DOI: 10.5281/zenodo.5874241
UDC: 631.15:633.854.78(477.7)

ECONOMIC EFFECIENCY OF INTENSIVE TECHNOLOGY OF SUNFLOWER CULTIVATION IN THE CONDITIONS OF THE SOUTHERN STEPPE OF UKRAINE

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Abstract. The article concerns the issues of the state of sunflower seed production in the Southern Steppe of Ukraine and country as a whole. Studies (2017-2019) were carried out on tillage of this crop together with the use of a modified plant growth regulator AKM-K1, AKM-K2 with a different treatment scheme, including control without treatment, seed encrustation, spraying of plants during the growing season. Based on the results of the experiment and statistical data of Zaporizhzhya region and country as a whole, economic calculations were carried out, the dynamics of sunflower yield were analysed, taking its maximum and minimum values into account, the results of the economic efficiency of sunflower cultivation in Zaporizhzhya region were summed up, and recommendations were given to increase profitability level. The issue of increasing sunflower productivity in arid regions, with the introduction of low-cost and at the same time effective ways to increase its yield, is discussed. The establishment of experimental plots and carrying out research on them was done taking into account the selection of the best hybrids, a high level of agricultural technology, the use of mineral fertilizers in optimal doses, and also the system of integrated protection of seeds and plants from pests, diseases and weeds.

Key words: *Helianthus* annuus; Soil tillage; Plant growth regulators; Crop yield; Economic efficiency.

INTRODUCTION

Ukraine is a leading exporter of the oil industry products in the world market, as it is a powerful complex focused on sunflower oil production. This industry is very important for the country's economy and is one of the most important export industries. But, at the same time, it requires correction of certain aspects of its improvement and development (Лозовський, О. М., Слободянюк, С. В., 2013; Бурлака, Н. І., Балтремус, О. М. 2016).

The sunflower and rapeseed are the main oilseed crops in Ukraine. The volume of sunflower production is significantly higher than that of rapeseed one and the gross harvest is 14923.4 thousand tons with a yield of 2.6 t/ha. The gross harvest of rapeseed in 2019 is 3302.9 thousand tons, with an average yield of 2.6 t/ha (Статистична інформація. Офіційний сайт Державного комітету статистики України. 2019).

Despite a rather significant increase in sunflower plantings (by almost 2 times over the last 10 years) and high level of profitability, during this period there is a decrease in crop yields (Сендецький, В. М. 2017). The level of profitability is growing due to the increase in prices; however, the cost of production increases every year due to the increase in the cost of seeds, mineral fertilizers, means of plant protection against pests and diseases, etc.

Due to the increase in the sowing area of sunflower, the profitability of other agricultural crops decreases, especially when it is cultivated in short crop rotations, where sunflower is sown in the fields for several years in a row. It also leads to a significant decrease in soil fertility and an increase in the field infestation with broomrape seeds. Such problems are relevant for Zaporizhzhya, Kherson, Mykolaiv and other regions of Ukraine.

A topical and urgent issue is to increase crop productivity using low-cost, but effective methods, one of which is the use of plant growth regulators for incrustation of seeds and spraying of crops during the growing season (Горова, А. І., Орлов, Д. С. 1995; Пономаренко, С. П. 2003; Присяжнюк, М. П. 2015).

The scientists such as V. Kalytka, O. Eremnko, S. Kalenska, A. Tymofiichuk, I. Klymenko and others have made a significant contribution to the use of plant growth regulators in sunflower cultivation technology, as well as other agricultural crops (Єременко, О. А., Калитка, В. В. 2016а, б; Єременко, О. А., Калитка, В. В., Каленська, С. М. 2017а, б; Тимофійчук, О. Б. 2012; Клименко, І. І. 2015).

The introduction of innovative (intensive) technologies in sunflower growing from an economic and energy point of view is of great scientific and practical importance, as it provides an opportunity to optimize and reduce the cost per unit of the product obtained. With the help of such calculations, it is possible to determine the maximum level of yield per unit of sown area (Мицибора, В. І. 1994).

