INFLUENCE OF BOOM HEIGHT AND WORKING PRESSURE ON DISTRIBUTION UNIFORMITY ON THE WIDTH OF SPRAYING MACHINES

INFLUENȚA ÎNĂLȚIMII RAMPEI ŞI A PRESIUNII ASUPRA UNIFORMITAȚII DE DISTRIBUȚIE PE LĂȚIMEA DE LUCRU LA MAŞINILE DE ERBICIDAT

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Abstract. *Distribution uniformity of agrochemicals on working width of spraying machines is influenced by many parameters. In this paper was determined the way in which distribution uniformity is influenced by working pressure and distance between the boom and target surface, in order to establish the proper height of nozzles in relation with working pressure.*

Rezumat. *Uniformitatea de distribuție a soluției pe lățimea de lucru a maşinilor de erbicidat este influențată de mai mulți factori. În cadrul lucrării s-a determinat modul în care uniformitatea de distribuție este influențată de presiunea de lucru şi distanța dintre rampă şi țintă, în vederea stabilirii înălțimii corecte a duzelor în corelație cu presiunea de lucru.*

Key words*: distribution uniformity, nozzle working pressure, nozzle distance to target surface*
Cuvinte cheie*: uniformitate de distribuție, presiune de lucru a duzelor, poziția duzelor față de țintă*

INTRODUCTION

Crop production in agriculture is influenced mainly by the technological level, crop protection having an important role in the frame of these technologies.

Present studies and research activities regarding the methods and equipments for agrochemical application are in the frame of new tendencies for practical use of sustainable agriculture concepts, being known the fact that crop protection is one of the main sources of environment pollution with agrochemicals.

Specific crop protection works in agricultural crops demands a good correlation between mechanical factors (machine), organizational and methodological factors. The effect of agrochemicals application is optimum only when the coverage degree of plants is high and drift losses or evaporation are at minimum level.

The best uniformity distribution on the working width leads to an increase of working quality index and, as a result, increasing of treatment efficiency and crop yield.

Based on these arguments, in this paper was determined the way in which the distribution uniformity on the working width is influenced by two main factors:

- boom position with regard to target surface;
- working liquid pressure at nozzle.

MATERIALS AND METHOD

In order to test the uniformity of distribution, the EEP-600 ME machine was used. This machine was designed by the Department of Mechanization within USAMV Cluj-Napoca and built by TEHNOFAVORIT Bontida, Cluj county.

The EEP-600 ME machine was designed in order to comply with the European Norms regarding the user's safety and comfort, reduction of environmental impact and to get the best quality index.

The main constructive parts are shown in fig. 1.

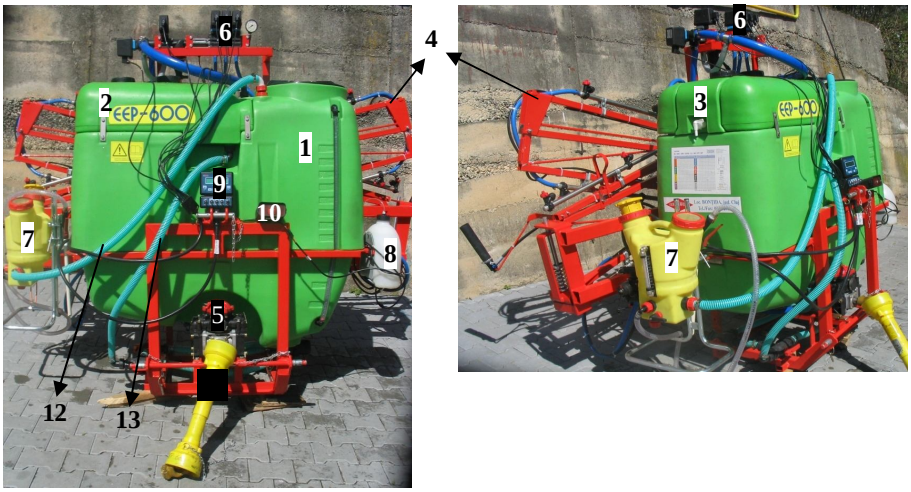

Figure 1 The main constructive parts of the EEP-600 ME machine
A-front view; B- side view
1- main solution tank; 2- washing tank for the main tank; 3- washing hands tank;
4-sections of distribution; 5-pump; 6- electric control unit; 7-device for mixing and transferring chemical products and for washing containers; 8-foam marker tank; 9-control unit; 10-left-right switch for foam marker; 11-cardanic transmission; 12-connection hose between the mini mixer and main tank;
13- hose for empting the washing tank

For this study, a set of Lechler IDK 120-03 nozzles were mounted on the machine.

