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EFFECT OF CRITICAL AGROTECHNICAL FACTORS IN SUNFLOWER PRODUCTION

Szabó András*, Dóka Fülöp Lajos*, Szabó Éva*

*Institute of Crop Sciences, Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen, ,e-mail: szabo@agr.unideb.hu

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 (crop density), nutrient supply and optimized, rational crop protection are highly important especially in highly sensitive sunflower cultures. The highest yield amount was measured in the treatment models treated two-times with fungicide and fertilized with NPK substances in case of all three hybrids.

Key words: sunflower, plant density, nutrient supply, fungicide treatment, yield

INTRODUCTION

Oil seed crops are present all around the world; they can be produced in almost every climatic zone. 57 different oil plant species are registered in Europe. Four of the oil plants (rapeseed, sunflower, oil palm and soybean) have become of economical significance in the past 50 years (Barbara, 2004). Sunflower is produced on 600 thousand hectares, however its importance have become significant more than twenty years ago.

According to Ragasits (1994) sunflower was categorized as one with low demands and it was produced mainly on weak soil types. At first only some rows were sown on the edge of maize or potato fields. Later – according to the government regulations – fields that were unsuitable for any other field crop were utilized with it. After hybrids have become common and production was well equipped with machines this previous approach totally disappeared and sunflower has become one of the most important industrial crops lately.

The effect of crop year among agroecological factors is the opposite of other plant's demands. Apart from extreme occurrences, favourable yield and oil content can be expected in rather dry and warm crop years, which is corresponding to the excellent adapting ability of sunflower (Pepó, 2010).

Due to the fact that production circumstances seem to be favourable sunflower production may be promising for many producers, however several expensive technological and unexpected plant protection aspects need to be considered during the vegetation. A crop year, in which every production factor is favourable, is rare, so sunflower production is always a risk (Nagy, 2002).

Dry springs have become more frequent; however, the amount of precipitation during the vegetation period shows significant deviances in different crop years. Drought crop years have become two-times as frequent in contrast to the previous decades, but it is rather favourable for sunflower than unfavourable, because pathogens cause higher infection in wet crop years.

Biological factors in production technology cover the variety, in particular the hybrid. The very wide palette of currently available hybrids in Hungary is world-class both regarding yield amount and yield quality. The number of hybrids and varieties registered in the national plant variety catalogue is 87, which offer a wide range of choices. However, yield safety of hybrids is not that uniform, which primarily refers to the resistance against abiotic (weather conditions and soil properties), biotic (pathogen organisms), just as against agrotechnical stress factors. Critical elements among agrotechnical factors shall be emphasized, that shall be ensured to an optimal input extent, while in case of other factors a minimal supply is essential which enables the effective, positive contribution of the critical elements. Critical production technology elements of sunflower production are the right choice of the hybrid, just as nutrient supply, sowing technology and plant protection. Genotype (hybrid) affects the effectiveness of sunflower production both directly and in an indirect way. Genetically determined productivity and oil content are determinant in a direct way, while resistance of hybrids against plant diseases, just as their adaptability (to both ecological and agrotechnical circumstances) and stem stability are determining from the aspect of yield (Pepó, 2007).

Regarding nutrient supply harmonic NPK-supply needs to be implemented since it is of high importance in sunflower production. Nitrogen demand shall be supplied properly from the aspect of both yield amount and yield quality development, since the lack of nitrogen results in yield decrement, while overdosing it can lead to decreasing oil content. According to the previous studies nitrogen decreases the oil content, but it increases yield per hectare. Phosphorous promotes the accumulation of dry matter substance and increases oil content. Potassium enhances drought tolerance and pathogen resistance (Frank, 1999). According to Geleta et al. (1997) the realized sunflower grain yield amount depends on nitrogen- and phosphorous supply, temperature and water-supply, just as its distribution in the vegetation and the genetic potential of the applied hybrid.

Most of the about 70 pathogens that occur on sunflower are fungi. Fungal diseases reduce produced sunflower yields drastically each year, because the assimilation area of the infected plants decreases and thus less oil will be incorporated (Rikk, 2007).

MATERIAL AND METHODS

The small-plot field experiment was carried out in the year 2015 at the Látókép Research Site of the University of Debrecen CAS. The experimental soil is a lowland calcareous chernozem type with deep humus layer based on loess. This soil is in a good agricultural condition, medium set (plasticity value acc. to Arany: 43), regarding its soil physical conditions it can be classified as a loam soil type. Three hybrids were involved into the experiment: NK Neoma, NK Ferti and NK Alego. The effect of unilateral N, just as PK supply and harmonic NPK nutrient supply (Table 1.) were investigated by different plant densities of 35000, 55000 and 75000 plants per hectare (Table 1.). The investigated acrotechnical factors have been evaluated in case of treatments without any fungicide plant protection (control treatment), just as of treatments with two-times fungicide application (in the plant development state of 8-10 leaves and flowering).

