

## FERTILIZATION OF SUNFLOWER, ACCORDING TO DATA FROM FOUR-CROP ROTATION LONG-TERM EXPERIMENT

*Jovan CRNOBARAC<sup>1\*</sup>, Igor BALALIĆ<sup>2</sup>, Nenad DUŠANIĆ<sup>2</sup>, Goran JAĆIMOVIĆ<sup>1</sup>,  
Dragana LATKOVIĆ<sup>1</sup>*

<sup>1</sup> *University Of Novi Sad, Faculty Of Agriculture, Sq. D. Obradovica, 21000 Novi Sad, Serbia*

<sup>2</sup> *Institute Of Field And Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia,*

\**jovanc@polj.uns.ac.rs*

### ABSTRACT

The sunflower is the most important oil crop in Serbia. It can be grown on poor soils more successfully than other crops, and usually on rich soils the effect of fertilizers is low. Optimal fertilising, beside supplying plant with required nutrients in the amounts and at the times they are most needed, also should simultaneously sustain nutrient level in soil and maximizes the economic benefits of nutrients while minimizing any environmental impact. For such multi purpose approach the most appropriate are data from long term experiment (LTE). The research was carried out on LTE, established in 1966 on chernozem soil type at Institute of field and vegetable crops in Novi Sad. It is four crop rotation (sugar beet, corn, sunflower and wheat) trial with 20 variants of different rates and quantities of single, double and triple NPK fertilizers (F). During near 50 years each plot was fertilized with same fertilizer and now there are plots with very different fertility. This paper presents the results of three year (Y) (2013-2015) for three domestic sunflower hybrids (H) (Ns-oskar, Ns-fantazija and NS-orfej). All factors (Y, F, H) and their interaction had highly significant influence on seed yield. Partitioning in total of sum squares off all treatments for yield were the highest for year (59%), while for F and H were 23% and 1%, respectively. Partitioning for oil content were the highest for hybrids (40%), for F is 29% and the lowest only 13% for Y. In three-year average the lowest seed yield and the highest oil content were in 2014, while the highest yield and the lowest oil content had hybrid Ns-orfej. Optimal seed yield reach with triple nutrients, with amounts of 50-100 kg ha<sup>-1</sup> of each. Oil content regularly decreases for about 1% with each increasing of nitrogen for 50 kg ha<sup>-1</sup>, considering triple nutrients combinations.

**Key words:** Sunflower, Fertilization, LTE, Seed yield, Oil content

### INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop which ranks fourth next only to soybean, groundnut and rapeseed as a source of edible oil of premier quality in the world (Malligawad et al, 2004) and for Serbia is the most important oil crop in. Sunflower could be successfully grown in a great range of climatic conditions and soils. It could also play an important role in the cultivation of the new reclaimed lands, which are suffering drought, high temperatures and salinity effects (Keshta et al, 2008) In Serbia it can be grown on poor soils more successfully than other crops since it uses less available water and nutrients from deep soil layers. It also responds positively to residual nitrogen from previous crop (Crnobarac et al, 2002). That is the reason why the effect of fertilization on good soils for sunflower is low. Among the different nutrients required, N and P are the primary limiting nutrients under most environments where it is being cultivated. Further, it is also reported that

sunflower has high N and moderate P requirements (Malligawad et al, 2004). Nitrogen deficiency reduces the leaf production, individual leaf area and total leaf area resulting in a reduced area for light interception for photosynthesis. Also, up to 75% of leaf nitrogen is found in the chloroplasts so in conditions of the nitrogen limitation, are often lower rates of photosynthesis and consequently sunflower yield decreasing (Cechin et al, 2004). At the same time it is necessary to bear in mind that it is more sensitive to diseases, which especially develop with increasing N in nutrition. N also decreases oil content, but like in other crops it is the most important for seed yield. Beyond monitoring of input costs and reduction of pollution risks due to N excess it is also necessary to increase net income avoiding yield losses due to N excess and N deficiency, as well as improving the oil content of the seeds. (Reau et al, 2004). Phosphorus and potassium are also very important for disease and drought resistance, oil content and positive interaction which increase nitrogen effect.

## METHODS

The data of sunflower seed yield and oil content are from long term experiment with a four crop rotation (sugar beet, corn, sunflower and wheat) which was established on chernozem soil type in 1966. There are 20 treatments with different rates and quantities of single, double and triple NPK fertilizers (F). The amounts of NPK are in kg per hectare of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O (Fig. 2 and 3). During near 50 years each plot was fertilized with same fertilizer and now there are plots with very different nutrient content. This paper presents the results of this practice on three new NS sunflower hybrids (H) (Ns-oskar, Ns-fantazija and NS-orfej) in the period 2013-2015 (Y). Data were analyzed by ANOVA using Mstatc method 19 (two factorial randomized complete block design combined over years) and graphically presented in Origin. For data interpretation, beside F-test and LSD- test, we used partitioning of each experimental factor in the total of sum squares off all treatments.

