THE DISPERSION UNIFORMITY OF A MACHINERY FOR COMBATING DISEASES AND PESTS IN VINEYARDS AND ORCHARDS, EQUIPPED WITH NOZZLES WITH/WITHOUT AIR ABSORPTION

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Abstract

The chemical method for the application of phytosanitary treatments in the vineyards is most effective for the control of diseases and pests, but also presents some disadvantages, because the pesticides end up in the water, air and soil, polluting them. Pesticides are transferred to plants, fruit, animals and people, with undesirable repercussions on health. The spraying devices are equipped with nozzles, which disperses plant substance in fine droplets on the plant. Their orifice can be decalibra due to hydroabrasive wear, favoring conducting to an uneven treatment, with untreated or overtreated areas, which also determines an excessive pollution. To determine the nozzles dispersion uniformity it was designed and built a laboratory stand, which allows quantification of the machine dispersion uniformity. In the experimental research conducted in laboratory conditions it was used a vineyards pest and disease control machine TARAL 200 PITON TURBO type, which there were mounted flat-jet air absorption-type nozzles IDK 120-02 from LECHLER and ALBUZ AMT 1.2 full cone spray nozzles. The tests were performed for different working pressures (0.2; 0.4; 0.6; 0.8; 1.0; 1.2 and 1.4 MPa) and mounting distances from stand to the spraying machine axis (1500, 1700, 1900 and 2100 mm). In these circumstances, it is reproduced in laboratory the spraying machine working process and it is determined the solution dispersion uniformity. The analysis results show that the air absorption nozzles have a much better uniformity than those without air absorption for all pressures and working distances. The best results, i.e. the dispersion uniformity of 90.93% were obtained by the stand arrangement at a distance of 1900 mm from the machine's axis and at a pressure of 1.0 MPa, for air absorption nozzles.

Key words: dispersion uniformity, nozzles, spraying machine

Pest and disease control from orchards and vineyards is a very important technological component, without which production would not be safe and steady year after year (Kamousantas D. et al., 2000; Tomoiagă L., 2013). Thus, diseases and pests can cause important economic losses. If the pesticide treatments are not applied effectively and on time, total production may be compromised (Berca, 2001).

Proper application of phytosanitary treatments with superior qualitative working indices, reduce production waste, the excess use of pesticides, and not at least it avoids environmental pollution, especially the ground (Nagy E.M. and Coța C., 2007; Diaconu A. *et al*, 2016).

Based on these considerations, there have been made researches in order to determine the best technical solutions to operate a vineyard spraying machine, equipped with two types of nozzles, namely air suction flat spray IDK 120-02, manufactured by LECHLER and full cone classic jet nozzles without air absorption, AMT 1.2, made by ALBUZ company.

MATERIAL AND METHOD

In order to determine the dispersion uniformity on the working height of the machines used to combat vineyard pests and diseases, in the Laboratory of Horticultural Machinery at the "University of Agricultural Sciences and Veterinary Medicine" in Iaşi, it was designed and made a stand for collecting solution dispersed droplets.

The stand is made of a vertical panel of polycarbonate, with a length of 2350 mm and a width of 830 mm, on which were mounted 18 inclined troughs, made of galvanized steel sheet. During the experimental research, the dispersed solution is collected from each trough, over a period of 60 seconds, after which it is directed in separate containers, laterally arranged, after which the amount of the solution is measured with graduated cylinders (*figure 1*).

The troughs were numbered starting from the base of the panel, from 1 to 18, trough number 1 being at the height of 300 mm from the ground, and number 18 at 2510 mm, the troughs being mounted on panel at 130 mm distance from each other.

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In order to perform experimental tests, it was used a TARAL 200 PITON TURBO vineyards universal pest and disease control machine on which were mounted LECHLER suction air jet flat nozzle IDK 120-02 and ALBUZ AMR. Full cone nozzle without air jet suction. With the specification that the air absorption nozzles prevent drift, due to the fact that it form large drops that contain air in the central zone, and in contact with the surface of the leaves break and carried out a further fragmentation of them, such is achieved under these conditions an efficient plant treatment, with minimum substance loss.

