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OPTIMIZATION OF SOME TECHNOLOGICAL FACTORS TO SOYBEAN CROP

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Abstract: *The research conducted at the Agricultural Research and Development Station Turda (ARDS), situated in the Transilvanian Plateau, they pursued the possibility of obtaining yield increases and quality for the Caro TD soybean variety, cultivated in four tillage systems (CS - conventional plow, MTC – minimum till chisel, MTD – minimum till disk, NT – no till direct sowing), by creating a larger space for plant nutrition and development. Sowing was done at 65 (germinative grains) gg/m², the distance between the rows being 18-36-54 cm. From the results obtained, in two experimental years, it was concluded that, in the climate and soil conditions of Turda, the tillage system corresponds to a certain sowing distance at which soybean lends itself, achieving higher yields: classic at 18 cm (3189 kg/ha), minimum till chisel at 36 cm (2779 kg/ha), minimum till disc at 54 cm (2875 kg/ha) and for no till direct sowing 36 cm (2349 kg/ha). It noted, the high percentage of protein content in the grains in the variant MTD (32,0% at 54 cm and 31,9% la 18 cm). The lowest values were recorded in the variant NT, at the same distances between the rows. The fact that in the variant NT the lowest values of grain protein content were determined, 30% at 18 cm, respectively 29,6% at 54 cm distance between rows, and the highest percentage was found at the same distances between rows in the variant MTD, at 54 cm 32,0%, respectively at 18 cm 31,9%. In terms of fat content, the minimum range was 20% in SC at 18 cm and maximum in MTC at 36 cm distance between rows.*

Key words: *non-conventional system, distance between rows, yield, soybean.*

Classification JEL: Q 01, Q 15, Q 16

INTRODUCTION

The development and modernization of industry, starting in the year 1800 (The Industrial Revolution), conducted to economic growth and the standard of living of mankind. Fossil fuels have been used on a large scale, and by burning them, the level of greenhouse gas emissions also increased. Also for the purpose of expanding cities, of agricultural areas or for tourist purposes, the degree of land use also changed, through massive deforestation. As a result, there was a sharp increase for the average temperature at the land surface. At European level, according to the European Environment Agency, in the year 2019, the polluter with the highest share of participation in the intensification of the greenhouse effect was the energy sector (77,01%), followed by the agricultural sector (10,55%), industrial processes (9,1%) and the waste management sector (3,32%). Romania contributes a percentage of 0,3% to global greenhouse gas emissions and under 3% from the total emissions of EU member countries (www.europarl.europa.e; www.mmediu.ro).

In Europe, many regions are at risk of desertification, due to the increase of temperature, and Romania is no exception to these calamities. An eloquent example is the fact that, due to uncontrolled deforestation of forests with a protective role, specialists say that the southern area is gradually turning into a desert, the largest area affected by aridification is found in Dolj (over 100,000 hectares), thus, this area is also called „Sahara of Oltenia” (www.digi24.ro). And in the Turda area, in the last 65 years, a slight increase in average annual temperatures has been observed, as well as a higher fluctuation in the distribution of precipitation (Șimon, 2022).

Soybean cultivation technology present differences depending on the climatic characteristics, of soil, the relief of the area, the machine system and the impact of applied technologies on the environment (Schutte și Nleya, 2019; Miransari, 2016; Anda, 2019; Taha, 1990; Chețan, 2020).

The paper presents the behavior of soybeans when is cultivated in different types of tillage and varied thicknesses, in the pedo-climatic conditions from ARDS Turda.

MATERIAL AND METHOD

Reducing the effects of atmospheric drought and pedological are part of the reasons that determine the orientation towards new variants of soil works and also the specific orography of the Transylvanian Plateau including also the experimentation area.

The experiment was established on a Clay Iluvial Vertic Chernosem type soil with loamy-clay texture, a neutral pH, good supply of nitrogen, phosphorus and potassium and a medium humus content (SRTS, 2012).

The experience is organized according to the method of subdivided plots (Săulescu and Săulescu, 1967) and is included in a three-year rotation, winter wheat – maize – soybeans.

The early soybean variety Caro TD was used as biological material, a variety with good resistance to falling and shaking, good tolerance to disease attack, and the insertion height of the first basal pods at approx 17 cm facilitates mechanized harvesting with minimal losses (Mureșanu, 2017).