The uniformity of distribution was measured for three heights (30, 50 and 70 cm) of the nozzles from the target and for three pressures (2 bar, 3 bar, 5 bar).

The uniformity of distribution was measured using a testing equipment (fig. 2) manufactured by HERBST Landtechnik-Prüftechnik. This equipment was bought from founds of a CEEX research programme.

This equipment can determine the following parameters:

- uniformity of distribution for the whole working width
- nozzle flow
- nozzle pressure
- pump flow and air presence into the outtake section
- gauge verification.

The sprayer test TEST 1000 has the following main parts:

- equipment for testing the uniformity of distribution
- equipment for nozzles testing
- equipment for pump and gauges testing
- set of connectors for the common pumps and nozzles
- collecting pool for used water

The equipment for testing the uniformity of distribution has mainly the following constructive parts: the railway and the self propelling measurement trolley.

Fig. 2 The EEP- 600 ME machine and the TEST 1000 equipment during experiments

The railway is modular in order to cover the whole working width up to 27 m. The stand has 9 modular tracks, 8 of them have 3 m and one is divided in two parts (1 and 2 m). Each track has the railway and three traverse used to determine the position of the trolley (1 m steps).

The measurement trolley collects the water from the nozzles and has the following parts: collecting platform, measurement system, the propeller, and the wireless transmitter.

The platform (fig. 2 A) has 1 m width and consists of 10 collecting spouts spaced at 10 cm each.

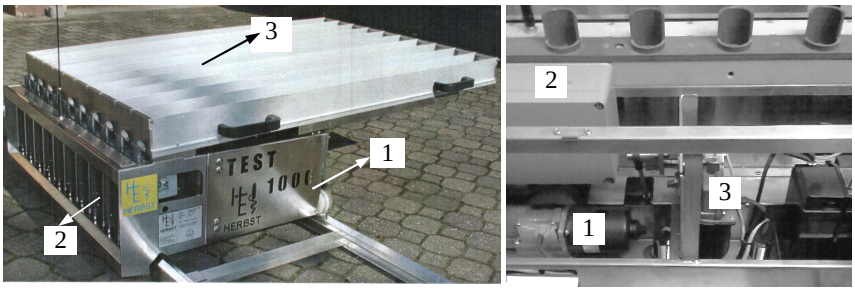

Fig. 3 Constructive parts of the measurement trolley
A - measurement trolley: 1-wheel; 2-measurement glasses; 3-collecting platform;
B - internal systems of the trolley: 1-electric engine for propeller; 2-ultrasonic generator;
3-electric motor for the emptying system

This platform is mounted on the top of the trolley with a quick coupling system. The spouts are mounted in an angle for a total drain of solution. Each end of the spout has mounted a small chain in order that the liquid has a continuous flow into the glass.

There are 10 glasses at the base of the trolley. They are used for collecting and measuring the solution.

An ultrasonic device makes the measurement of the solution in the glasses. This device is situated also on the trolley frame (2, fig. 3 B). After the liquid is measured, the glasses are emptied by an automated system driven by an electric motor (3, fig. 3 B).

All the data collected are sent to a remote computer through a wireless network. The computer receives the data and dedicated software is analyzing and saves them. Also the software shows a real-time graph for the uniformity of distribution.

RESULTS AND DISCUSSION

At 30 cm height (fig. 4) from the target, it can be observed that the uniformity of distribution of IDK 120-04 nozzle is better at 2 bar working pressure. Along with the increase of the pressure, the total flow is rising, but against this fact the uniformity is decreasing. The flow variation coefficient for 2 bar pressure is 6,13 meaning a good uniformity. For 5 bar the variation coefficient is 10,6 resulting a unacceptable uniformity. Also at this height, for 3,5 bar the uniformity of distribution is unacceptable.