With the proviso that the absorption of air nozzles prevent drift due to the fact that large droplets containing air in the central area and in contact with the leaf surface are broken and achieve a further fragmentation thereof. By making these treatment conditions effective protections with minimum loss of substance.

Figure 1 **The laboratory stand for the dispersed solution distribution uniformity study of the vineyards TARAL 200 PITON TURBO spraying machine**

Determinations were made for different working pressures (0,2; 0,4; 0,6; 0,8; 1,0; 1,2 and 1.4 MPa) and distances between the stand and the spraying machine axis (1500, 1700, 1900 and 2100 mm). The height of the panels layout above ground was 300 mm, and the axial fan speed of 1400 RPM .

The liquid dispersion uniformity (%) on the machine working height must be higher than 85% and has been calculated with the relationship:

$$U_d = \left[1 - \frac{\sqrt{\frac{\sum_{i=1}^{i=n} (q_i - q_m)^2}{n(n-1)}}}{q_m} \right] * 100 \ (\%),$$

in which: q_i – the amount of liquid collected from each trough; q_m – the average amount calculated for all the collecting troughs; n – the number of troughs.

RESULTS AND DISCUSSIONS

The experimental research conducted in laboratory conditions, for each variant, revealed the peculiarities of the working process. Thus, at a distance of 1500 mm from the layout of the stand to the spraying machine axis it is found that, for nozzles without air absorption, the amount of fluid recorded a maximum value up to height of 1000 mm from the ground, after which it decreases more and more towards the top of the stand. Therefore, the dispersed liquid jet of the spraying machine equipped with AMT 1.2 full cone jet nozzles, achieved a larger amount of liquid in the lower zone up to the height of 1000 mm and decreases towards the upper part (*figure 2*).

In the case of IDK 120-02 air absorbtion nozzles, the amount of dispersed liquid recorded a maximum value between 500 and 1000 mm from the ground. Outside this range, the quantities of collected liquid at the level of each trough are smaller, with a more pronounced decrease in the upper part of the stand (*figure 3*).

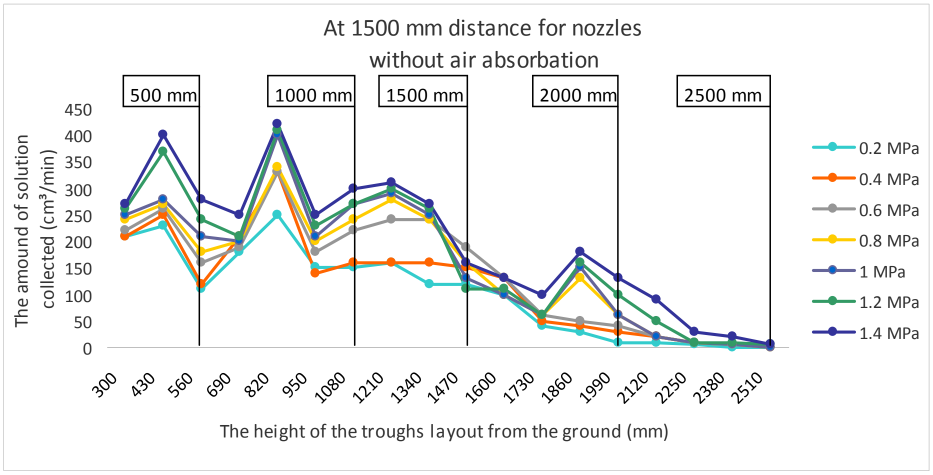

Figure 2 **The amount of liquid collected at each trough level for different working pressures, at 1500 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