The experimental factors were represented by:

- the tillage system (A): a₁ conventional plough (CS), a₂ minimum till chisel (MTC), a₃ minimum till disk (MTD), a₄ no till direct sowing (NT);
- sowing distance (B): b₁ 18 cm, b₂ 36 cm, b₃ 54 cm;
- the climatic conditions of the two experimental years (C); c₁ 2020, c₂ 2021.

Soybeans generally have a slow growth rate in the first stages of vegetation, so that, by pre-emergent herbicides on the ground, a wide spectrum of weeds are combated and the crop is kept clean in the first phenophases of vegetation, without weed pressure. To achieve this goal, we chose a proven herbicide, namely the Sencor 600 herbicide dose of 0,35 l/ha (metribuzin 66 g/l) and another molecule, the herbicide Spectrum (dimetenamid-P) 1,4 l/ha). Post-emergence weed control is an absolutely necessary link to the success of the soybean crop, however, for combating dicot weeds, the range of herbicides is quite limited. Thus, to combat dicot weeds, Corum product where used 1,9 l/ha (480 g/l bentazon, 22,4 g/l imazamox), and after 4 days, to combat monocotyledonous weeds, Agil 100 EC was applied 1,0 l/ha (100 gr/li propaquizafop).

Soybean sowing was realized at 65 germinative grains/m², simultaneously applying mineral fertilization with 100 kg/ha NPK 20:20:0 (N₂₀P₂₀ a.s/ha).

Rising temperatures, prolonged drought (Hossain, 2006; Bailey, 2011; Lombardi, 2015), uneven distribution of precipitation and tillage systems with mulch, they represented favorable conditions for the manifestation of the pest *Tetranychus urticae* Koch (the common red spider) in the first decade of July, in both experimental years. Chemical treatment was required, this being done with the Ortus 5 SC (50 g/l fenpiroximat) product in dose of 0,5 l/ha.

The harvesting of the soybean experiment was carried out respecting the methodological rules of the experimental technique. The harvestable surface of the experimental plot was 28 m².

The experimental data were processed by analysis of variance (PoliFact, 2015) and the establishment of limit differences.

Climatic conditions from April to September 2020 and 2021 are presented in figure 1 and 2 (source: Turda Meteorological Station).

RESULTS AND DISCUSSIONS

The thermal regime of the area has a particularly important role in choosing the assortment of varieties to be cultivated. From the data presented, result, in most months, temperatures registered positive deviations in relation to the multi-year monthly average (Figure 1). A limiting factor of soy culture is water. To obtain satisfactory harvests, a pluviometric distribution is necessary in relation to the critical phenophases for water and at least one volume of 500 mm from sowing to physiological maturity, as mentioned in the specialized literature (https://www.donausoja.org/wpcontent/uploads/2022/03/BMP_Soia_ro_06.02.2020_Moldova_conventional-1.pdf). If we analyze the rainfall regime of the two years (Figure 2) it can be observed that there are negative deviations from the soy requirements, but still the reserve of moisture in the soil that has accumulated until the time of sowing must also be taken into account.

