MODERN METHODS FOR DETERMINING THE UNIFORMITY OF DISTRIBUTION ENSURED BY CHEMICAL FERTILISERS MANAGED MACHINES

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ABSTARCT

Using on a large scale of chemicals in agriculture and sometimes administration in excess on certain areas has led to an accumulation in soil and their involvement in the surrounding water sources. Increase in nitrate levels in surface waters (who are trained on the fertilized soils) is evident in the recent years and eutrophication of rivers and lakes in particular has come to constitute a very important issue.

INTRODUCTION

The widespread use of machinery for managing solid chemical and amendments, equipped with centrifugally devices for distribution imposed to achieve a constructive and functional analyses focused specifically on adjustments that must be executed in order to obtain the corresponding quality indicators (Alexandru T and M Glodeanu, 2008). Also it is necessary to test the performance of these machines through the use of advanced techniques of acquisition and processing of data.

Major requirements that must be satisfied by these machines are: ensuring good distribution uniformity of the distributed material on the surface of the field; the material should be symmetrically distributed in relation to the longitudinal axis of symmetry of the machine (Alexandru T and M Glodeanu, 2008; Bădescu M and colab, 2003). Compliance required per hectare is an essential requirement, with the technical and economic implications and that is why, in order to ensure this requirement it is necessary to correlate the flow of distributed material with displacement velocity of the machine.

In case of the machines for solid fertilizers, the correlation between the flow of material with displacement velocity of the machine can be done most simply by exercising devices for distribution to the wheels of the machine. Is obtained a proportional dosage of the material with speed and thus compliance of fertilizer per hectare (Boruz S., 2008).

Special attention should be given to ensure adequate adjustments of these machines, in order to ensure stable rules, in accordance with the technical requirements. After making the adjustment process in order to prevent pollution of the environment it requires a rigorous practical verification of qualitative indices of work. This verification can be done easy with aid of a complex system of data acquisition and processing of data.

MATHERIALS AND METHODS

It will examine constructively and functional the machine for managing solid chemical and amendments *MA 3,5 A*.

The main adjustments made before testing machine are:

- Regulate the flow of fertilizer administered is achieved by speed of movement of the conveyor chain and also through modifying the exhaust section of fertilizer; the conveyor chain speed shall be modify through changing toothed gears from intermediate and final transmission; section of the fertilizer shall be amended by the opening of the proper device;
- Adjusting the position of the gutter is made so that it will lead the material to the center of the disk;

- Adjust the position of the blades of the disk for distribution publisher (angles with values between -7º... +7º);

Experimental investigation of the machine was based on collecting particles of material distributed on a well-defined area, followed by quantitative analysis of samples, by weighing, acquisition and processing of data in the computerized system. Distributor testing was done for a dose of distribution of NPK, N=230 kg/ha, respectively N=450 kg/ha, in accordance with requirements concerning the adjustments from technical book (Technical note MA-3.5 A, 2005).

Experimentation the machine work process was made after a method that consisted in determination of the following qualitative indices of the work: transversal distribution uniformity; longitudinal distribution uniformity. For determining the uniformity of distribution was used the relation:

$$U_{dl} = 100 - C_V = 100 - \frac{\sqrt{\frac{\sum_{i=1}^{n}(g_i - g_m)^2}{n-1}}}{g_m} \cdot 100 [\%] \quad (1)$$

where: C_v is the coefficient of variation of the distribution uniformity on the direction of travel, in %; g_i – the quantities of material collected (in collecting trays), in g; g_m – average quantity of distributed material, in g.

- Transversal distribution uniformity

Gutters placed next to each other, should cover overall width of distributing, so their longitudinal axis is parallel to the feed direction of the distributor (fig. 1).

