Reasearches Concerning the Achievement of a Machine for Spreading Low Rates of Chemical Fertilizers

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Abstract: The paper presents the Romanian concerns regarding the preservation of a friendly environment, by researches for achievement of a machine which can spread low rates of chemical fertilizers. It’s about the necessity to transport a great quantity of chemical fertilizer and spread it with cheap costs, during the optimal period and satisfying the agro-technical necessary requirements of the plants chemical fertilizer.

Keywords: sustainable agriculture, friendly environment

INTRODUCTION

As defined, "sustainable development is a development which aims to meet the needs of present without compromising the ability of future generations to meet their own needs," Romania must act in the direction of the development of technologies in agriculture. In this context was prepared in November 2008 "The National Strategy for Sustainable Development of Romania. Orizonturi 2013-2020-2030" with the motto "Keep healthy what keeps you healthy".

Thus, this article presents a part of efforts to improve technologies of chemical fertilization with granular fertilizers. The results of experimental research will be incorporated in the construction of a machine intended for granular chemical fertilizers in small quantities, up to 50-60 kg / ha.

MATERIALS AND METHODS

The machine designed for spreading chemical fertilizers, useful weight of 3.5 tones, MA 3.5, made at SC MAT SA Craiova, spreads rates for distribution of over 100 kg/ha. Therefore, was examined the possibility to change the constructive solutions in a way that it could distribute low rates of approximately 50 kg/ha.

Therefore, there was conceived a centrifugal spreading device with 2 disks (fig.1) in order to enlarge the spreading area during the work process. The rear spreading device of the machine was modified and there was also added an element in order to conduct the transported fertilizers to the distribution conveyors, a special type conveyors with special alveoli. Fertilizers are directed in a certain area on the spreading surface of the discs.

There were made and tested two spreading devices provided with two discs, of 260 mm diameter, and another device with two discs, 400 mm diameter, with 4 adjustable palettes in the horizontal plane. The discs are placed at 410 mm distance and operated by a group of three reduction gears.
The movement is transmitted from the tractor’s PTO to a cardan transmission, at the entrance of the central gear, and it is sent to two lateral conical reducers, which move the disks circular contrariwise.

Fig.1. Construction of the spreading device by two centrifugal discs

The tests in operating conditions have included the determination of qualitative indices of the field testing:

- Uniformity of the transversal distribution;
- Uniformity of the longitudinal distribution;
- Spreading width;
- Spreading fertilizers rate.

The determination of transverse distribution was made in compliance with SR ISO 5690-1:1995 "Equipment for distribution of fertilizers. Test method. Part.1. Fertilizer spreading surface devices, section 5.1. For the collection were used trays: 250x1000 mm (Fig.2; Fig.3).

Fig.2. Disposal scheme of the collection boxes

Fig. 3. Aspects regarding the determination of the chemical fertilizers collecting, in case of the transversal spreading

The determination of longitudinal distribution was made in compliance with SR ISO 5690-1:1995 "Equipment for distribution of fertilizers. Test method. Part.1. Fertilizer
spreading surface devices, section 5.2 and it was the distribution of fertilizer to an area that has been disposed transverse collector trays with dimensions of 250 x 1000 mm (Fig. 4; Fig. 5).

![Fig. 4. Disposal scheme of the collection boxes](image)

![Fig. 5. Aspects regarding the determination of the chemical fertilizers collecting, in case of the longitudinal spreading](image)

The fertilizers collected from the numbered trays were put in plastic bags and after that, they were weighed (Fig. 6).

![Fig. 6. Aspects from the weighings](image)

Indices that characterize the uniformity of distribution, for transverse and longitudinal spreading, are: the degree of uniformity of distribution, $G_{ud} > 75\%$ and the constance of the flow distribution, $C_{d} > 85\%$.

To determine the values were used the formulas:

- **The coefficient of the stability of the flow - $C_{d}$**

$$C_{d} = 1 - \sqrt{\frac{\sum_{i=1}^{p} (Q_i - Q_m)^2}{p-1}} \cdot 100 \%$$

where:

- $Q_m$ - the average quantity of fertilizer fell into trays to a sample, in kg.
Q_{i}\) - the amount of fertilizer collected in \(n\) trays, at the \(i\) test, in kg;
p – number of repetitions of the tests.

- **The degree of the uniformity of the material distribution width during the spreading process** \(G_{ud}\)

\[
G_{ud} = (1 - \frac{\sigma}{Q_m}) \cdot 100 \quad [\%]
\]

where:
- \(G_{ud}\) is the uniformity of the material distribution width during the spreading process, \(\%\);
- \(\sigma\) – mean square deviation;
- \(Q_m\) – the average quantity of fertilizer fell into trays to a sample, in grams.

**The mean square deviation** \(\sigma\) was calculated by the formula:

\[
\sigma = \sqrt{\frac{\sum_{i=1}^{n} (Q_i - Q_m)^2}{n-1}} \quad [g]
\]

where:
- \(\sigma\) – mean square deviation;
- \(Q_m\) – the average quantity of fertilizer fell into trays to a sample, in grams;
- \(Q_i\) – the average quantity of fertilizer fell into \(i\) tray to a sample, in grams;
- \(n\) – number of trays taken into account.

**Rate of the fertilizer distributed per unit area**

The minimum, maximum and average amount of fertilizer that can be distributed by the machine was determined when the bunker was loaded with fertilizers on 2/3 of its capacity. There have been made adjustments to the chain wheel of the chain conveyor and opening the gate adjustment in order to achieve the minimum, maximum and average distribution rate, at the division 1, division 3 and division 6. The fertilizer, distributed on an area of 100 square meters, was collected in bags and was weighed with an accuracy of 1 gram.

