Researches Regarding on the Impruvement and Efficiency of Minimal Soil Works System in Soybean Crop, Specific to Different Pedoclimatic Conditions, in Turda Area

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Abstract
The paper presents the influence of the conventional and minimum tillage system, the fertilization system and the agricultural year (expressed by different climatic conditions) on the production and economic efficiency of the soybean culture. The experience poly-factorial, was placed on the type of soil Phaeozem (clay, iluvial) in the Transylvanian Plain (with multi-annual average temperature of 9.1°C and multi-annual average rainfall of 531.0 mm). The soybean culture responded favorably to the minimal tillage technology, the production being very close to that obtained in the conventional system. The application of the “minimum tillage” system to the soybean culture requires a fuel consumption of 63.1 l/ha at the price of 328.12 lei/ha compared to the classic technology at which 78.6 l/ha is consumed at the price of 412.36 lei/ha, is 84.24 lei/ha in favor of the minimum system.

Key words: technology, fertilization, production, efficiency, soybeans

INTRODUCTION
Energy consumption is different for each crop, so the soybean cultivation technology has the highest direct energy consumption per unit area and 40% of soil preparation work (Nedeff and Eșanu, 1998). The energy consumed during the mechanical work is influenced by the climatic and soil conditions, the working depth of the machines and equipment, the parcel surface, the working speed, the degree of mechanization, the type of equipment used and must be used adequately to ensure the quality of the works and, implicitly, the productivity at lower costs (Stănileă et al., 2011). In the US, corn crops, by applying soil conservation technology through minimal works, a 30% energy saving compared to classical technology is achieved (Faidey, 1992). Griffith et al., (1982) finds that the classical soil cultivation system produces a 10% higher profit than the minimum system on a poorly drained soil. In contrast, the profit is 8% higher at minimum work on well-drained soil. Fausey (1984) argues that reducing the number of works on poorly drained soils leads to seeding delays, and plants show symptoms of nutrient deficiency. On poorly drained soils, compared to the classic system, close crops can be obtained through the minimal chisel system or the minimum system on the billiards. Also, from the studies on the efficiency of soil cultivation technologies in maize crops, in climatic and soil conditions in the Banat Plain, it is clear that between the classic system and the minimum system there are no big differences in fuel consumption, consumption of 31.3 l/ha in the classical system and 36.1 l/ha in a minimum system (Lăzureanu et al., 2011).

By excessive work of the soil with mechanical machinery and primarily the basic work, the appearance, which has negative effects through
a greater water loss, a weaker mineralization of the vegetal remains, the creation of the harpand, breaking the continuity of the capillarity, and if it appears on sloping land is made after the slope of the highest slope favors erosion (Guş, 1983; Bogdan et al., 2007; Cociu, 2011; Ibanez et al., 2008; Moraru and Rusu, 2010; Pop et al., 2013). A poorly executed cut reduces production, increases consumption and leads to soil compaction and, implicitly, to its degradation. At the same time, by removing the vegetation, the fields are exposed directly to the action of precipitation and wind, which leads to the detachment of particles and the erosion phenomenon (Berca, 2006). Also, the excessive use of fertilizers, especially nitrogen fertilizers, leads to soil acidification, in general the use of chemical fertilizers leads to pollution of watercourses and through absorption in plants has direct effects on the health of consumers (Mărghităș and Rusu, 2003; Marin et al., 2015; Dumitrut et al., 2013).

The transition from the classical soil cultivation system to the application of variants of the unconventional and soil conservation system includes a series of phytosanitary and phytosanitary measures of the land. Many of these measures are included in the concept of integrated weed control (Guş et al., 2004; Cheţan et al., 2016), diseases and pests, but which should be given greater attention when applying non-conventional systems.

From an economic and energy point of view, agriculture becomes more anti-entropic by reducing fuel and lubricant consumption, reducing aggregate wear, lower total cost and lower cost of labor, increasing labor productivity, shortening performance soil works etc. From an ecological point of view, preserving biodiversity and balance in agroecosystems requires the partial maintenance of plant debris as soil mulch in order to reduce water evaporation, thermal amplitudes in the superficial soil layer, the degree of soiling, but also to provide the source of the material energy for the various living creatures that contribute to the transformation of vegetal remains into humus.

Soy is currently one of the most important crops with high nutritional value. As a leguminous plant, soybean also has agrotechnical importance contributing to soil fertility, by fixing atmospheric nitrogen as a good precursor for most agricultural crops, can be used as a green fertilizer but also as raw material for biofuel (Cheţan and Cheţan, 2014; Ion, 2010; Guş et al., 2004; Vidican et al., 2013; Lăcătușu, 2006).

