The Influence of Some Technological Elements on Sunflower Yields, Cultivated in the Timis Low Plain

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Abstract
Due to the outstanding biological qualities and the versatility of the oil obtained both for human consumption and for industrial and energy uses, in recent years, the national and international demand for sunflower seed production has become increasingly high, which has led Romanian farmers to include the cultivation of this species in their different crop rotations, year after year. Against a backdrop of favorable climatic and soil conditions, sunflower has become a traditional crop in Romania, as demonstrated by the dynamic of the areas and yields obtained in the last decade, which have consecutively placed our country at the top of the European and even world rankings. At the same time, this particular species also has a remarkable fodder value in terms of the secondary products obtained after processing the seeds, namely sunflower grit and sunflower cakes, which are used in various fodder recipes, for several animal species such as sheep, goats and cattle. It is not to be neglected either that this crop is of particular importance for honey production in our country. For these reasons, it is necessary to constantly improve and adapt the cultivation technology of this valuable species to the current economic and environmental challenges, in order to ensure the same high level of this crop's productivity. In this present paper, through research carried out over three experimental years (2022, 2023 and 2024), it was monitored the behaviour of two sunflower hybrids, adapted and cultivated in the pedo-climatic conditions of the Timiș Low Plain, an area recognized for its favourable results in sunflower seed production, both due to the high natural fertility of the soils and the sufficient water supply from rainfall. At the same time, the impact on production of some technological element essential for cultivation was observed, namely the chemical fertilization carried out on two distinct levels.

Keywords: cultivation technology, fertilization, fodder, seed production, tillage systems

1. Introduction

With multiple uses, sunflower (*Helianthus annus L.*) is a particular species of the botanical family Asteraceae, native to the American continent, known and appreciated, primarily as an oil plant, due to the superior quality of the oil extracted from the achenes, but also for its color, taste and pleasant odor, in addition to its high content in vitamins (A, D, E, K) and minerals [1-3].

Because of its special properties and the versatility of the oil obtained (for human consumption, biofuel production or for different industries), the demand for sunflower cultivation is increasingly high, both nationally, as well as at European and even international level, which is the main reason for more and more Romanian farmers to include, year after year, the cultivation of this species in their crop rotation [4,5].
For Romania, in the last twenty years, sunflower has become a traditional crop, due to a high favorability of the soil and climatic conditions, occupying the largest area among the cultivated industrial plants.

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At the same time, this species also performs particularly well in the organic cultivation system, and in recent years, in the field of ecology, its pollution-reducing potential has been widely studied [5,6].

The dynamics of the areas and yields obtained in the last decade (Table 1), have consecutively placed our country at the top of the European and even world rankings [4,5,7].

Table 1. Evolution of cultivated areas and yields in Romania

Year	Cultivated area (ha)	Average yield (Kg/ha)	Total yield (to)
2015	1.011.527	1.765	1.785.771
2016	1.039.823	1.955	2.032.340
2017	998.415	2.917	2.912.743
2018	1.006.994	3.041	3.062.690
2019	1.282.697	2.783	3.569.150
2020	1.142.841	1.858	2.122.865
2021	1.123.960	2.530	2.843.531
2022	1.093.265	1.927	2.106.573
2023	1.077.867	1.870	2.015.621

Source: INS data – Tempo online

In addition to the utility of the oil, there are also other parts of the plant, from which, two secondary products are obtained after oil extraction: sunflower grit and sunflower cakes, well-known in animal nutrition. They are high in protein, minerals (phosphorus, iron, copper) and vitamins (B-complex) and can be used as part of the feed for several animal species [8-10].

Sunflower grit is the most widely used secondary product of this cultivated species and is considered a high quality feed ingredient with outstanding nutritional properties and high protein and lipid content. Used in various recipes, it contributes to the healthy growth of several animal species, including sheep, goats and cattle, supporting both their health and productivity [8-10].

Another important secondary product of the sunflower species are the sunflower cakes, which are obtained by the cold-pressing extraction of the oil. Although less widely used, this method is considered to be superior, as the final product has a higher fat content of up to 20%.

In animal feed, sunflower cakes are used for their special nutritional properties, balancing the protein content of the feed and accounting for up to 50% of the structure of compound feed.

The calathidiums remaining after harvesting are also not to be neglected, as they are a valuable source of feed, especially for sheep [8-10].

In recent years, thanks to the financial support offered to young people through the access to European funds for beekeeping, sunflowers have also become increasingly appreciated as a honey plant.

2. Materials and methods

For the research carried out in the period 2022-2024, in the Timiș Low Plain, part of the great Western Plain of Romania, two sunflower hybrids were used as genetic materials, one of which is P64LE137, an early hybrid and Subaro HTS, which is semi-late one, recommended to be cultivated in all lowland areas, both in natural and irrigated conditions.