Samples were made with three repetitions.

Rates \(N\) in kg/ha were calculated by the formula:

\[
N = \frac{Q \cdot 10000}{b \cdot l} \quad [kg/ha]
\]

where:
- \(Q\) is the quantity of fertilizer collected, kg;
- \(b\) – width of the fertilizer area, m;
- \(l\) – distance to a sample, m.

**RESULTS AND DISCUSSIONS**

**Determination of longitudinal distribution**

In the case of disks with a diameter of Ø260 and distance between the disks \(d = 410\) mm, there was a relatively small distribution in the central area, registering superior behavior in the case of distribution equipped with discs Ø 400 mm diameter, placed at the same distance \(d = 410\) mm (table 1).
Results obtained by weighing the amount of fertilizer collected in trays, which have spread by two devices for distribution, with discs by 260 mm diameter and 400 mm diameter, respectively, for three repetitions, are according to the charts presented in fig.7 a and b.

Indices that characterize the spreading work in case of longitudinal distribution
Degree of the uniformity of the longitudinal distribution and Stability of the flow

<table>
<thead>
<tr>
<th>Fertilizer type; Spreading device type</th>
<th>Degree of the uniformity of the longitudinal distribution - $G_{ud}$ [%]</th>
<th>Stability of the flow $C_d$ [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex Fertilizers NPK 16.16.16; Discs Ø400; d=410; Palettes arranged radially</td>
<td>R 1 87,44 R 2 88,09 R 3 88,70 R 3 88,08</td>
<td>R 1 89,72 R 2 87,50 R 3 90,91 Average 89,38</td>
</tr>
<tr>
<td>Complex Fertilizers NPK 16.16.16; Discs Ø260; d=410; Palettes arranged radially</td>
<td>R 1 81,77 R 2 77,15 R 3 74,10 R 3 77,67</td>
<td>R 1 83,12 R 2 84,57 R 3 86,3 Average 84,66</td>
</tr>
</tbody>
</table>

d – distance between discs; R 1- 1st repetition; R 2 – 2nd repetition; R 3 – 3rd repetition

**Determination of the transversal distribution**

After weighing the quantities of chemical fertilizer collected in trays in the case of 3 repetitions were computed indices characterizing the quality of the spreading work. The results are shown in Tab. 2.
Indices that characterizes the spreading work in case of transversal distribution

<table>
<thead>
<tr>
<th>Fertilizer type; Spreading device type</th>
<th>Degree of the uniformity of the transversal distribution - $G_{ud}$ [%]</th>
<th>Stability of the flow $C_{d}$ [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R 1</td>
<td>R 2</td>
</tr>
<tr>
<td>Complex Fertilizers NPK 16.16.16; Discs Ø400; d=410; Palettes arranged radially</td>
<td>82,79</td>
<td>84,32</td>
</tr>
<tr>
<td>Complex Fertilizers NPK 16.16.16; Discs Ø260; d=410; Palettes arranged radially</td>
<td>78,34</td>
<td>76,54</td>
</tr>
</tbody>
</table>

$d$ – distance between discs; $R_1$ - 1st repetition; $R_2$ – 2nd repetition; $R_3$ – 3rd repetition

Results on **transverse distribution**, for the distribution of discs diameter 400 mm, for three repetitions, are according to the graph shown in Fig.8:

![Fig.8. Transversal distribution graph. Discs Ø 400](image)

**Width distribution**

The spreading width was determined taking into account the transverse distribution uniformity, resulting a spreading width of about 16...17 m. In order to obtain the same amount of fertilizer per unit area, at the next transition of the aggregate in the spreading process, there will be a 3 m overlap.

**Rate of fertilizer distributed**

Aspects of the determination of fertilizer distributed rate are shown in Fig.9.

![Fig.9 Aspects of the experiments](image)
The results recorded for the minimum opening suber’s position, at 1\textsuperscript{st} division, the average position at 3\textsuperscript{rd} division and the maximum position, the 6\textsuperscript{th} division, are shown in Tab. 3.

<table>
<thead>
<tr>
<th>Rate of fertilizers distributed per hectare</th>
<th>Discs Ø260; Palettes arranged radially</th>
<th>Suber’s position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discs Ø400; Palettes arranged radially</td>
<td>Div.1</td>
</tr>
<tr>
<td>Complex fertilizer NPK 16.16.16</td>
<td></td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

CONCLUSIONS

Conclusions resulting from carried out tests show that the distribution of fertilizers to land by a device equipped with discs of Ø400 diameter with palettes arranged radially, are near to those desired, which mean there can be spread a low quantity of fertilizer, approx. 60 kg/ha.

However, the uniformity of longitudinal and transverse distribution and the distribution’s stability are better when the machine MA 3.6 is equipped with spreading device with discs of Ø400 diameter, compared with that equipped with discs of Ø260 diameter.

To obtain a uniform administration throughout the area, the land will be landmarked in order to overlap the distribution width of about 3 meters, given that at a single transition the distribution is close to the Gauss’ curve.

Researches will continue with the testing of the distribution fitted with discs of 600 mm diameter, to take notice of the best option, when the qualitative indices of the spreading work will be significantly improved.

Conclusions that will result will be the basis for the design and execution of zero serie of granular chemical fertilizers and amendments spreading machine, weight capacity of 3.6 tons, MA3.6, which will be made to SC MAT SA Craiova.

REFERENCES