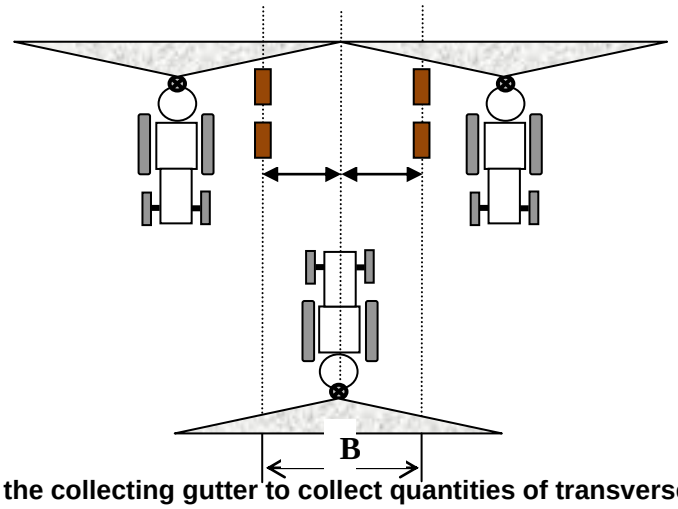

Fig. 1. Layout mode of the collecting gutter to collect quantities of transverse distributed material (with overlays of extreme areas).

Conducting the experiment

Machine is moving at a constant speed of 8 km/h (bunker being half full). Successive crossings must be perfectly superimposed. After the fertilizer collected in each gutter is weighing. Weighing values shall be recorded cumulatively.

Thus, the acquisition program will allow obtaining a data file with n (the number of trays) cumulative values gi, (i = 1 ... n). The program allows the processing of collected quantities, in order to determine the quantities of each gutter through the relation:

$$g_i = g_i - g_{i-1} \quad (2)$$

Also the program enables optimum working width, the width of which is touching the uniformity of 80% (for granulated chemical fertilizers).

- Longitudinal distribution uniformity

Gutters are placed next to each other, on one row so that their longitudinal axis is perpendicular to the axis of the feed direction of the distributor (fig. 2).

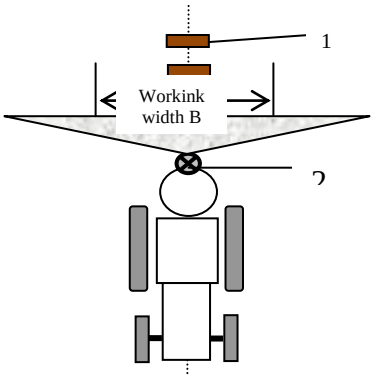

Fig. 2. Layout mode of the collecting gutter: 1-collectors trays; 2- spreader disc.

Conducting the experiment

Machine is moving at a constant speed of 8 km/h (bunker being half full). For the samples used for the determination of longitudinal distribution were placed 10 collectors trays. After it shall be determined the quantities of material collected in each tray.

RESULTS AND DISCUSSIONS

Weighing values recorded in experiments have been saved in the form of data files, which can be imported directly into the program processing and graphical representation. The data files are processed: initial data files (without overlapping); the final data files (with some overlap) (table 1,2).

Table 1

The values of the masses of the fertilizer collected for transverse distribution diagram, in order to ensure standards of 230 kg/ha
NPK complex fertilizer

Tray number	1	2	3	4	5	6	7	8	9
Initial quantities	0,2	0,6	2,1	2,0	2,4	3,2	4,0	5,7	6,0
Final quantities	6,3	6,0	6,4	5,4	5,3	5,8	5,3	5,8	6,0

10	11	12	13	14	15	16	17	18	19	20	21
6,6	6,7	6,5	6,3	6,1	5,8	6,0	5,8	5,6	5,7	5,8	5,9
6,7	6,6	6,5	6,3	6,1	5,8	6,0	5,8	5,6	5,7	5,8	5,9

22	23	24	25	26	27	28	29	30	31	32	33
6,4	6,6	6,8	6,6	6,7	6,5	5,5	5,0	3,5	2,1	1,5	0,9
6,4	6,6	6,8	6,6	6,7	6,5	5,4	5,2	4,0	3,3	3,1	3,2

During the test it was determined also the optimum width and (in the case of transverse distribution).