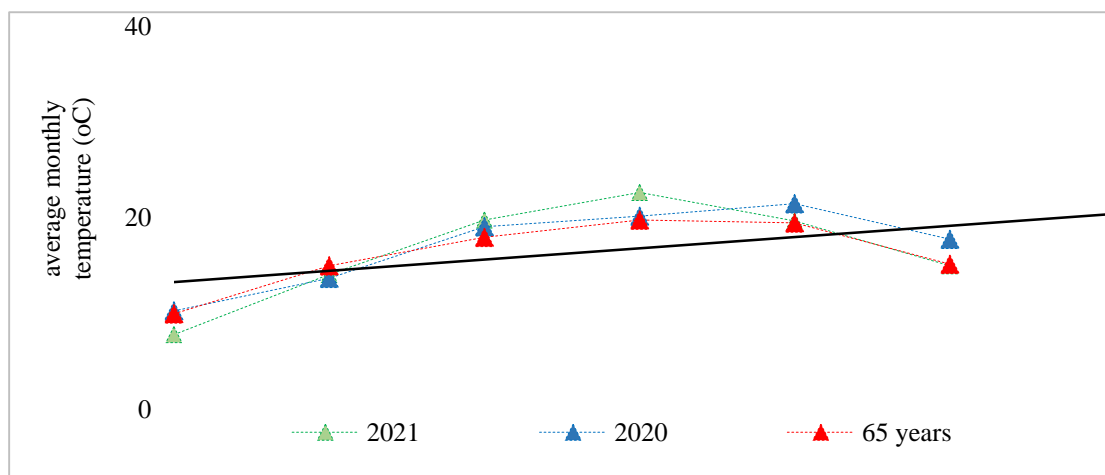


Figure 1. The thermal regime from the period IV-IX 2020, 2021 in Turda

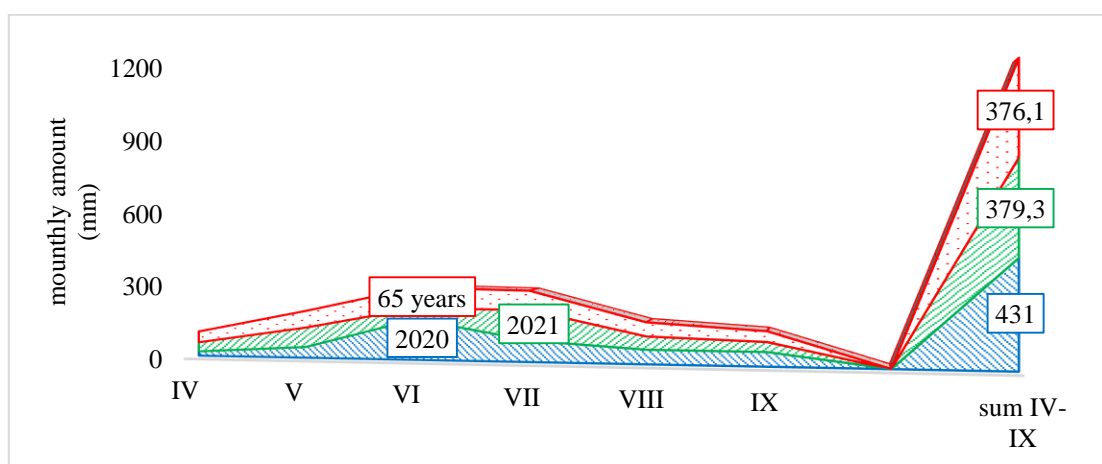


Figure 2. Rainfall regime from IV-IX 2020, 2021 in Turda

The soybean yield obtained show the importance of choosing the optimal tillage option. Soil work, fertilization, plant protection from pest attacks (Mureșanu, 2020; Tărău, 2020), in interaction with other important factors (variety, climatic conditions) they have a direct influence on the yield

and quality of crop yield (Morea, 2017; Chețan, 2020; Chețan, 2015). Soybean plants use nitrogen from the soil solution (35-50%) and nitrogen obtained from symbiosis with bacteria *Bradyrhizobium japonicum* from soybean root nodules. Including soybeans in a crop rotation also leads to an economy of chemical fertilizers (Okereke, 1996; Arima, 2000; Ruiz, 2005; Hartman, 2011; Basal, 2020; Șimon, 2018).

The data in table 1, reflect the fact that, soybeans have tillage requirements. Of the four variants studied, the conventional tillage system (plough) it is the most suitable for soybean culture in the pedo-climatic conditions of Transylvania. In the other non-conventional systems compared to the conventional one, soybean yield were diminished, the differences being very significantly negative. Apparently, under the conditions of a soil with more than 40% clay, soybeans are less suitable for direct sowing in uncultivated land (no till), in this variant, the lowest yield is recorded.

Table 1. The influence of the tillage variant in achieving soybean production, Turda 2020-2021

Factor A, tillage system	Yield kg/ha	%	Diferenvece ± kg/ha
a ₁ conventional - plough	3079	100	control
a ₂ minimum till - chisel	2730	89	-348 ⁰⁰⁰
a ₃ minimum till - disk	2653	86	-426 ⁰⁰⁰
a ₄ no till - direct sowing	2259	73	-820 ⁰⁰⁰
LSD (p 5%) = 65, LSD (1%) = 120, LSD (0,1%) = 266.			

⁰⁰⁰ = very significantly negative for the probability 0,1%

Soybean spacing is a technological element debated by many researchers, but most opinions converge towards the idea that soy reacts most favorably, if it is sown at a greater distance between the rows, distance that is not over 70 – 80 cm. From field observations followed by further analyses Ardelean, (1973) state that sowing in closer rows favors vegetative development, while sowing in more distant rows is favorable to generative development (grain crops). And our observations were in the same direction, thus, at the sowing distance of 54 cm, the plants formed a compact bush and they branched much more pronounced compared to the 18 cm distance. This fact was realized through a yield of 2744 kg/ha, superior to the other two sowing options. Compared to the control variant, an increase of approximately 100 kg was obtained, the difference being statistically ensured as significantly positive (Table 2). However, it need to mention that, there are certain situations in which due to the large reserve of weeds, if sowing in rare rows is practiced and no special attention is paid to weed control, soybean yield could be significantly affected. Based on the results obtained, the distance between rows at sowing can vary from 18 cm up to 70 cm and it is chosen taking into account primarily the cultivated variety (compact or sprawling bush shape), the degree of weeding of the soil, equipping with machines and equipment for weed control (chemically, leeks), the cultivation system (classical or ecological) etc.