## RESULTS

According to F-test of ANOVA all factors (Y, F, H) and their interaction had highly significant influence on seed yield and oil content. Partitioning in total of sum squares off all treatments for seed yield were the highest for year (59%), while for F and H were 23% and 1%, respectively. Partitioning for oil content were the highest for hybrids (40%), for F is 29% and the lowest only 13% was for Y (Table 1). It means that the highest influence on seed yield had year and hybrids on oil content, while influence of fertilizers for both traits were almost similar. The highest interaction for seed yield was Y\*F (8%) and for oil content Y\*H (10%).

On the three year average significantly the highest seed yield had hybrid NS-orfej (3.80 t<sup>ha</sup><sup>-1</sup>), mainly due to relatively high yield in 2014. Between other two hybrids there were no significant differences. (Fig.1). On average for all hybrids in 2014 was extremely low seed yield caused by diseases. Differences in oil content between all hybrids were significant and the highest had NS-oskar and the lower NS-orfej. This relation was similar in almost all year.

On average for three years and hybrids, nitrogen alone or in combination with P and K significantly increased seed yield, but it simultaneously decreased oil content related to control, alone P and K and double PK treatments. (Colons in Fig. 2 and 3). P and K alone or in combination had significantly higher seed yield and lower oil content only in regard to control. The effect of NK treatment was slightly better than NP for both traits.

Triple NPK combination with the lowest amount of 50 kg ha<sup>-1</sup> of each nutrient had significantly higher oil content than treatments with nitrogen alone or in combination with P

and K, but there is no significant differences between them in seed yield. It is proof that balanced triple combination of NPK is better then any single or double combinations.

Table 1. Probability of F –test and partitioning of experimental factor in the total treatments of sum off squares

Source of variation	Seed yield		Oil content	
	F probabability.	Partitioning	F probabobability	Partitioning
Year	<,001	59%	<,001	13%
Fertilisers	<,001	23%	<,001	29%
Year * Fertilisers	<,001	8%	<,001	4%
Hybrids	<,001	1%	<,001	40%
Year * Hybrids	<,001	2%	<,001	10%
Fertilisers * Hybrids	<,001	2%	<,001	2%
Year * Fertilisers * Hybrids	<,001	4%	<,001	3%

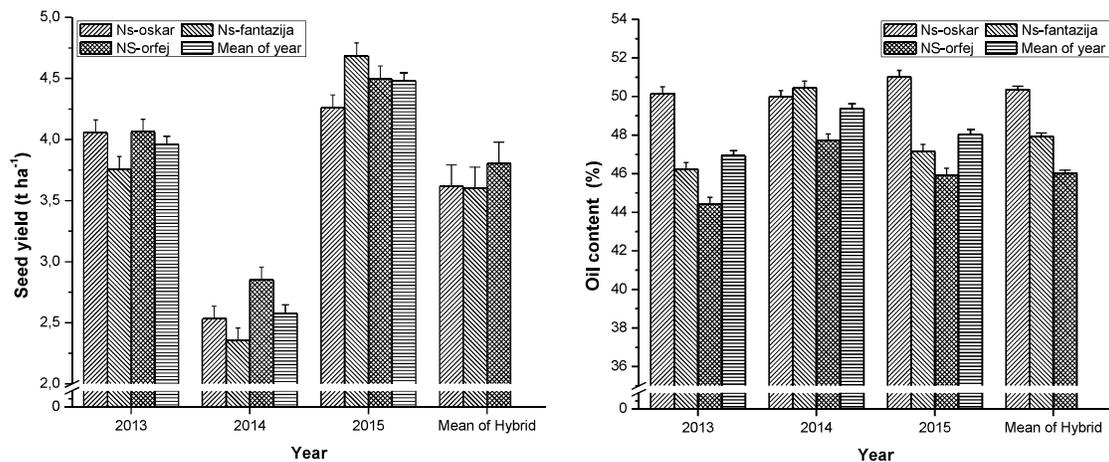


Figure 1. Seed yield and oil content, average values per year, hybrids and their interaction

Among triple NPK combinations the lowest combination with 50 kg ha<sup>-1</sup> of each nutrient had significantly the highest oil content but also the lowest seed yield. Next three triple combination had similar oil content which were significantly higher then all other triple treatments. Also, after the same triple combinations, in all other triple treatments there were no significantly higher seed yields. Regarding seed yield and oil content simultaneously in average for three year and three sunflower hybrids in our environmental condition the best is balanced nutrition, with triple NPK combinations in amount between 50-100 kg ha<sup>-1</sup> of each nutrient.

Considering triple nutrients combinations in average for three hybrids, oil content regularly decreases for about 1% with each increasing of nitrogen for 50 kgha<sup>-1</sup> (Fig. 3)

Differences in oil content between hybrids were similar in all fertilizers treatments, the highest had NS-oskar and the lowest NS-orfej (Fig 3). Contrary, hybrid NS-orfej had especially higher seed yield in treatments without N and in triple combination with highest amount of 100-150 kg ha<sup>-1</sup> of each nutrient (Fig. 2).