The choice of these two hybrids was also made due to the fact that both show good drought and heat tolerance and can be grown with good results in the natural conditions of the lowland area in the Western part of Romania.

The experience carried out was a bifactorial one, in which:

Factor A – the cultivated hybrid

a_1 – P64LE137 developed by Pioneer company

a_2 – Subaro HTS developed by Syngenta company

Factor B – The fertilization level

b_1 – N15P15K15 = 300 kg/ha + 10 kg sulphur

- fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha
- foliar fertilizer Lebosol bor – 2 l/ha

b_2 – N15P15K15 = 250 kg/ha + 10 kg sulphur

- fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha
- foliar fertilizer Lebosol bor – 2 l/ha

The sunflower hybrid P64LE137 is an early hybrid, known by local farmers for its performance and the very good results obtained, having an absolutely remarkable tolerance to stress factors such as atmospheric and pedological drought that frequently occurs in our country, specially in the Western Plain in recent years and also having a high ability to adapt perfectly to the microclimatic conditions specific to different agricultural areas [11,12].

This hybrid is also characterized by high productivity and increased crop resistance, not only against common diseases, but especially against the pest species *Orobanche cumana* (known in Romanian as Lupoaie).

The second cultivated sunflower hybrid, the semi-late hybrid Subaro HTS, is known as a genetic material with outstanding properties, including high adaptability to climatic conditions, also a high resistance to drought and prolonged heat and to sunflower common diseases (*Phomopsis helianthi, Macrophomina, Plasmopara helianthi M9* or *Sclerotinia sclerotiorum*). It is known to have a high and stable yield potential, as confirmed by the very good results obtained by Romanian farmers [13,14].

From the agro-phyto-technical point of view, the plants belonging to this hybrid showed during the vegetation period a particular vigor, with a medium-high height, healthy plant appearance and green stems until harvest.

Regarding the applied technology, we mention that, in both cases, the precursor plant was autumn wheat, and the soil type was a weakly gleized chernozem, with a medium texture in the first 50 cm and a high natural fertility due to its outstanding physical, hydrophysical, chemical and biological properties [15].

The soil was cultivated in a classical system (the main work - ploughing to a depth of 22 cm, supplemented with the seedbed preparation work, carried out with a disc harrow), and fertilization strictly involved the use of chemical fertilizers (NPK + sulphur, a fertilizer based on nitrogen, calcium and magnesium and foliar fertilizer - *Lebosol bor*) [6].

Lebosol bor is a fertilizer containing a microelement essential for plant growth and development, namely boron, which plays an important role in cell division, root system development and plant fruiting. In the case of sunflower, the application of this product has proved a favorable impact for both flowering and grain formation, the increase of the number of seeds/calthidium or their oil content.

At the same time, its application was also correlated with a better resistance of the the crop to diseases, leading to higher yields [16].

3. Results and discussion

The research carried out in the three experimental years, respectively 2022, 2023 and 2024, on a weakly gleyed chernozem soil type with a medium texture in the first 50 cm and high fertility, shows a different behaviour of the two cultivated hybrids, in relation to the fertilization applied.

In the experimental year of 2022, the climatic conditions were within the multiannual ones. There were some exceptions, with days with higher temperatures and reduced precipitation, but their impact on the yields was limited [17].

The behavior of both cultivated hybrids was very favorable, with grain yields exceeding 4000 kg/ha in all cultivated variants. According to the analyzed data, the overall average of all variants was 4215 kg/ha, as recorded in Table 2.

Regarding the experimental year of 2023, the climatic conditions during the sunflower growing season were less satisfactory, with both periods of atmospheric and soil drought, especially in the months of July and August. These had a negative impact on the yields and regarding the four cultivation variants analyzed, only one reliably exceeded 4000 kg of grain per hectare.

In the other cases the yields obtained were around 3900 kg/ha and the overall average of the two cultivated hybrids in the four variants was 3959 kg/ha (Table 3).

The experimental year of 2024, remains the driest year on record. The particularly high temperatures in the summer months, coupled with the acute lack of precipitation, affected all summer and fall crops, including sunflowers. The great atmosferic and soil drough of this year has overshadowed all the good cultivation links applied, especially the fertilization [18].

The plants suffered greatly in vegetation, with a major impact on the productivity elements, which is the reason of the reduced yields, that were considered half of the production potential of the studied hybrids. Thus, the overall average of the cultivation variants was the lowest of all the experimental years, respectively 3203 kg/ha.