The specialized literature also mentions other research on the influence of the distance between rows of plants, however, it is not possible to accurately determine the effect on plant variability as well as the response of varieties to different sowing densities (Mellendorf, 2011). Taylor (1980) states that the greater distance between the rows contributes to a better development of the plants, these forming more pods.

Table 2. The influence of row spacing in achieving soybean yield, Turda 2020-2021

Factor B, distance between rows	Yield kg/ha	%	Diference ± kg/ha
b ₁ 18 cm	2647	100	control
b ₂ 36 cm	2549	96	-98 ^{ns}
b ₃ 54 cm	2744	104	97*
LSD (p 5%) = 86, LSD (1%) = 125, LSD (0,1%) = 188.			

^{ns} = insignificant, * = significantly positive for probability 5%

As it results from the data presented in table 3, the difference between the average yield of the two years is only 96 kg/ha, therefore it can be stated that in the two years the climatic conditions were not very differentiated regarding the degree of favorability for the soybean crop. In the two years, there were large fluctuations of the two climatic factors throughout the soybean vegetation period, as is: low temperatures in the first part of spring, the alternation between periods of prolonged drought and torrential rains, sometimes accompanied by strong winds or light hail, dbig differences between day and night temperatures etc. The difference compared to the control variant (the average of the two years) is insignificant, only 48 kg/ha. Even though there were no important quantitative differences between the soybean yield of the two years affecting the profitability of the crop are also years in which soybean yield can be significantly reduced and therefore also the profit obtained. It was found that, lately, the frequency of recorded years in which climatic conditions are less favorable to soybean cultivation is increasing. There are other authors who confirm that, crop productivity is mainly conditioned by the climatic conditions during the vegetation period, among which Yamoah, (1998). He claims that soybean production is negatively correlated with rising temperatures in late summer.

Table 3. The influence of climatic conditions on soybean yield, Turda 2020-2021

Factor C, crop year	Yield kg/ha	%	Diference ± kg/ha
c ₀ average years	2680	100	control
c ₁ 2020	2632	98	-48 ^{ns}
c ₂ 2021	2728	102	48 ^{ns}
LSD (p 5%) = 71, LSD (1%) = 100, LSD (0,1%) =142.			

^{ns} = insignificant

The value of protein content in soybeans was around 31% (Table 4). The highest percentage was found in the MTD variant at 54 cm (32,0%), respectively at 18 cm (31,9%), and the lowest in the NT variant at 54 cm. Protein content did not fluctuate much in soybeans grown in deeper tillage variants (CS, MTC), this being contained between 31,0-31,7%. It seems that both soybeans cultivated in SC, where the soil is very loose, as well as for the version without soil mobilization, the grain fat content was the most reduced at the row spacing of 18 cm (20,0%).

Table 4. Results regarding the influence of tillage system x row spacing on the main quality parameters of soybean, Turda 2020-2021

Tillage system	Spacing between rows (cm)	Protein (%)	Fat content (%)
CS (conventional-plough)	18	31.3	20.0
	36	31.3	20.4
	54	31.2	21.1
MTC (minimum till-chisel)	18	31.7	20.5
	36	31.3	21.3
	54	31.0	21.1
MTD (minimum till-disk)	18	31.9	20.1
	36	31.5	20.7
	54	32.0	20.9
NT (no till-direct seeding)	18	30.2	21.2
	36	31.0	20.9
	54	29.6	21.0

CONCLUSIONS

According to the results obtained, we can say that, in the Transylvanian Plateau and on soils with a high clay content, soybean lends itself best to the classic tillage system. Also, the chisel work system cannot be omitted, system in which the yield obtained are quite close to those of the classical system, but in return the amounts of fuel saved are significant, knowing that plowing is the work with the highest fuel consumption. From the sowing distances between rows experimented it is very clear that, soybeans react best at a distance of 54 de cm and recommend to farmers, using this distance when precision planters are not available for creeping plants.

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