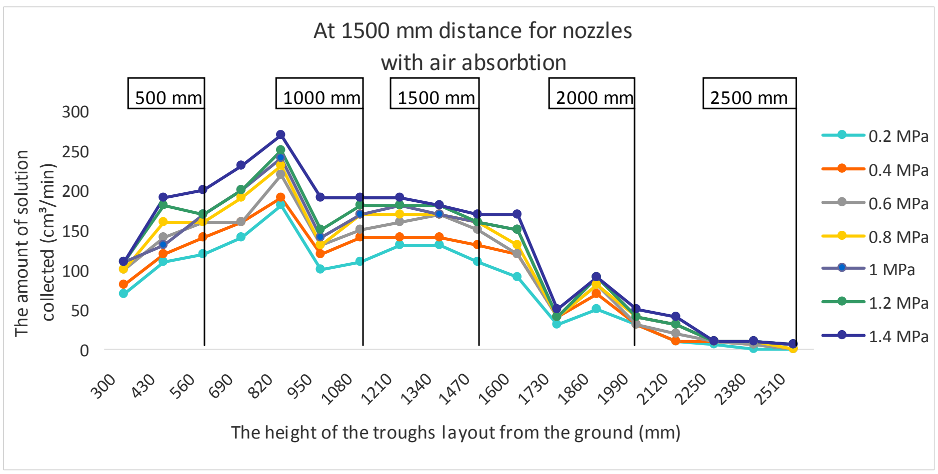

Figure 3 **The amount of liquid collected at each trough level for different working pressures, at 1500 mm distance between stand and the spraying machine axis, using air absorption nozzles**

By increasing the distance of the layout of the stand to the axis of the spraying machine, respectively to 1700 mm, for both types of nozzles there is the same tendency as in the case of the distance of 1500 mm, except that the overall amount of fluid collected is smaller. This is because some of the liquid droplets is evaporated and another part thereof is lost by drift *(figure 4 and 5*).

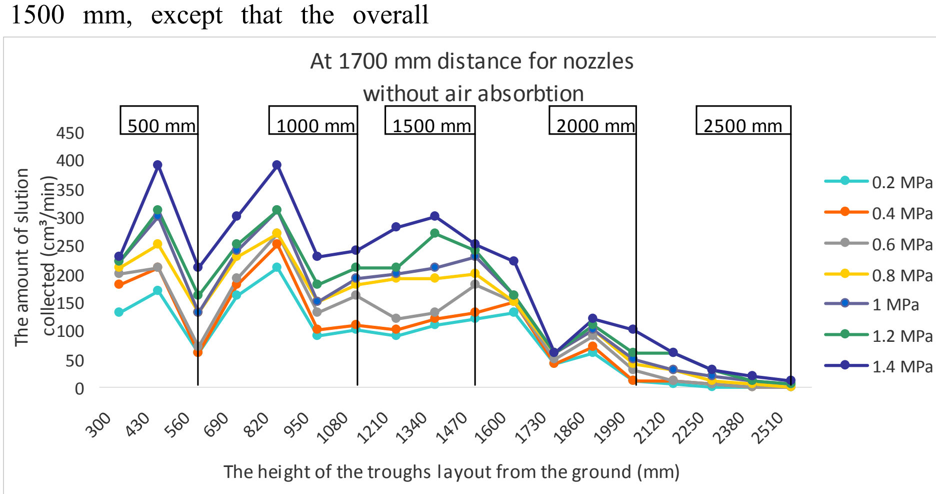

Figure 4 **The amount of liquid collected at each trough level for different working pressures, at 1700 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