It is important to calculate these indicators for each farm separately, taking into account the growing conditions, the level of agricultural technology and other indicators for the selection of the best cultivars and hybrids into account, as well as the use of organic and mineral fertilizers; and selection of integrated plant protection system against diseases, pests, weeds, etc. (Бурка, А. В. 2008).

The aim of our research was to calculate the economic efficiency of the use of AKM-K1 and AKM-K2 growth regulators in sunflower plantations against the background of different soil tillage in the South of Ukraine.

MATERIALS AND METHODS

The research is based on the scientific publications of the main domestic and foreign scientists on the development of the economic and energy efficiency of agricultural production. In order to process the data, we used legislative and regulatory materials of the control and inspection services of the Ministry of Agrarian Policy of Ukraine, the National Academy of Agrarian Sciences of Ukraine, the State Statistics Service of Ukraine, the Main Department of Statistics in Zaporizhzhya region, materials of scientific publications, reports of agricultural enterprises of Zaporizhzhya region, Internet, the own research by the authors.

The observations and data of plant growth and development, the formation of sunflower yield structure was carried out in accordance with the "Methodology of field experiments for the study of agrotechnical methods of sunflower cultivation" (Поляков, А. И. и др. 2005). In the process carrying out the research, generally accepted scientifically and special research methods were used (Рожков, А. О., Каленська, С. М., та ін. 2016; Рожков, А. О., Пузік, В. К., Каленська, С. М. та ін. 2016).

The mathematical processing of the obtained results was carried out using the Agrostat software (Ушкаренко, В. О. та ін. 2008).

RESULTS AND DISCUSSIONS

Since the sunflower is the main crop for exporting, the production of vegetable oil and animal feed in Ukraine, its cultivation provides a high income. Thus, sunflower cultivation with the introduction of innovative technologies into production contributes to an increase in the economic efficiency of cultivation of this crop and sustainable development of the agro-industrial complex. If we compare the production of sunflower and rapeseed in Ukraine, the former is almost six times higher by the gross harvest values (Fig. 1), which confirms the demand for its export.

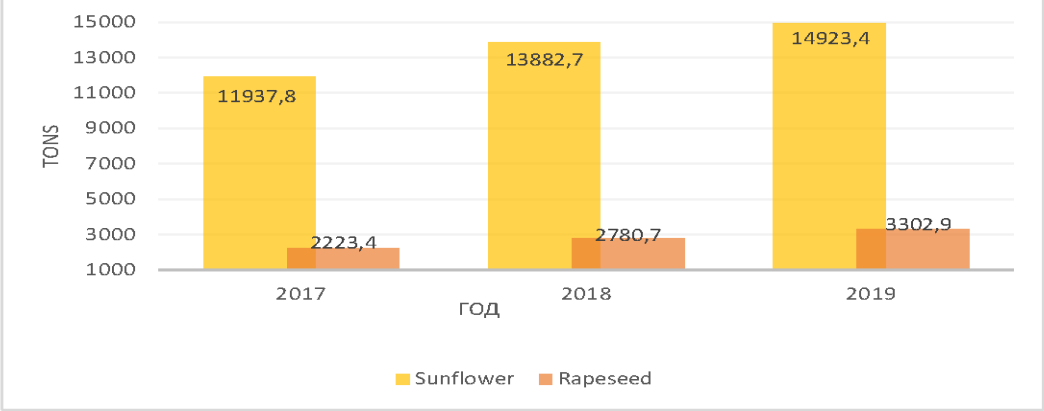

Figure 1. *Sunflower and rapeseed production in Ukraine (2017-2019), thousand tons*
Source: based on data from the State Statistics Service of Ukraine

In recent years, there has been a trend towards an increase in sunflower yield in the country (Fig. 2). This can be explained by the fact that in Ukraine, during its cultivation, foreign hybrids, which are more resistant to drought, diseases, pests, broomrape and other negative biotic and abiotic factors, began to be introduced into production. Also, the growing technology has improved in general: modern equipment, high-quality means of plant protection, elite sowing material and other aspects had a complex influence on the increase in yield and its quality.

