Analysis of Working Qualitative Parameters for No-Till Machines

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Abstract. Authors designed a system to modify the SPC romanian seeding machine for in order that it can be used for no-till technology. This machine was manufactured with the help of S.C. MECANICA M.A.R.I.U.S. S.A. in Cluj- Napoca and it was used in laboratory conditions in a state of the art soil bin of Hohenheim University, Stuttgart and in laboratory-field conditions. The field experiments were located on a plot of Experimental Teaching Facility of USAMV Cluj-Napoca, on aluviosol molic soil after SRTS – 200, in location Lunca Someşului Mic (Podişul Someşan).

Keywords: no-till technology, indexes for seeding quality.

INTRODUCTION

Increasing development of new soil tillage technologies that are superior both economically and in terms of sustainable agriculture, with classical technologies, more research is required to agricultural machines built in these technologies in order to respect the requirements for crop growth and development.

The main condition that is imposed for no-till machines results from the fact that it must conduct a soil aeration and mixing to a minimum and to put the seed into the soil so that it has optimal conditions for germination and growth.

MATERIAL AND METHOD

Testing under field conditions were carried out on land of Experimental Teaching Facility of USAMV Cluj-Napoca, on aluviosol molic soil - SRCS, 1980 from meadow of Someşului Mic river (on Someşan Plateau). For trials was made an experimental no-till model and the seed distribution parts were taken from the Romanian sowing machine SPC.

At sowing maize was low rainfall, water reserves accumulated in the soil and sowing corn in optimal time, ensured its emergence in a range of 16 to 21 days. Due to unfavorable rainfall maize growth was slow, the plants going through periods of stress in the decisive phase for the formation of production (May-June).

Were sown 8 rows of plants each with a length of 45 m. Distance between rows was 70 cm. The unit of seed distribution of sowing machine was set for a turn away from grains of 18 cm. Working speed was 5 km/h. Sowing depth was set 5 cm. Soil moisture was 70% and temperature of 9 °C. In fig. 1 is showed the no-till experimental model used during the tests in the field.
The trials aimed the analysis of following items:
- seeds sowing precision as the distance between seeds on a row;
- seeds sowing precision as number of seeds in place;
- average depth of seed incorporation;
- percentage of waste vegetable cutting;
- the opening of the sowing gutter;
- the closing of sowing gutter;
- emergence time;
- emergence degree;

Basically these indices were determined on each row. Were made 25 de measurements on each row. The amount of straw on the soil surface was 200 g/m², which is 2000 kg/ha. The sowing precision as the distance between seeds, \( P_d \) on a row was computed with [1.1]. The results are showed in table 1

\[
P_d = \frac{n_0}{n_i} \times 100 \text{ [%]}
\]

in witch \( n_0 \) is number of the distances between seeds places on the row, for which deviation from the theoretical distance \( d \) is \( \pm 0,2 \times d \);

\( n_i \) – total number of the distances between seeds. It is considered that the accuracy of sowing is good if \( P_d \geq 80\% \).

From the resulting data shows that the sowing precision as distance between seeds on row is average of 87.5% and the minimum allowed value is 50%.

Results to determine the sowing precision as the distance between seeds on a row

<table>
<thead>
<tr>
<th>Row</th>
<th>Samples</th>
<th>Correct samples</th>
<th>Deviation</th>
<th>Sowing accuracy ( P_d ) [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>22</td>
<td>3</td>
<td>88%</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>22</td>
<td>3</td>
<td>88%</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>21</td>
<td>4</td>
<td>84%</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>22</td>
<td>3</td>
<td>88%</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>23</td>
<td>2</td>
<td>92%</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>22</td>
<td>3</td>
<td>88%</td>
</tr>
</tbody>
</table>
The sowing accuracy as number of seeds in place, $P_c$, was computed with [1.2] and the results are showed in table 2.

This index, $P_c$ (%), is computed with:

$$P_c = \frac{n_{cc}}{n_t} \cdot 100\%$$

[1.2]

in which $n_{cc}$ is number of seeds places on a sample taken as correct number of seeds in place (for which the machine was adjusted);

$n_t$ – total number of seeds places on taken sample.

Permissible value is $P_c \geq 80\%$, but there should be no seed place without any seed.

<table>
<thead>
<tr>
<th>Row</th>
<th>Samples</th>
<th>Places with one seed</th>
<th>Empty places</th>
<th>Places with two seeds</th>
<th>Sowing accuracy $P_c$ [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>24</td>
<td>0</td>
<td>1</td>
<td>96%</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>24</td>
<td>0</td>
<td>1</td>
<td>96%</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>23</td>
<td>0</td>
<td>2</td>
<td>92%</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>24</td>
<td>0</td>
<td>1</td>
<td>96%</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>175</td>
<td>0</td>
<td>0</td>
<td>97.5%</td>
</tr>
</tbody>
</table>

From the resulting data shows that the sowing precision number of seeds in place has average value 87.5 % and the minimum allowed value is 80%.