The SCDA Turda perimeter is as follows: the peaks are quiet, the sunny slopes are shorter and steeper than those with the Nordic display. On the slopes, slope processes (erosion, landslides, the excess moisture) are very common because of which the slopes are uneven, preventing the execution of agricultural works in the general direction of the level curves. The slopes of the exhibition S, SE, SV have the inclination between 7-15 degrees, their length being 150-300 m, the slopes with exhibition N, NE, NV have the inclination between 4-10 degrees, their length being between 250-600 m. The slopes with obvious signs of instability marked by field rocks, ruptures and dislocations revealed that at the surface of the soil up to 1-1.50 m there is a peat bed of clay that has a friction angle exceeding 20-22 degrees, a cohesion of about 1.00 kg / cm², consistency index 1, plasticity index to 30, porosity 30-35%. Erosion disturbances are reflected by lower productivity per unit area by 20-35% compared to non-eradicated land. In addition, the landfill degradation of the land is also added to soil damage, which often exceeds 30-35 t/ha/year (ARDS Turda, 50th anniversary, 2007).

Purpose of the paper: Due to the fact that most of the agricultural land in the Turda area is located in hilly area and given the many benefits of soybean culture, this work attempts to bring new data on the efficiency of soybean culture by applying the minimum tillage system in the area of the Transylvanian Plain.

MATERIALS AND METHODS

The research starts from the idea of optimizing the possible relationship between the soil cultivation system, the structure of the crops and the productions that can be realized at a lower cost price. These researches were carried out in a multifactorial experiment, during the period 2014-2017, the experimental field being included in a three-year crop rotation: soy - autumn wheat - corn. The experimental factors were:

A - Soil working system: a, classic (CS), Kuhn Huard Multi Master 125T plow with 30 cm depth + seedbed preparation in spring with rotary harrow HRB 403 D + sowing + fertilized with the Gaspardo
The harvesting of soy experiences was carried out in two stages: pre-emergence and post-emergence, in both soil systems using the products: pre-emergent 0.35 l/ha Sencor liquid 600 SC (metribuzin 600 g/l) + 1.5 l/ha Tender (960 g/l S-metolachlor) and post-emergence 1.0 l/ha Pulsar 40 (40 g/l imazamox) + 1.5 l/ha Agil 100 EC (100 g/l propaquizafop). Post-emergence application was carried out at the time when the soy was in the phenophase 3-4 trifoliate leaves, the dicotyledonous weeds in the 2-4 leaf stage and the monocotyledonous weeds were not twinning. To control the Tetranicus urticae pest, which produces premature defoliation, treatment with 0.8 l/ha Omite 570 EW (570 g/l propargit) insecticide was performed at the time of the signal. The control of Peronospora manshurica and Pseudomonas glycine diseases, which are transmitted through soil and vegetal remains, was carried out with the 2.5 kg/ha Ridomil Gold MZ 68 WG fungicide (4% mefenoxam + 64% mancozeb).

The harvesting of soy experiences was carried out in the following stages: harvesting the bands around the experiences; harvesting the frontal and lateral edges of the experimental variants (frontal discharges were 1 m and lateral removals of 0.60 cm), taking into account the working width of the combine harvested experimental plots. The harvest area of the experimental plot was 28 m². The economic efficiency of the researched variants was determined depending on the number of technological works applied, the fuel consumption (based on the characteristics of the agricultural machines and the used equipment, the works performed on a land with 1.19 % slope coefficient) and the materials used, per hectare. The experimental data were processed by variant analysis (Polifact, 2015) and limit differences determination (LSD, 5%, 1%, 0.1%).

The meteorological conditions in the experimental years (Turma Meteorological Station, longitude: 23°47’ latitude 46°35’, altitude 427 m) are presented in Figure 1.

RESULTS AND DISCUSSIONS

The experience has been established on a fertile soil but also with a susceptibility to rapid compaction at the passage of large agricultural aggregates or when working mechanically in high humidity conditions. The year 2014 was favorable for agricultural crops, even if the highest annual average temperature of 11.1°C in the last 10 years, the alternation of months with thermally normal temperatures and the warm ones were beneficial to the soybean vegetative stages. The 2014 precipitation with an annual sum of 741.5 mm was high in quantity, especially during the summer even though the number of days with rain was lower.

Year 2015 was characterized as a warm and rainy year. The average was 10.7°C, with 1.5°C more than the 60-year multiannual average. The precipitation of this year exceeded by 122.4 l/m² the value of 518.6 l/m², the multiannual average for 60 years. The recorded amount was 641.2 l/m².

