STUDY REGARDING THE FORCES THAT OCCURS IN A NO-TILL TECHNOLOGY PROCESS IN RELATION WITH GEOMETRICAL PARAMETERS OF THE COULTER DISCS

Ranta Ov¹, K. Koller², V. Ros³, I. Drocaş¹, Ov. Marian¹

1- University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca,
2- Hohenheim University Stuttgart, Germany
3- Technical University Cluj-Napoca

e-mail: ranta_o@yahoo.com

Key words: no-till, disc coulters, operating forces

Abstract: This paper presents the coulter disc type influence on vertical and horizontal forces during no-tillage process. The practical research was done in laboratory conditions (soil bin) at the Hohenheim University, Stuttgart, Germany with three different coulters disc for no till

INTRODUCTION

The development of new technologies for soil tillage, which are superior to the classic ones, impose further researches of the machines involved in the new soil management systems. These researches are necessary in order to improve the factors that regards the growing needs of the plant.

No-till seeding means that in an untilled soil a narrow culvert is opened, the seed is placed at an optimum depth and the optimum coverage of the seed must be achieved.

From design point of view, the no-till seeding machine differs from the classic ones. Mainly these differences consist in the fact that they have other furrows and some auxiliary parts. A distinctive part of these machines is the furrow disc, which cuts the vegetal residues on the soil and breaks the soil in the culvert.

This paper analyses the influence of the geometric elements of the openers over the soil resistance where the seed is placed. This research is made in order to establish the influence of the geometry over the horizontal and vertical forces and to determine the adaptability of this coulter disc to different working conditions.

MATERIAL AND METHODS

The researches were carried out at Hohenheim University in Stuttgart – Germany. Three coulter discs where studied mounted on a romanian no-till seeding machine. One of the discs was flat and the other two were rifled with different rifle intervals.

The soil bin has an artificial soil, which has the following composition: 72% sand, 16% clay, 12% dust.

The soil bin is 46 m long, 5 m wide and 1,2 m deep. The tests were made at different speeds: 3, 5, 11 km/h and 5 km/h, which was considered optimum for the seeding machine

The main geometric elements of the rifle discs tested are shown in figure 1.
Fig 1 Geometric elements of the rifle disc
RE – exterior radius; RI- beginning radius of the rifle; c- working width; t-thickness; p- rifle interval; s – angle of the cutting edge;

Fig 2 Direct seeding machine working in the soil channel

The equipment used for forces measurement

For measurement and data acquisition, the tractor has a computer connected to a tensiometer frame. On this equipment the tested machines are mounted. The frame has 6 pressure sensors which measure three components of the horizontal frame: X1, X2 and X3, two components of the vertical frame: Y1 and Y2 and one which measures the deviation Z.

The data acquisition system has a signal amplifier-collector, which receives signals from the sensors and a computer. With the necessary software, the data is downloaded as text files, which later can be interpreted. For force measuring, the HBM CATMAN, version 2.0 was used.
RESULTS

After the soil was prepared, the initial parameters of the soil are presented in tables 1 and 2.

**Initial mean values of the soil cone index**

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>Soil resistance [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>C2</strong></td>
</tr>
<tr>
<td>0</td>
<td>0,95</td>
</tr>
<tr>
<td>2,5</td>
<td>1,30</td>
</tr>
<tr>
<td>5</td>
<td>1,20</td>
</tr>
<tr>
<td>7,5</td>
<td>1,00</td>
</tr>
<tr>
<td>10</td>
<td>0,85</td>
</tr>
</tbody>
</table>

**Initial mean values of the soil shearing**

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>Shearing moment of the soil [N.m]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>C2</strong></td>
</tr>
<tr>
<td>5</td>
<td>11,39</td>
</tr>
<tr>
<td>10</td>
<td>9,28</td>
</tr>
</tbody>
</table>

*Results obtained with the flat disc mounted on the experimental machine*

In figures 3 and 4 are presented the average forces measured when moving with 3 and 11 km/h, on 40 m distance.

*Fig. 3 Average forces for soil resistance at 3 km/h*
Fig. 4 Average forces for soil resistance at 11 km/h

For this experimental machine for no-till seeding, equipped with a flat opener, the variation of forces on the given distance, it can be seen that the traction force (X) decrease when the travelling speed increase. The values vary in a larger interval than in the high speed case. In the same time, along with the X variation the force Y vary too. These variations are also influenced by the travelling speed. The pressure value is higher for the flat disc, which means that the disc can cut better the plant residues on the soil.

Results obtained with the rifle disc (n=14)
The rifle disc used in this experiment had a diameter of 400 mm, thickness 4 mm and angle of the cutting edge was $s = 30^\circ$. The number of rifles was 14.
When the machine was equipped with a rifle disc opener (n=14) one can observe from the figure above, that the traction force (X) decrease when the travelling speed increase and has values which vary in a larger interval than the high speed case. Along with the X force variation one can observe variations of the Y force. These variations are also influenced by the speed. The pressure force is lower in this case, which assures a very good cut of the plant residues, only if the soil is harder.

Results obtained with the rifle disc (n=26)

The rifle disc used in this experiment had a diameter of 400 mm, thickness 4 mm and angle of the cutting edge was $s = 30^\circ$. The number of ht rifles was 26.
Analyzing the figure 9, it can be seen that the traction force (X) decreases when the travelling speed increases and has values which vary in a larger interval than the high speed case. Along with the variation of the X force, the Y forces vary too. These variations are also influenced by the travelling speed.

CONCLUSIONS

By analysing the acquired data, in all three cases, we can conclude that:
- the resistance at maximum traction force (X) is for the flat disc because of the higher resistance to roll and cut in the frontal area
- the resistance at maximum pressure (Y) is for the rifle disc which has a higher number of intervals (26). This happens because of the increase of the surface contact with the soil and movement induced in soil in horizontal plane.
- when the travelling speed increases it is possible to see high variations of the traction force (X). This is a sign of machine functioning with shocks and vibrations. This phenomenon is common for flat disc and rifle disc with a lower number of intervals (14). We can say that the stability in work increase when the number and amplitude of the rifles increase;
- we recommend higher working speeds, the limiting factors being: the characteristics of distribution device, machine design, relief and slope, geometrical parameters of the disc;
- we recommend to use flat discs on easy grounds with a lot of plant residues when the moisture is low and when soil resistance increase should be used rifle discs with a higher number of rifles and a larger working width.

REFERENCES