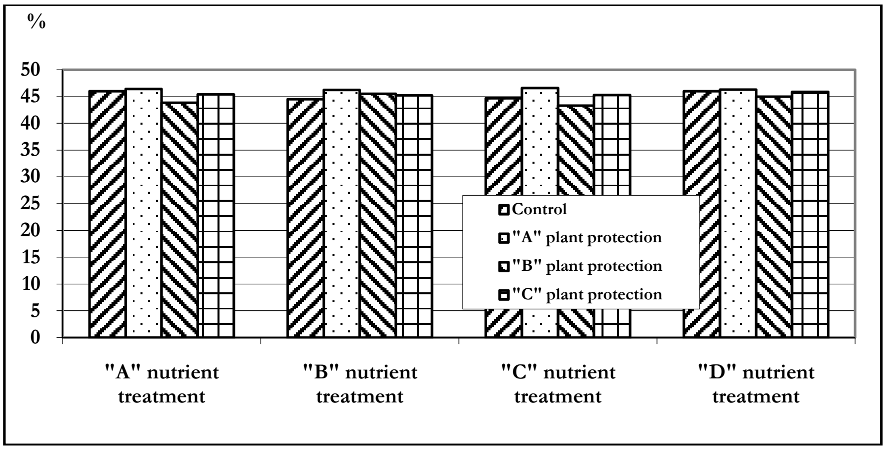

Figure 4. Oil content % 2010, Kompolt

During the statistical analysis we pointed out that the impact of plant protection treatments had shown a significant difference in two of the cases.

6. Oil content (%) of different plant protection treatments and their SzD5% values

Treatment	Average t/ha	SzD5%
Control	45.269	0.67
‘A’ plant protection	46.350***	
‘B’ plant protection	44.381***	
‘C’ plant protection	45.419	

*** on 5% reliability level significant difference

Conclusions. Intensive nutrient supply, especially increasing N dose are favourable for infections. In our experiment we could prove that both plant protection and nutrient supply could result in significant differences in the infection values of Diaporthe helianthi and Sclerotinia sclerotiorum.

We also concluded from the experiment that plant protection and nutrient supply significantly influenced yields that could be reached. Optimal nutrient supply and professional plant protection also led to significant yield increases in the year of the examination.

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Футо З. Влияние питательных веществ и защиты растений на урожайность и содержание масла в подсолнечнике *(Helianthus Annuus L.)* // Корми і кормовиробництво. – 2014. – Вип. 78. – С. 143–150.

Подсолнечник является наиболее важной масличной культурой в Венгрии, которая выращивается на самой большой площади среди всех масличных культур. Площадь выращивания подсолнечника выросла до 400–520 тыс. га в последнее десятилетие по сравнению с примерно 100 тыс. га в 1970-х годах. В ходе исследования были изучены различные гибриды подсолнечника. Дозы минеральных удобрений были следующие в 2010 году: 0-30-90-150 кг/га N, 0-50-90-90 кг/га P_2O_5 и 0-70-110-110 кг/га K_2O. Три различных системы защиты растений были использованы в эксперименте, чтобы защитить их от грибковых инфекций. Повышение дозы азота привело к увеличению инфекционных заболеваний. Самая большая грибковая инфекция была выявлена при внесении 150 кг/га N, 90 кг/га P_2O_5 и 110 кг/га K_2O. Средняя урожайность была 1.96–2.67 т/га в 2010 году. Исследование было также направлено на анализ влияния различных методов обработки на рентабельность выращивания подсолнечника. Библиогр. 5 названий.

Ключевые слова: подсолнечник, обеспечение питательных веществ, урожайность, защита растений.

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Futó Z. The effect of nutrient supply and plant protection in yield and oil content of sunflower (Helianthus annuus L.) // Feeds and Feed Production. – 2014. – Issue 78. – P. 143–150.

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