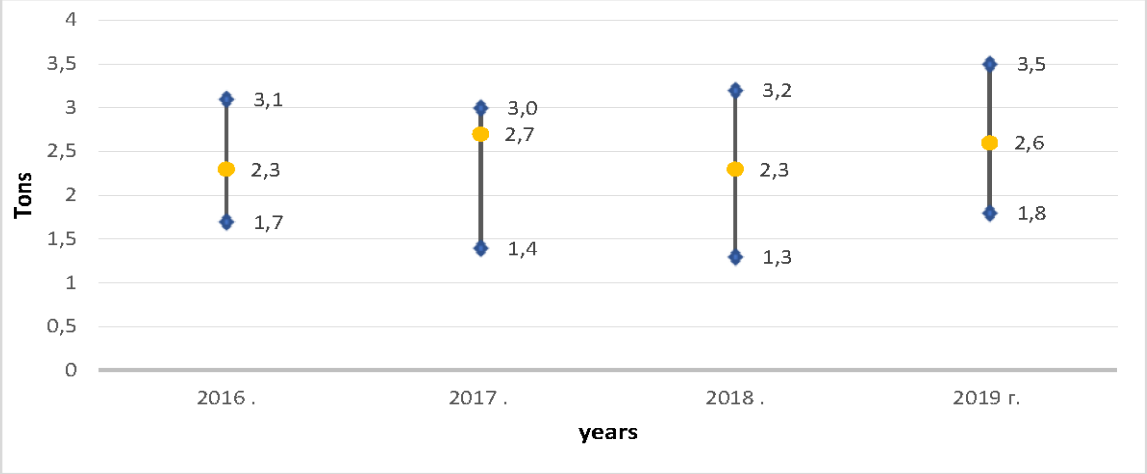

Figure 2. *Sunflower yield dynamics in Ukraine in 2016-2019 (taking into account the indicators of maximum and minimum values into account), t/ha*
Source: based on data from the State Statistics Service of Ukraine

However, in Zaporizhzhya and Donetsk regions, there has been a decrease in the yield of this crop over the past few years, since during this period there was insufficient rainfall, and the air temperature exceeded +37 °C. Consequently, the producers noted a weak filling of seeds and a high percentage of empty grain, which led to a decrease in productivity in these areas (Table 1).

Table 1. *Dynamics of sunflower yield in Ukraine, t/ha*

Region	1990, t/ha	2018, t/ha	Percentage, %
Vinnytsya	1.95	3.11	59
Volyn	0.90	2.94	227
Dnipropetrovsk	1.59	2.16	36
Donetsk	1.93	1.71	-11
Zhytomyr	1.61	2.09	30
Zakarpattya	1.45	1.97	36
Zaporizhzhya	1.49	1.27	-15
Ivano-Frankivsk	0.54	2.32	330
Kyiv	1.16	2.97	156
Kyrovograd	1.70	2.48	46
Lugansk	1.55	2.00	29
Lviv	-	2.34	39
Mykolayiv	1.53	1.94	27
Odessa	1.40	2.14	53
Poltava	2.03	2.86	42
Rivne	1.17	2.41	106
Sumy	1.60	2.91	82
Ternopil	2.03	2.69	33
Kharkiv	1.76	2.78	58
Kherson	0.87	1.62	86
Khmelnytskiy	0.90	3.07	241
Cherkasy	2.15	3.17	47
Chernihiv	1.75	2.68	53
Total for Ukraine	**1.58**	**2.30**	**46%**

Source: based on data from the State Statistics Service of Ukraine

In Zaporizhzhya region, the efficiency of sunflower seed production largely depends on agro-climatic conditions. Although the potential of natural fertility of the southern chernozem is 1.2 t/ha, with an optimal fertilization system for the field, it is possible to achieve a yield of 2.8-2.9 t/ha in the Steppe zone.

The use of plant growth regulators is a low-cost, but effective way to increase sunflower productivity (Table 2).