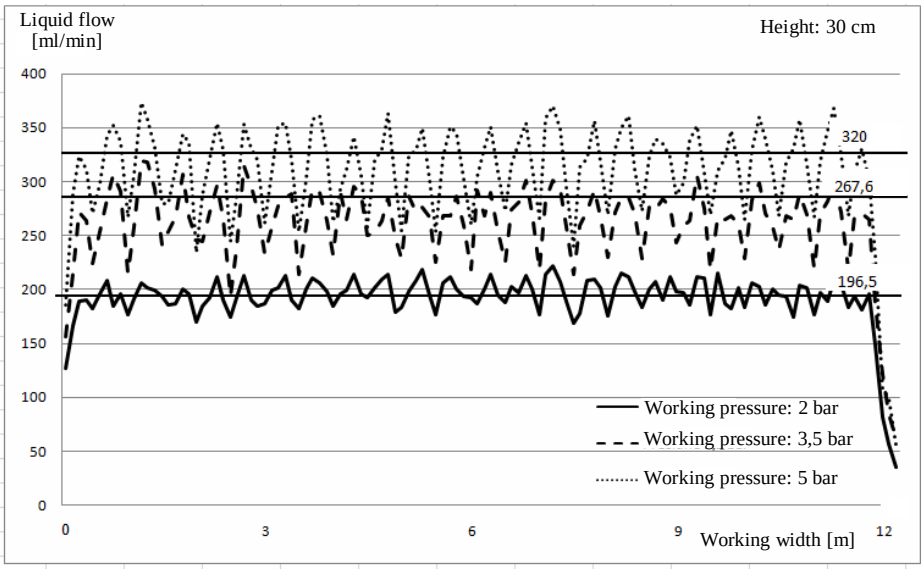

Fig.4 Liquid flow variation on the working width of the tested spraying machine, for several working pressures

At 50 cm height (fig. 5) for all working pressures, the uniformity of distribution is good. For all pressures, the variation coefficient is low (3,93 for the 3,5 bar pressure and 4,85 for 5 bar pressure).

Comparing the 30 and 70 cm heights from the target, it can be observed that there are no significant differences regarding the uniformity of distribution. The variation coefficient is 4,33 and 4,85 for this heights.

As a conclusion, for the IDK 120-03 nozzle it is recommended the 50 cm height from the target, even if the pressure is modified between 2 and 5 bar.

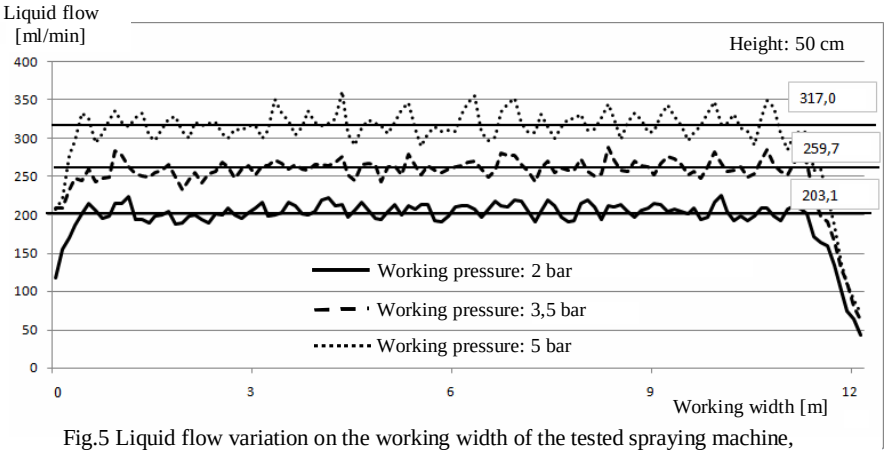

Fig.5 Liquid flow variation on the working width of the tested spraying machine, for several working pressures

Working at 70 cm height (fig. 6) from the target and at 2 bar pressure, the uniformity of distribution is good (variation coefficient = 5,52) but decreases along with the increasing of pressure reaching a variation coefficient of 7,33%. This coefficient means an acceptable uniformity of distribution.