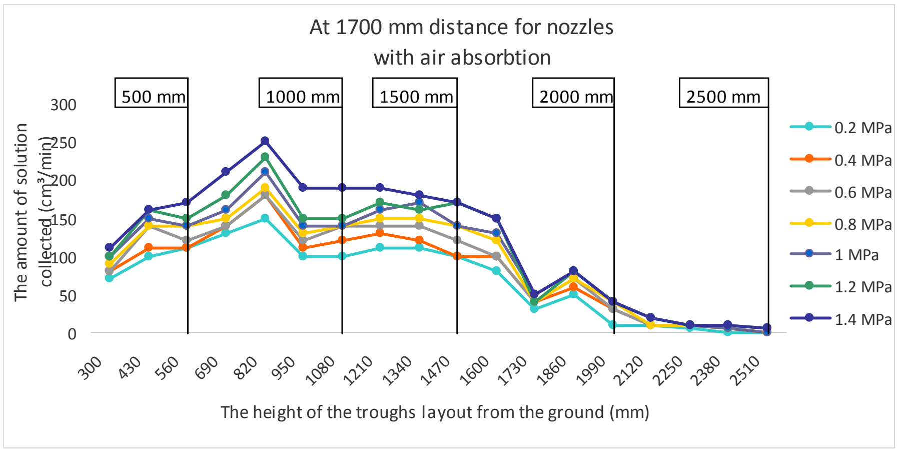

Figure 5 **The amount of liquid collected at each trough level for different working pressures, at 1700 mm distance between stand and the spraying machine axis, using air absorption nozzles**

At the distance from the stand layout to the spraying machine axis of 1900 mm, the amount of fluid collected in each trough declines further due to increasing distance of the layout of the panel, reached by a smaller number of drops. In the case of nozzles without air suction, the amount of fluid decreases from 300- 500 mm to 2500 mm, while in the case of air absorption nozzles maximum amount of dispersed liquid is concentrated to about 1000 mm from the ground and lower 500 and above 1000 mm, exactly as for the other distances of the layout of the stand in relation to the axis of the spraying machine (*figure 6 and 7*).

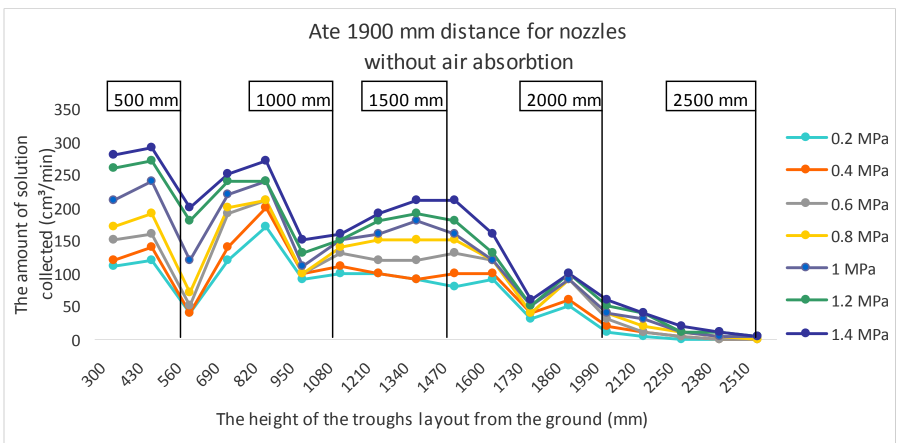

Figure 6 **The amount of liquid collected at each trough level for different working pressures, at 1900 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

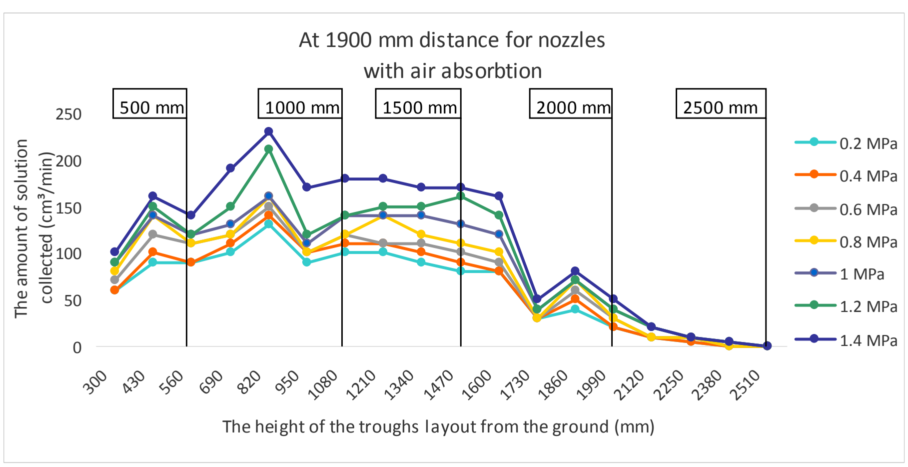

Figure 7 **The amount of liquid collected at each trough level for different working pressures, at 1900 mm distance between stand and the spraying machine axis, using air absorption nozzles**

At a distance of 2100 mm the amounts of solutions collected by stand's troughs are closer to those obtained at a layout distance of 1900 mm from the machine axis. In the case of air suction nozzles it can be seen that the uniformity is achieved in the region from 500 mm to 1500 mm (*figure 8 and 9*).