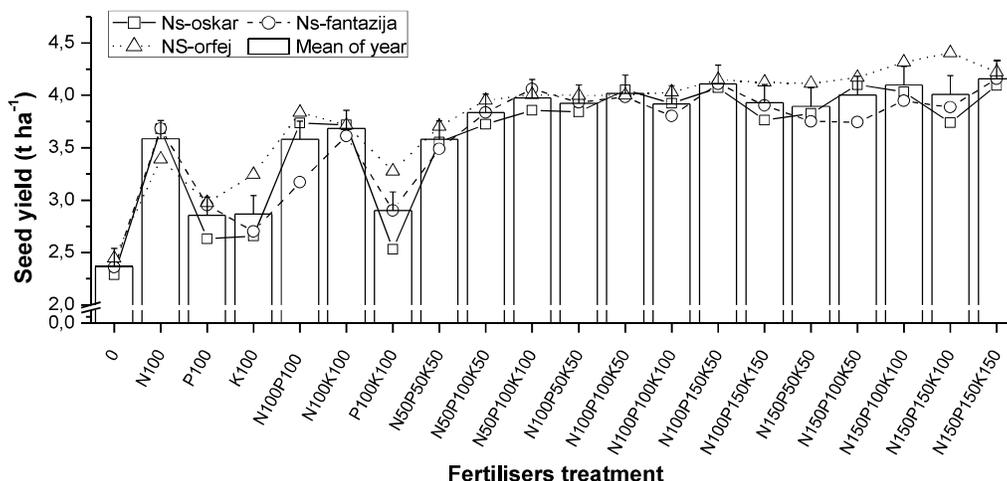


Figure 2. The effect of NPK fertilizers and hybrids on sunflower seed yield (average of 3 year)

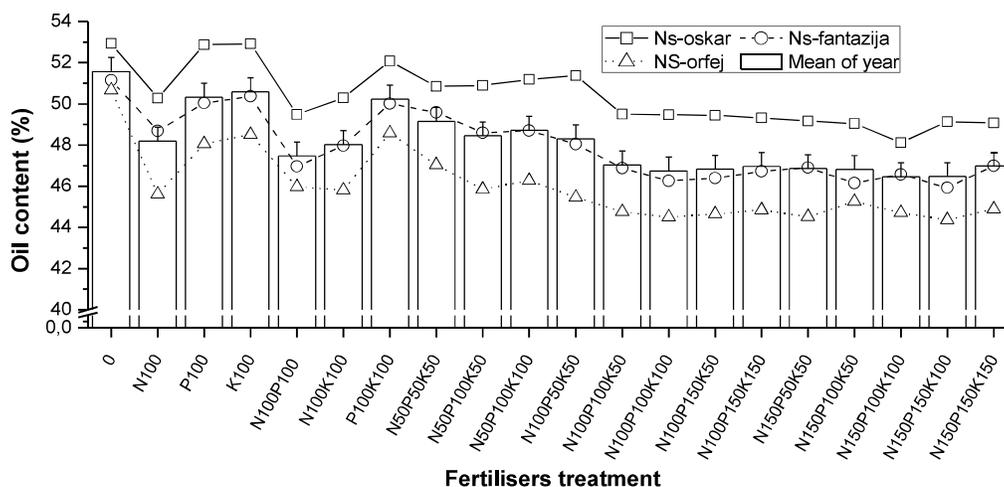


Figure 3. The effect of NPK fertilizers and hybrids on sunflower oil content (average of 3 year)

## CONCLUSION

Based on obtained results it can be concluded that regarding seed yield and oil content simultaneously in environmental condition of Serbia the best is balanced nutrition, with triple NPK combinations in amount between 50-100 kg ha<sup>-1</sup> of each nutrient.

## ACKNOWLEDGEMENTS

*This work was supported by Ministry of Education, Science and Technological Development of Republic of Serbia, project TR 31025.*

## LITERATURE

- Cechin I., de Fátima Fumis T. (2004): Effect of nitrogen supply on growth and photosynthesis of sunflower plants grown in the greenhouse. *Plant Science* 166, 1379–1385
- Crnobarac J., Dušanić N., and Marinković B. (2002): N-min method in sunflower fertilization. *Proceedings of 7<sup>th</sup> Congress European Societu for Agronomy*, p 675-676. Cordoba, Spain
- Keshta M.M., Rizk T.Y., Abdou E.T. (2008) Sunflower response to mineral nitrogen, organic and bio-fertilizers under two different levels of salinity . *Proc. 17 th International Sunflower Conference, Córdoba, Spain, June 8-12, 2008 vol.2*. p 451-454
- Malligawad L. H., Parameshwarappa K. G., Giriraj K. (2004) Studies on the effect of ratios and levels of NPK fertilizer nutrients on the productivity of hybrid sunflower under rainfed farming situations. *16th ISC, Fargo, North Dakota, USA, Aug 29-Sept 2, 2004, vol.1* 377-386
- Reau R., Champolivier L., Sauzet G., Ségura R., Wagner D.,(2004): Heliotest: a decision support system for sunflower nitrogen fertilization, *16th ISC, Fargo, North Dakota, USA, Aug 29-Sept 2, 2004, vol.1* 387-393