Table 1

Fertilizer treatments applied in the experiment (Debrecen-Látókép, 2015)

1. treatment (N)	60 kg ha^{-1} N + 0 kg ha^{-1} P_2O_5+0 kg ha^{-1} K_2O
2. treatment (PK)	60 kg ha^{-1} N + 45 kg ha^{-1} P2O_5+0 kg ha^{-1} K_2O
3. treatment (NPK)	60 kg ha^{-1} N + 45 kg ha^{-1} P_2O_5+75 kg ha^{-1} K_2O

Evaluation of the weather conditions of 2015

An amount of precipitation of 39.5 mm fell in January 2015, while in February it was 18.6 mm. Due to the low amount of precipitation during the autumn and winter months soil water stock was filled only to a low extent. The amount of precipitation was 10.2 mm in March, which did not even reach the long-term average value (33 mm). The monthly average temperature was 6.2 °C that was similar to the long-term average. The amount of precipitation was 21.9 mm in April and 52.9 mm in May. This amount in April was lower than the long-term average (42.4 mm), while in May it was slightly over the average value (58.8 mm). Lack of precipitation was not observed in these months, the average temperature values were similar to the long-term average values. The monthly average temperature was 10.1 °C in April and 15.8 °C in May respectively. 60.5 mm precipitation fell in June and the average temperature was 19.9 °C. This amount of precipitation was 19 mm lower than the 30-years average value. The significant amount of precipitation in August (84.0 mm) was favourable for the development of fungal diseases; however pathogens could not cause any serious damage in the population then.

Evaluation of the weather conditions of 2016

Significantly higher amount of precipitation fell in October 2015 (86.6 mm) than the several years' average value (30.8 mm). November can be considered as rather average. But in December far lower amount of precipitation fell than the average value. Precipitation amount in January (58.6 mm) was also higher than the 30 years' average (37 mm) and February (78.8 mm) showed similar tendency as well (long-term average value: 30.2 mm). Overall, autumn and winter months were significantly wetter and warmer than the average. The amount of precipitation during the spring was also higher than the average. Thus later sunflower had favourable conditions for vegetative and generative development. All summer months were characterized by significantly higher amount of precipitation than the average value. Consequently weather circumstances were favourable for both sunflower development and the occurrence of fungal diseases of the population. Average temperature vales proved to be higher than the several years' average values as well. (Figure 1).

RESULTS AND DISCUSSIONS

Essential elements of successful sunflower production are balanced nutrient supply, adequate sowing technology and reasonable plant protection management. In our experiment we tried to reveal the extent how much these factors influence yield amount of sunflower.

According to the results of the crop year 2015 it can be stated that the yield amount result (5242 kg ha^{-1}) of the experimental model treated with fungicides with balanced nutrient supply (NPK) was higher than those of other studied models (Table 2.).

Changes in plant densities proved to be significant yield affecting factors. In the control treatment the highest yield amount was produced in case of the application of optimal plant density (55000 plants ha^{-1}) in the NPK nutrient supply model. In the too dense, 75000 plants ha^{-1} population microclimatic conditions were favourable for the spread of fungal pathogens, thus lower yield amounts were produced in case of this high plant density, even in the balanced NPK nutrient supply treatment model (2332 kg ha^{-1}). As an effect of fungicide application the density of sunflower populations could be effectively increased. Due to the application of fungicide treatments yield amounts of hybrids were higher than 4500 kg ha^{-1} in all treatment combinations in the crop year 2015. Regarding the average of the studied hybrids the highest yield was measured in the populations with a density of 75000 plants ha^{-1} with balanced NPK supply in treatments with two-times fungicide application.

Table 2

Crop yields with different crop protection and cultivation models on the average of sunflower hybrids in 2015 (Debrecen-Látókép, 2015)

		35000 plant ha^{-1}	55000 plant ha^{-1}	75000 plant ha^{-1}	Average
kontroll (kg ha^{-1})	N	1777	3676	1981	2478
	PK	1944	3685	2005	2545
	NPK	2007	3896	2332	2745
	Average	1909	3752	2106	2589
2 times treated (kg ha^{-1})		**35000 plant ha^{-1}**	**55000 plant ha^{-1}**	**75000 plant ha^{-1}**	**Average**
	N	4585	4653	5490	4909
	PK	4645	4845	5857	5115
	NPK	4878	4905	5943	**5242**
	Average	4702	4801	5763	5089

In the crop year of 2016 yield amounts of the studied populations were lower than those measured in the crop year 2015 due to the unfavourable, wetter weather conditions (Table 3.)