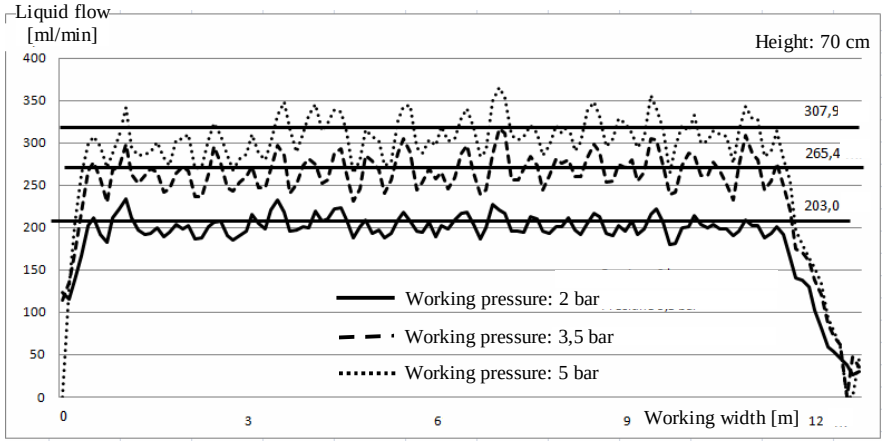

Fig.6 Liquid flow variation on the working width of the tested spraying machine, for several working pressures

Analyzing the variation graphs depending on same working pressure and several height values of the nozzle, we can observe that at low pressures the working process can continue at different heights and the uniformity of distribution is maintained (fig. 7). This uniformity is the best at 50 cm height from the target. Working at higher pressures and smaller heights, the uniformity of distribution is unacceptable.

By analyzing the variation of distribution uniformity on the working width at the same working pressure for different height values, it is possible to see that when the application

height is 50 cm, the distribution uniformity is between approved limits (± 15%), the variation coefficient being the lowest (3,93). When the height is 30 cm, variation coefficient is 9,62, value which is not suitable for agrochemicals applications, so it is not recommended to be used. When the height is 70 cm, the flow variation coefficient is 7,28, value which is good and were observed three situations, which exceeds the approved limits for liquid flow.

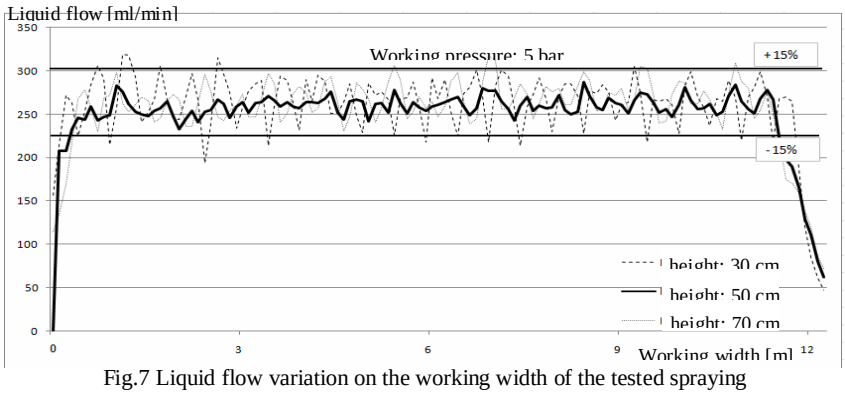

Fig.7 Liquid flow variation on the working width of the tested spraying machine

In conclusion, it was showed that the optimum height between boom and target surface is 50 cm, the height value by 70 cm can be used only in special circumstances and the height value by 30 cm is not at all recommended for agrochemical applications with this nozzle type.

CONCLUSIONS

1. In order to assure a better distribution uniformity on the working width of spraying machines we must to have in view nozzle type; working pressure and height of nozzle measured at target surface;
2. Testing the spraying machine for agrochemicals application with state of the art equipments in order to check the distribution uniformity for the best working quality index;
3. For IDK 120-03 nozzle at working pressure value by 2 bar it is possible to use it in good conditions for a height between 30-70 cm;
4. At a working pressure by 5 bar only a height by 50 cm can be assured for a good distribution uniformity and for other height (30 cm and 70 cm) the distribution uniformity on the working width is not suitable.

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