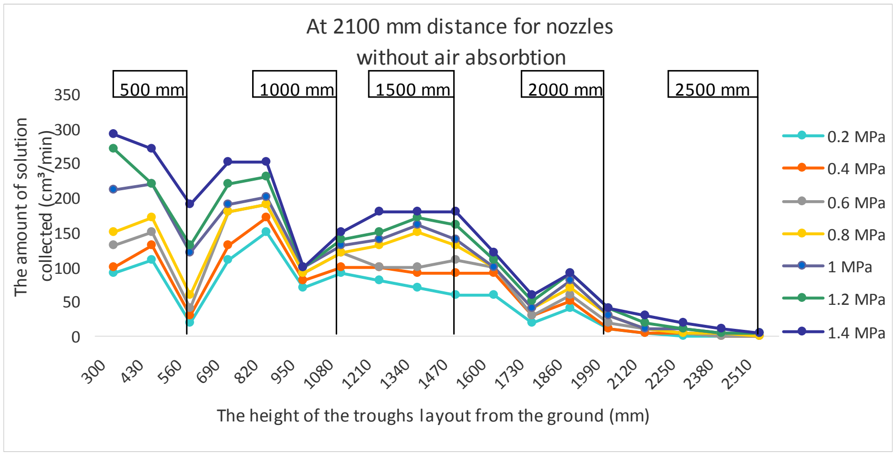

Figure 8 **The amount of liquid collected at each trough level for different working pressures, at 2100 mm distance between stand and the spraying machine axis, using nozzles without the air absorption**

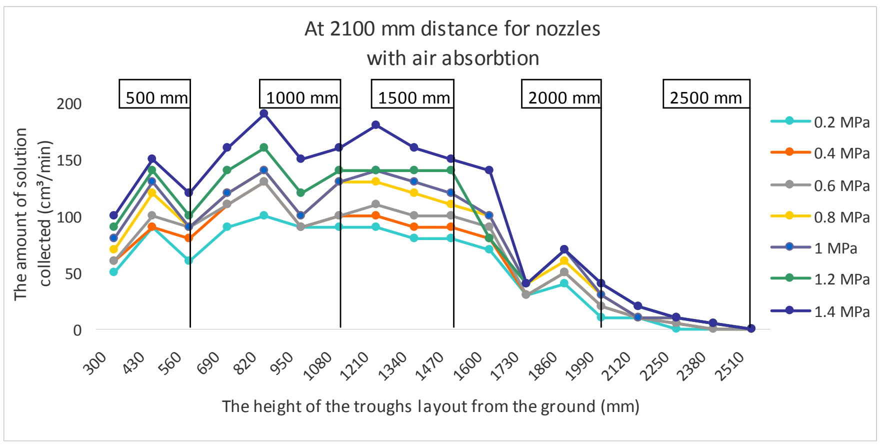

Figure 9 **The amount of liquid collected at each trough level for different working pressures, at 2100 mm distance between stand and the spraying machine axis, using air absorption nozzles**

In order to determine the solution dispersion uniformity U_d(%) on the spraying machine working height, using two types of nozzles with or without air absorbtion, there were removed from the calculation troughs from 15 to 18, namely those positioned over 2000 mm height, because over this quota the vineyard vegetation is reduced and the dispersed solution amount is insignificant.