Year 2016 is characterized as a warm year, with a deviation of + 0.9°C from the multiannual average, recording an average annual temperature of 10°C. From the point of view of the pluviometric regime, 2016 with 816.8 l/m² compared to the multiannual average is characterized as an excessively rainy year.
Year 2017 began with a cold January and excessive drought, February was a warm month and normal rainfall, March warm and excessively rainy, followed by April and May to be warm and with sufficient rainfall. The summer month, warm and normal from a thermal point of view, as well as precipitation, which, although in sufficient quantities did not always come to the critical moments of the crop growing period, was a warm and rainy autumn. Overall, the year was less favorable to soybean culture in the Turda area.

Specifically for the four years you studied (2014, 2015, 2016, 2017) was the uneven distribution of precipitation, there were periods of dry time with prolonged droughts followed by torrential rains (Figure 1).

In comparison with the multiannual average (15.0°C) in May the temperature values were higher, with deviation + 1°C in 2014; + 0.8°C in 2015; + 0.7°C in 2017. Deviation - 0.7°C in May 2016 where was the most cold month in the experimental years. Temperatures above average were recorded in June with + 0.6°C deviation in 2014; + 1.5°C in 2015; + 1.9°C in 2016 and the highest + 2.8°C value was recorded in 2017 compared to the multiannual average (17.9°C). July also had temperature increases over the multiannual monthly average (19.7°C) with deviation + 0.7°C (2014); + 0.6°C (2017); + 0.8°C (2016) and + 2.6°C in 2015 (in the last decade there were 4 consecutive days of arched (atmospheric drought) that extended until the first decade of August indicating the drought stabilized. The biggest deviation + 3.0°C was recorded in August 2017 (with temperatures that have, over 32°C and lasting several consecutive days). From these data it can be noticed an increase

Figure 1. Thermic and pluviometric regime during 2014-2017 at ARDS Turda

Table 1. Thermal regime from 1 March to 31 August, 2014-2017, ARDS Turda

<table>
<thead>
<tr>
<th>Year</th>
<th>Month/decade/air temperature (°C)</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>2014</td>
<td>13.2</td>
<td>13.8</td>
<td>17.9</td>
<td>18.4</td>
<td>18.9</td>
</tr>
<tr>
<td>Monthly average</td>
<td>15.1</td>
<td>18.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>15.7</td>
<td>15.1</td>
<td>16.4</td>
<td>21.4</td>
<td>20.0</td>
</tr>
<tr>
<td>Monthly average</td>
<td>15.8</td>
<td>19.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>12.4</td>
<td>12.4</td>
<td>17.8</td>
<td>17.2</td>
<td>19.3</td>
</tr>
<tr>
<td>Monthly average</td>
<td>14.3</td>
<td>19.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>14.1</td>
<td>15.7</td>
<td>17.3</td>
<td>19.5</td>
<td>19.3</td>
</tr>
<tr>
<td>Monthly average</td>
<td>15.7</td>
<td>20.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average 60 years</td>
<td>15.0</td>
<td>17.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
of the average monthly temperature in the period from May to August, which corroborated with the pedological drought with negative affect the soybean production in 2015 and 2017 (Tab. 1).

The role of water in production has been extensively researched, being one of the main limiting factors of soybean production. In this regard we can state that in general the conditions in Turda area correspond to the formation of superior quantities of soy qualitative and quantitative soy. However, lately, there is a significant variation in the amount of rainfall recorded in the critical phase of soybean water and a significant difference of the years in this case (Tab. 2). A major contribution to the production of soybeans is due to precipitation from the second half of June (at the beginning of the bloom) to the filling of seeds corresponding to the second half of August.

Monthly average rainfall in May was maintained in three years 2014, 2015 and 2017 near 68.7 mm (average 60 years) except in 2016 with + 21.7 mm. June has had rainfall in 2014 (- 36.4 mm) and 2017 (- 54.2 mm). In July 2016, rains grouped more in the second decade and in the third decade in 2014 when two high-intensity rainfall occurred which increased the monthly precipitation amount. Month August was generally very dry in the first decade (exception 2016), the second decade in 2014 and 2017, and in the last decade in all experimental years. Although climatic conditions were optimal from the point of view pluviometric in the spring months what was led to a rapid and uniform plant emergence at 12 days after sowing, the drought in June 2014 and 2017 affected the flowering of the soybean and the drought in the first two decades of August 2017 had a negative influence on the pods and filling of grains with negative repercussions on the production achieved. The August drought forced the ripening of the soybean.