Table 2. *Economic efficiency of sunflower seed production of 'Talento' and 'Colombi' hybrids (2017-2019)*

Soil tillage	Hybrids	Treatment	Yield, t/ha	Value of the produce, UAH/ha*	Production costs, UAH/ha	Cost price, UAH/t	Net profit, UAH/ha	Profitability, %
Deep tilling	Colombi	Control (C)	1.78	18245	12660	7112	5585	44.12
		AKM-K1	2.20	22550	12702	5773	9848	77.53
		C+(AKM-K2)	2.14	21935	12898	6027	9037	70.07
		AKM-K1+AKM-K2	2.46	25215	12940	5260	12275	94.86
	Talento	Control (C)	1.81	18552	12660	6994	5892	46.54
		AKM-K1	1.99	20397	12702	6382	7695	60.58
		C+(AKM-K2)	2.03	20807	12898	6353	7909	61.32
		AKM-K1+AKM-K2	2.16	22140	12940	5990	9200	71.10
Ploughing	Colombi	Control (C)	1.68	17220	12760	7595	4460	34.95
		AKM-K1	1.93	19782	12802	6633	6980	54.53
		C+(AKM-K2)	1.91	19577	12998	6805	6579	50.62
		AKM-K1+AKM-K2	2.05	21012	13040	6360	7972	61.14
	Talento	Control (C)	1.43	14657	12760	8923	1897	14.87
		AKM-K1	1.73	17732	12802	7400	4930	38.51
		C+(AKM-K2)	1.76	18040	12998	7385	5042	38.79
		AKM-K1+AKM-K2	1.93	19782	13040	6756	6742	51.71

Source: built on the basis of the State Statistics Service of Ukraine, Main Department of Statistics in Zaporizhzhya region, reports of agricultural enterprises of Zaporizhzhya region and the results of the authors' own research

* - as of November 01, 2019

Our studies have proved that the highest level of profitability (94.86%) was in the variant AKM-K1+AKM-K2 with deep tilling ('Colombi' hybrid), while with ploughing this variant was 33.7 percentage points lower. 'Talento' hybrid showed lower economic efficiency than 'Colombi' hybrid in all variants. The lowest profitability indicator was noted in the control variant (C) with ploughing ('Talento' hybrid) and reached only 14.87%.

It should be noted that the profitability of all variant for deep tilling was higher than for ploughing: from 9.17 pp. (C) up to 33.72 p.p. (AKM-K1+AKM-K2).

The highest profitability was observed in AKM-K1+AKM-K2 variant with different soil tllage methods, both for 'Talento' and 'Colombi' hybrids.

Based on the research carried out, processing of legislative, regulatory materials of the control and inspection services of the Ministry of Agrarian Policy of Ukraine, National Academy of Agrarian Sciences of Ukraine, the State Statistics Service of Ukraine and other organizations mentioned above, it can be concluded that when growing sunflower in arid regions, in particular in Southern Steppe of Ukraine, it is necessary to follow the basic agrotechnological methods, which will be aimed at preserving moisture in the soil, while not impairing its fertility. This means that it is necessary to abandon ploughing and carry out the deep tilling in autumn in the fields that are being prepared for sowing sunflower in spring.

CONCLUSIONS

The highest level of profitability (94.86%) was observed in AKM-K1+AKM-K2 variants with deep tilling ('Colombi' hybrid), while on ploughing this variant was 33.7 percentage points lower.

The lowest profitability was noted in the control variant with ploughing ('Talento' hybrid) and reached 14.87%.

We recommend to carry out the incrustation of seeds 2-3 days before sowing the crop, with modernized AKM-K1 preparation, in order to increase the protective properties of the antioxidant system of the seed to abiotic and biotic environmental factors.

During the inflorescence emergence phase, plants should be sprayed with AKM-K2 in a tank mixture with plant protection products to remove the herbicide load and increase the adaptive properties of plants to thermal stress.

In the conditions of the Southern Steppe of Ukraine, it is recommended not to carry out ploughing for sunflower, but deep tilling instead, which contributes to an increase in yield up to 4 t/ha.

To select sunflower hybrids with the greatest adaptive properties to the agrometeorological conditions of the growing zone.

Thus, it will be possible to achieve a high level of profitability when growing sunflower, not by increasing prices for products, but by increasing the yield and its quality, thereby not violating the agroecological conditions for growing other crops.

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Data prezentării articolului: 17.11.2021

Data acceptării articolului: 03.12.2021