Table 3

Crop yields with different crop protection and cultivation models on the average of sunflower hybrids in 2016 (Debrecen-Látókép, 2016)

		35000 plant ha^{-1}	55000 plant ha^{-1}	75000 plant ha^{-1}	Average
kontroll (kg ha^{-1})	N	2909	4049	3750	3570
	PK	2704	3911	3492	3369
	NPK	3704	4240	3988	3977
	Average	3106	4067	3743	3638
2 times treated (kg ha^{-1})		**35000 plant ha^{-1}**	**55000 plant ha^{-1}**	**75000 plant ha^{-1}**	**Average**
	N	3946	4391	4597	4311
	PK	3723	3915	4661	4100
	NPK	4420	4839	4932	4730
	Average	4030	4382	4730	4380

In treatment combinations not treated with fungicides in case of both unilateral N, PK-supply and balanced NPK-supply yield amounts were lower than 4250 kg ha^{-1}. Yield amounts were lower than 4000 kg ha^{-1} in the control treatments with plant densities of 35000 plants ha^{-1} in case of all studied nutrient supply levels. The results of our study confirmed that adequate nutrient supply and fungicide treatments are determining factors in sunflower productivity. Regarding the nutrient supply levels of both unilateral N and PK supply, and balanced NPK supply as well, it can be stated that the results of the populations treated two-times with fungicides show significant yield increment in case of all three studied plant densities. Regarding the average of the studied sunflower hybrids the highest yield was measured in the treatment combination with balanced NPK-supply, treated two-times with fungicides. In case of the application of balanced NPK nutrient supply level and two-times fungicide application yield increment of the plant density 55000 plants ha^{-1} was over 500 kg ha^{-1}, while in case of the density of 75000 plants ha^{-1} it was almost 1000 kg ha^{-1} higher in contrast to the control treatment

Regarding the average of the studied hybrids and nutrient supply levels it can be stated that by the highest studied plant density

(75000 plants ha^{-1}) fungicide treatments increased yield amount by 987 kg ha^{-1}. Such yield increment could not be measured in case of the populations with the plant density of either 35000 plants ha^{-1}, or 55000 plants ha^{-1}. Populations treated with fungicides and balanced NPK nutrient supply showed maximum yield (4932 kg ha^{-1}) amount in case of the plant density of 75000 plants ha^{-1}. However for such dense populations even the application of unilateral N and PK supply resulted in yield amounts above 4500 kg ha^{-1}.

CONCLUSIONS

Critical factors of sunflower production are sowing technology, harmonic nutrient supply and the adequate fungicide plant protection measurements. The results of the present experiment confirm the yield determining effect of nutrient supply and fungicide treatments in case of all three studied hybrids. The highest yield amount was measured in the treatment models treated two-times with fungicide and fertilized with NPK substances in case of all three hybrids. The highest yield amount was harvested in all treatments in case of the hybrid NK Ferti.

Regarding the average of the hybrids the highest yield (2015: 3,896 kg ha^{-1}; 2016:4240 kg ha^{-1}) without any fungicide treatment was measured in the treatment with harmonic nutrient supply with plant density of 55,000 plants ha^{-1}. When applying the plant density of 35,000 plants ha^{-1} and 75,000 plants ha^{-1} yield amounts were in 2015 below 2,500 kg ha^{-1} in case of all nutrient supply levels. Treatments with two-times fungicide treatment resulted maximal yield amounts in case of all three nutrient supply levels by the highest plant density, i.e. 75,000 plants ha^{-1}.

REFERENCES

1. Barbara, E. Franz, E., 2004, Pflanzenöl als Kraftstoff. Autos und Verbrennungsmotoren mit Bioenergie antreiben. ökobuch Verlag, Staufen bei Freiburg. 103 p.
2. Frank J., 1999, Napraforgó biológiája, termesztése. Mezőgazda Kiadó, Budapest
3. Geleta, S.- Baltensperger, D. D.- Binford, G. G.- Miller, J. F. (1997): Sunflower response to nitrogen and phosphorus inwheat-fallow cropping-systems. Journal of Production Agriculture. 10. 3. 466-472.
4. Iváby K. , Kismányoky T. , Ragasits I., 1994, Növénytermesztés. Mezőgazda Kiadó, Budapest. 373 p.
5. Nagy Z., 2002, A Napraforgó-termesztés dilemmái. Mezőhír 13. 3. 12.
6. Pepó P., 2007, A hibridspecifikus napraforgó-termesztés néhány agrotechnikai eleme. Agrofórum 18.11.10-14
7. Pepó P., 2010, A napraforgó termésbiztonságának agronómiai feltételei Agrofórum 21.3. 12-15.
8. Rikk I., 2007, Szálljon be Ön is az olajüzletbe! Agrofórum 18.11.16