Table 2

The values of the masses of the fertilizer collected for transverse distribution diagram, in order to ensure standards of 450 kg/ha
NPK complex fertilizer

Tray number			**1**	**2**	**3**	**4**	**5**	**6**	**6**	**8**	**9**
Initial quantities			0,5	1,8	3,5	4,2	6,0	8,0	10,2	12,0	12,5
Final quantities			13,0	11,9	10,4	10,1	10,0	10,3	11,9	12,4	12,6
10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
13,9	13,8	13,0	12,2	12,1	12,0	11,8	11,7	11,5	11,6	11,7	12,1
14,0	13,9	13,0	12,3	12,2	12,0	11,9	11,7	11,5	11,6	11,7	12,2
22	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
13,2	13,8	13,7	13,9	13,8	13,6	10,5	10,0	6,2	4,8	4,0	3,4
13,2	13,8	13,8	13,9	13,7	13,6	10,4	10,3	6,6	6,0	6,8	6,7

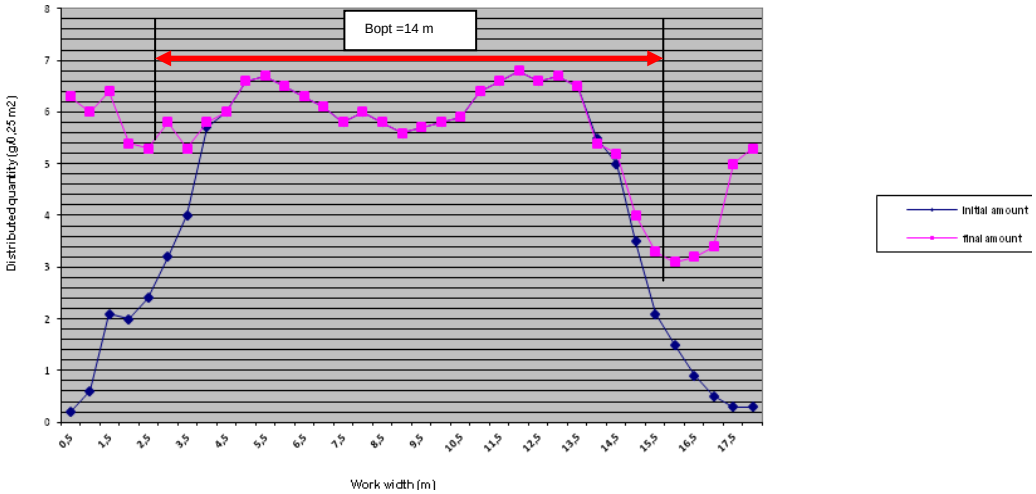

Fig. 3. Transversal distribution diagram (NPK complex fertilizer, N=230 kg/ha).

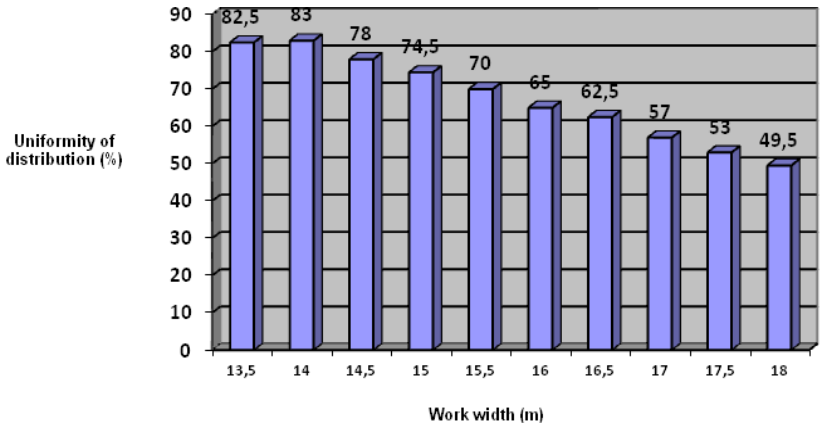

Fig. 4. Values of transverse uniformity distribution for different work width (NPK complex fertilizer, N=230 kg/ha).