The soybean production is not significantly influenced by the tillage system, the 48 kg/ha production difference between the two soil systems, confirms the effectiveness of the minimum tillage and the applicability at at the soybean culture in the conditions of the Transylvanian Plain (Tab. 3).
Experimental years directly influence the recorded productions. Compared with the year 2014, where the registered production is 2756 kg/ha, in the other years the yields were slightly higher, the differences was between 306 - 331 kg/ha, due to the positive distinctly signification influence. In order to reduce the harvest losses caused mainly by the low insertion of the first pods remaining under the combine cutter, the land on which soy is grown must be as uniform and straight as possible, the density must be optimum, the varieties used must be zoned and have the insertion the first pods over 14 cm above the ground (Tab.4).

As a result of researches carried out in different countries, it was found that replacing the soil with a chisel soil is more energy efficient and economical, reducing fuel consumption by up to 34% or even 80% relative to the plow (Tiganov, 1981).

At ARDS Turda the price with the mechanical works on the classical system (C.S.) was 701.8 lei/ha comparative with the minimum tillage system (M.T.) when the expenditure was 507.2 lei/ha. Differences lei/ha was 194.6 lei/ha in the favor on minimum tillage. For all the hand works have been spent 101.45 lei/ha in the C.S. and 89.45 lei/ha in M.T., with a differences 89.45 lei/ha. The price of materials was very high in both systems, however a lower value is recorded in the M.T. because in the C.S. use the string to bind the soybeans and transport them from the field and in the M.T. after harvest the vegetal debris spreads on the soil surface.

Soybean production at sale of about 2 lei/kg brings in the C.S. a profit of 96 lei but which is finally dimmed by the high cost of mechanical and manual works. Following the calculations made at Turda, it is convenient to cultivate soybean in the M.T. because the total technology makes a profit of 210 lei/ha compared to the C.S. (Tab. 5).

<table>
<thead>
<tr>
<th>B·Year</th>
<th>Yield kg/ha</th>
<th>%</th>
<th>Differences</th>
<th>Signification</th>
</tr>
</thead>
<tbody>
<tr>
<td>b·2014</td>
<td>2756</td>
<td>100</td>
<td>0.00</td>
<td>Mt.</td>
</tr>
<tr>
<td>b·2015</td>
<td>3093</td>
<td>112</td>
<td>337</td>
<td>**</td>
</tr>
<tr>
<td>b·2016</td>
<td>3107</td>
<td>113</td>
<td>351</td>
<td>**</td>
</tr>
<tr>
<td>b·2017</td>
<td>3062</td>
<td>111</td>
<td>306</td>
<td>**</td>
</tr>
</tbody>
</table>

\[(LSD\ test, \ P < 5\%) = 75; (LSD\ test, \ P < 1\%) = 113; (LSD\ test, \ P < 0.1\%) = 182.\]

Table 4. The influence of the years on the soybean production during 2014-2017

<table>
<thead>
<tr>
<th>No crt.</th>
<th>Elements of expenditure</th>
<th>Tillage system</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mechanical works (lei)</td>
<td>SC  701.80</td>
</tr>
<tr>
<td></td>
<td>Fuel consumption (l/ha)</td>
<td>78.6</td>
</tr>
<tr>
<td>2</td>
<td>Hand works, (lei)</td>
<td>101.455</td>
</tr>
<tr>
<td>3</td>
<td>Materials (lei)</td>
<td>1510.47</td>
</tr>
<tr>
<td></td>
<td>Total expenses lei/ha</td>
<td>2313.725</td>
</tr>
<tr>
<td></td>
<td>Difference lei/ha</td>
<td>306.6</td>
</tr>
<tr>
<td>4</td>
<td>Average soybean production kg/ha</td>
<td>3028</td>
</tr>
<tr>
<td>5</td>
<td>Sale price soy 2.0 lei/kg</td>
<td>6056.0</td>
</tr>
<tr>
<td></td>
<td>Difference lei/ha</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Total profit in favor of the minimum tillage system = 210 lei/ha</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. The technological expenses for 1 ha of soybeans
By realizing this experiment we did not intend to get higher net productions in the M.T. system but to get production close to those obtained in C.S., at a lower cost price taking into account the principles of sustainable agriculture mentioned in the literature (Carter, 1994): preserving or even improving physical, mechanical, chemical and biological properties of the soil, while creating the optimal conditions for plants growing by renouncing to the plowing of the periodic or in total, by reducing the number of works applied to the soil, by keeping at least 30 % of the total vegetal debris at the surface of the soil, by protecting the environment.

CONCLUSION

Soybean does not have preferences for the soil cultivation system, the average production achieved in the two systems is very close (C.S. 3028 kg/ha; M.T. 2980 kg/ha);

The production of soybeans is influenced by the precipitation from the second half of June to the second half of August;

The application of the minimum tillage system to the soybean culture requires a fuel consumption of 63.1 l/ha at the price of 328.12 lei/ha compared to the classic system at which consumption of 63.1 l/ha at the price of 328.12 lei/ha is favored of the minimum system.

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