Table 2. Production syntesis 2022

Cultivated hybrid	Fertilization level	Achenes production kg/ha	Difference production compared to the control variant kg/ha	% compared to the field average
PT64LE137	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	4413	+198	104.69
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	4208	-7	99.83
Average production of the hybrid		4311	+96	102.27
Subaro HTS	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	4211	-4	99.90
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	4024	-191	95.46
Average production of the hybrid		4118	-97	97.69
Average production of the cultivated variants kg/ha		4215	Control variant	100

Table 3. Production syntesis 2023

Cultivated hybrid	Fertilization level	Achenes production kg/ha	Difference production compared to the control variant kg/ha	% compared to the field average
PT64LE137	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	4054	+95	102.39
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3915	-44	98.88
Average production of the hybrid		3985	+26	100.65
Subaro HTS	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3971	+12	100.03
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3895	-64	98.38
Average production of the hybrid		3933	-26	99.34
Average production of the cultivated variants kg/ha		3959	Control variant	100

Table 4. Production syntesis 2024

Cultivated hybrid	Fertilization level	Achenes production kg/ha	Difference production compared to the control variant kg/ha	% compared to the field average
PT64LE137	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3289	+86	102.68
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3148	-55	98.28
Average production of the hybrid		3219	+16	100.49
Subaro HTS	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3225	+22	100.68
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3149	-54	98.31
Average production of the hybrid		3187	-16	99.50
Average production of the cultivated variants kg/ha		3203	Control variant	100

From the data recorded in the summary table (Table 5), we note that the highest achene yield among the four analyzed variants was recorded by the early hybrid Pioneer PT64LE137, in the first cultivation variant (fertilization level 1) of 3917 kg/ha, which is higher than the average of the control by 125 kg/ha, meaning, in percentage, by 3.29%. For the same hybrid in the second cultivation variant, the yield was 3757 kg/ha, but this value was with 35 kg/ha below the average yield of the experimental field taken as a control.

The average yield of this hybrid, on the two fertilization levels was particularly valuable, reaching 3837 kg/ha, which in percentage compared to the control, represents 101.18%.

The average yields realized by the semi-late hybrid Subaro HTS, in the three experimental years, were below of those obtained by the Pioneer hybrid, with about 100 kg/ha of achene less in both variants.

In the first cultivation variant, the achene yield was 3802 kg/ha (roughly equal to the average of the variants), and in the second variant - 3689 kg/ha, with 103 kg/ha less than the control (overall average of the experimental field). The average yield of this hybrid was 3746 kg/ha, with 46 kg/ha below the average of the variants, meaning a percentage of 97.03%.

The yield difference between the two hybrids was 91 kg/ha, in favor of the earlier hybrid PT64LE137, which proved to be more tolerant to the heat stress conditions existent in the summer months of the experimental years of 2023 and 2024.

Table 5. Production synthesis 2022-2024

Cultivated hybrid	Fertilization level	Achenes production kg/ha	Difference production compared to the control variant kg/ha	% compared to the field average
PT64LE137	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3917	+125	103.29
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3757	-35	99.07
Average production of the hybrid		3837	+45	101.18
Subaro HTS	Level 1 N15P15K15 = 300 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 250 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3802	+10	100.26
	Level 2 N15P15K15 = 250 kg/ha + 10 kg sulphur fertilizer based on nitrogen, calcium and magnesium = 300 kg/ha foliar fertilizer Lebosol boron – 2 l/ha	3689	-103	97.28
Average production of the hybrid		3746	-46	98.78
Average production of the cultivated variants kg/ha		3792	Control variant	100

The average yield of the two hybrids cultivated in the three experimental years, on two fertilization levels, under the pedoclimatic conditions of the researched period, was of 3792 kg/ha.

Although the overall yield achieved, under the cultivated conditions mentioned above, is not at the value of the genetic potential of the analyzed hybrids, these sunflower varieties have still proved to be profitable for the Timiș Low Plain farmers.

4. Conclusions

Of the two hybrids studied during the reference period, the Pioneer PT64LE137 hybrid showed better tolerance to climatic stress factors during the vegetation season.

The higher yield potential of this genetic material, coupled with an additional amount of fertilizer (50 kg of phosphorus and potassium, administered in variant 1), resulted in the higher yield.

The fact that the average synthesized yields in the three experimental years did not reach the maximum yield potential of the hybrids, was largely due to the lack of rainfall and high temperatures, especially during the period of grain formation and filling of the grains. This period was mainly during the summer months of July and August - 2024, which was the year of lowest grain yields among the all three experimental years.

In conclusion, we can state that, in the years with climatic conditions close to normal, with the application of suitable technology (with a focus on the fertilization plan) and considering the production potential of these hybrids, sunflower grain yields in the Timiș Low Plain can be very high, making this crop one of the most profitables for the farmers of the area.

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