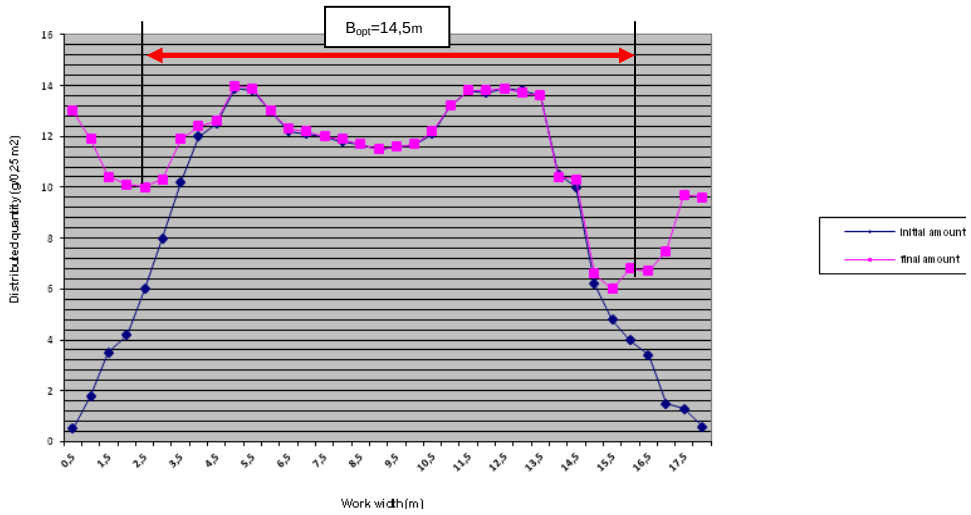

Fig. 5. Transversal distribution diagram (NPK complex fertilizer, N=450 kg/ha).

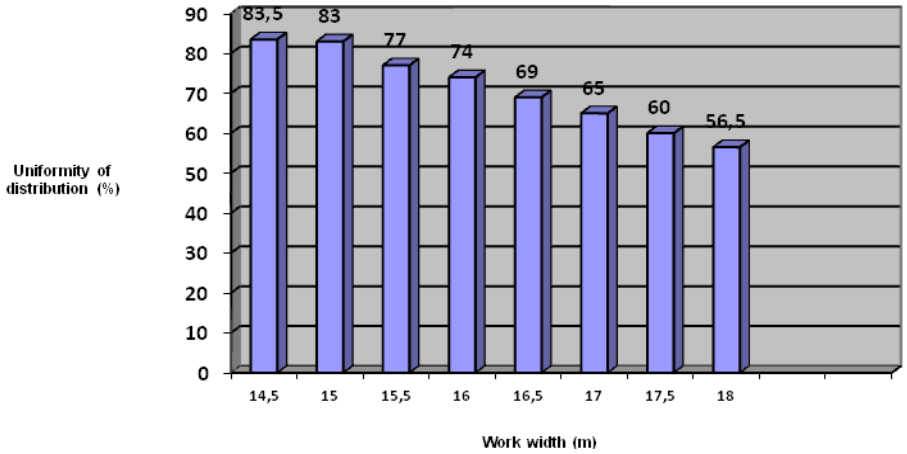

***Fig*. 6. Values of transverse uniformity distribution for different work width (NPK complex fertilizer, N=450 kg/ha).**

Data files with recorded weighing values used for determining longitudinal distribution uniformity are presented in table 3 and 4. Distributor testing was done also for a dose of distribution of NPK, N=230 kg/ha, respectively N=450 kg/ha.

Table 3

Weighing values used for determining longitudinal distribution uniformity (NPK complex fertilizer, N=230 kg/ha)

Collectors trays	Weighing values (g)	Ensured average standards (kg/ha)	Longitudinal distribution uniformity (%)
1	4,7	**226,4**	**92,74**
2	5,4		
3	5,8		
4	5,9		
5	5,9		
6	6,1		
7	6,0		
8	5,4		
9	5,6		
10	5,8		

Table 4

Weighing values used for determining longitudinal distribution uniformity (NPK complex fertilizer, N=450 kg/ha)

Collectors trays	Weighing values (g)	Ensured average standards (kg/ha)	Longitudinal distribution uniformity (%)
1	10,1	**441,6**	**90,69**
2	10,2		
3	11,4		
4	11,8		
5	12,3		
6	12,6		
7	11,7		
8	10,2		
9	9,8		
10	10,3		

In figures 7 and 8 are presented the diagrams of longitudinal distribution uniformity corresponding to the data submitted in the above files.