The average depth of seed incorporation, $a_m$(cm) was computed with [1.3]

This index, $a_m$ (cm), is computed with:

$$a_m = \frac{\sum_{i=1}^{n} a_i}{n}$$

[1.3]

in which $a_i$ are the values of working depths (cm);

$n$ – number of measurements, $n \geq 20$, on a distance by 100 m traveled with the no-till machine, properly adjusted and with working speed as the maximum speed.

In this way the value was $a_m= 4.94$ cm.

Average deviation from the working depth $\delta_a$ (cm) was computed with [1.4]. The allowed value is $\delta_a \leq \pm 0.08$.

This index, $\delta_a$ (cm), is computed with:

$$\delta_a = \frac{\sum_{i=1}^{n} |a_i - a_m|}{n}$$

[1.4]

It is recommended that $\delta_a \leq \pm 0.08 x a_m$.

For our circumstances the index was $\delta_a = 0.06$;
The percentage of residues incorporated by the parts for gutter opening was computed with:

\[ \phi = \frac{m_r}{m_s} \times 100 \, \% \], \[1.5\]

in which \( \phi \) is percentage of residues incorporated;
\( m_r \) - dry mass of plant debris;
\( m_s \) – soil dry mass;

The average value obtained was 1.8 \%. This cutting rate may be considered as very good.

Following field-laboratory tests, the experimental model of no-till machine showed that the track parameters are within limits. Cutting the plant debris was done correctly, the amount of non cutted straw inserted into gutter was minimum, the gutter opening was appropriate providing a fair settlement of the seeds on the bottom of the gutter, seed coverage degree was up and soil compaction on row was sufficient.

Determining the degree of emergence was made after a period of 15 days after sowing.

For a row of 40 m length at a distance of 18 cm between seeds, should be theoretically 222 seeds and after emergence was determined number of plants (tab.3).

With \[1.6\] was computed the degree of emergence on row and in total for the entire plot sown.

\[ Gr = \frac{P_r}{P_s} \times 100 \, \% \], \[1.6\]

in which \( Gr \) is the degree of emergence;
\( P_r \) – number of plants;
\( P_s \)- number of incorporated seeds;

<table>
<thead>
<tr>
<th>Row</th>
<th>Number of plants (theoretical)</th>
<th>Number of plants (real)</th>
<th>Remaining empty spots</th>
<th>Degree of emergence ( Gr ) [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>222</td>
<td>210</td>
<td>12</td>
<td>94%</td>
</tr>
<tr>
<td>2</td>
<td>222</td>
<td>204</td>
<td>18</td>
<td>91%</td>
</tr>
<tr>
<td>3</td>
<td>222</td>
<td>201</td>
<td>21</td>
<td>90%</td>
</tr>
<tr>
<td>4</td>
<td>222</td>
<td>212</td>
<td>10</td>
<td>95%</td>
</tr>
<tr>
<td>5</td>
<td>222</td>
<td>209</td>
<td>11</td>
<td>94%</td>
</tr>
<tr>
<td>6</td>
<td>222</td>
<td>194</td>
<td>28</td>
<td>87%</td>
</tr>
<tr>
<td>7</td>
<td>222</td>
<td>205</td>
<td>17</td>
<td>92%</td>
</tr>
<tr>
<td>8</td>
<td>222</td>
<td>211</td>
<td>11</td>
<td>95%</td>
</tr>
<tr>
<td>Total</td>
<td>1776</td>
<td>1646</td>
<td>0</td>
<td>92.68%</td>
</tr>
</tbody>
</table>

Determining the gutter closing

This determination was made by evaluating the soil surface profile with a Profilograph equipped with its own data acquisition system which measures height above ground on the issue of light waves and the received signal is converted into electricity and transmitted to a data card acquisition and is stored in the computer as a text file. Operation can be chosen for two measurement modes, namely a single plane and spatial measurement.

In fig.3 is presented the soil across profile taken with the Profilograph after machine passing and gutter closing and in fig. 4 is showed the soil front profile.
However, influence of soil tillage system especially related to conditions of humidity where was placed a corn seed, the presence of vegetable residues and of fertilizers on the soil surface, impairing the development of root system during germination – emergence has influence on root system development, on the plant height and on the achieved production.

The SPC machine adapted for no-till technology respected the major indices for quality assessment for sowing, it places the seeds in good conditions and gutter closing is made in optimal conditions.

REFERENCES