In the case of the nozzle without air absorption it is observed that the obtained dispersion uniformity values were lower, but over 85% for the small working pressures, such as 0.2, 0.4 and 0.6 MPa for all the mounting position of the stand. The best uniformity, obtained for the distance of 1500 mm, is of 89.44% at a pressure of 1.4 MPa, and the other values were 88,40% at 0.8 MPa, 87.47% at 1.2 Mpa, 87, 38% at 1.0 MPa and 87.37% at 0.6 MPa. It is followed by the 1700 mm distance with the following uniformity values: 89.22% to 0.8 MPa, 89.10 % at 1.4 MPa and 89.03 % at 1.2 MPa. At the 1900 mm distance were obtained the optimum levels of uniformity at the 1.4 MPa pressure of 89.10%, at 1.4 Mpa of 88.67% to and 85.37% at 1.2 MPa. At the distance of 2100 mm the obtained values were as follows: 88.02% at 0.8 Mpa, 87.97%, to 1.0 Mpa, 87.64% at 1.2 MPa and 87.43% to 1.4 MPa (*figure 10*).

So, for this type of nozzle, by increasing the stand layout distance, uniformity decreases more and more, and increased pressures are needed to achieve it.

In the absorption air nozzle it has been obtained a good solution dispersion uniformity on the working height of the spraying machine, for all distances between the stand and the the spraying machine axis. At the 1900 mm distance it was obtained the maximum uniformity of 90.93% at

1.0 MPa working pressure, followed by the 2100 mm distance, with a maximum of 90.59% at apressure of 1.0 MPa, then the 1700 mm distance with 90.32% at a pressure of 1.0 MPa and the 1500 mm distance to 89.56% at 0.4 MPa (*figure 11*).

It is noted that for the air absorption nozzle it is not necessary a high pressure is required to achieve a solution flow uniformity over 85%, the optimal pressure of between 0.2 and 0.8 MPa.

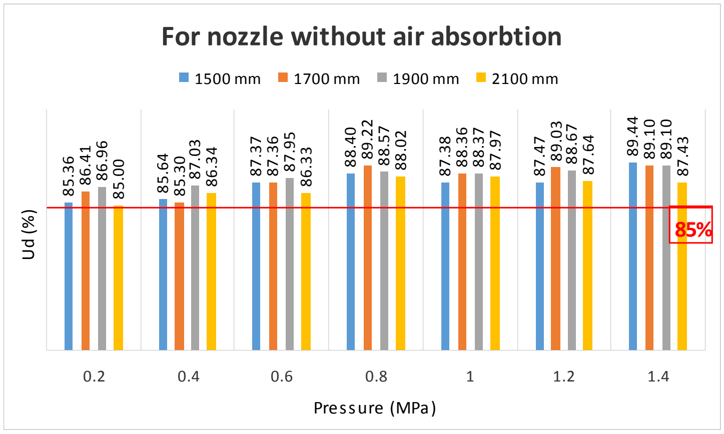

Figure 10 **Solution dispersion uniformity on the working height of the nozzles without air absorption, at different distances from spraying machine axis and different working pressures**

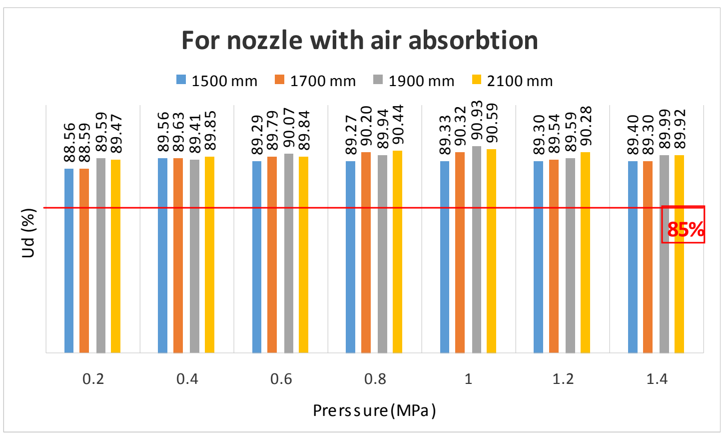

Figure 11 **Solution dispersion uniformity on the working height of the nozzles with air absorption, at different distances from spraying machine axis and different working pressures**

CONCLUSIONS

From the obtained results, the investigations shows that the nozzles absorption of air, compared to those without absorbing air, makes a better uniformity of dispersion at all work pressures and all distances layout of the stand to the axis machine spraying.

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