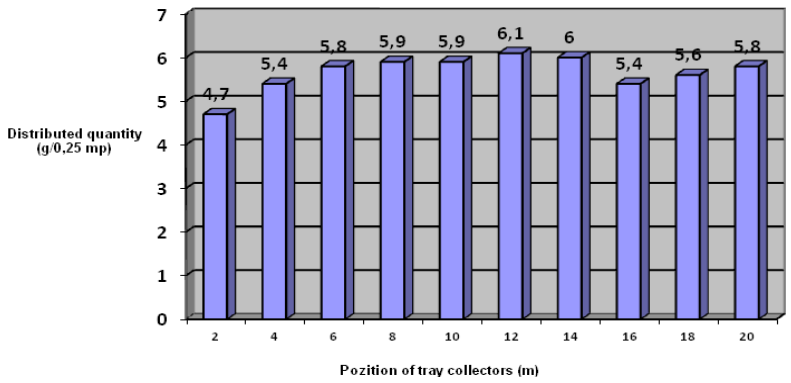

Fig. 7. Longitudinal distribution diagram distribuţiei longitudinale (NPK complex fertilizer, N=230 kg/ha).

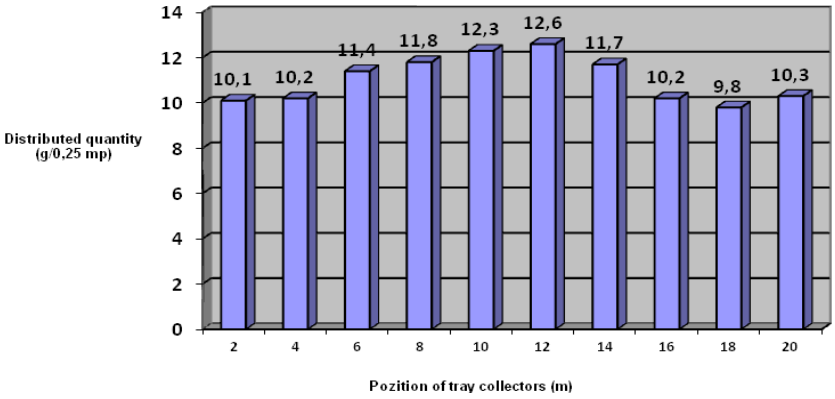

Fig. 8. Longitudinal distribution diagram distribuţiei longitudinale (NPK complex fertilizer, N=450 kg/ha).

CONCLUSIONS

1. Special attention should be given to achieve adequate adjustments of these machines, in order to ensure stable rules, in accordance with the technical requirements; making the adjustment process has an important role to prevent environmental pollution; It requires a rigorous practice of checking the quality index, preferably using a complex system of data acquisition and processing of data;
2. The results of the tests for determining the optimal working widths in case of NPK complex fertilizer, (N=230 kg/ha, respectively N=450 kg/ha) showed the values between 14,0 and 14,5 m;
3. As a result of the processing used to determine the longitudinal uniformity distribution charts resulting values between 90,69 and 92,74% (values in accordance with the technical requirements).

BIBLIOGRAPHY

1. **Alexandru T., M. Glodeanu**, 2008, *Exploitation of agricultural machinery*, *SITECH Publishing House,* Craiova.
2. **Bădescu M., M. Glodeanu, T. Alexandru, Sărăcin, I.,** 2003, *Farm machinery, UNIVERSITARIA Publishing House,* Craiova.
3. **Boruz S**., 2008, *Farm machinery-A guide to practical work, UNIVERSITARIA Publishing House,* Craiova.
4. *** Technical note MA-3.5 A, 2005, MAT Magrit Company, Craiova.