RESEARCH REGARDING THE INFLUENCE OF THE FAN SPEED OVER THE OPERATING PROCESS OF A MACHINE FOR PEST AND DISEASE CONTROL IN VINEYARDS, WITH SOLLUTION RECOVERY

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Abstract

Pest and disease control in vineyards is one of the major technological links that require high costs; therefore, the construction of the spraying machines has an important role in the development of effective treatments, while achieving low consumptions of phytosanitary solution. In order to improve the working process, the vineyards and orchards sprayers are equipped with axial fans, which provide the transport of the toxic liquid droplets dispersed by the nozzle and the agitation of the foliar mass, favoring the deposition of the substance on both sides of the leaves. In order to reduce the solution losses during the working process, an equipment for recovering the droplets that are not retained by the foliar mass was designed and developed. The recovery equipment was mounted on a low volume sprayer for vineyards and intensive orchards, type TARAL 200 PITON TURBO, equipped with an axial fan; the solution dispersion is achieved hydraulicaly, due to the high pressure of the liquid. The solution recovery equipment consists of two reclining vertical panels, positioned on each side the vineyar row; at the base the pannels are equipped with gutters for collecting the solution which is not retained by the leaf system. The recovered solution is taken from the gutters with a hydraulic pump and transferred to the graded collection receptacles. The hydraulic circuit of the machine is equipped with flow meters in order to measure the total amount of solution sprayed by each pad. The experimental investigations were carried out in laboratory conditions, for different working pressures in the hydraulic system, for fan speeds of 800, 1100 and 1400 rpm, and for different positions of the recovery panel. The analysis of the experimental results shows that the working process of the sprayers is complex and endowing with the recovery equipments may significantly reduce the consumption of the toxic solution used for pest and diseas control.

Key words: axial fan, solution recovery equipment, fan speed.

Performance of diseases and pests in vineyards requires high costs of pesticide prices increasing in recent years by about 90%. Because many treatments are applied within one year (8-10 treatments) and binding for high output, they get to pollute the environment. Pesticide residues that reach the soil endanger human health, the animals and the microorganisms. Therefore, plant protection should be an integrated concept, taking into account the technical, economical and environmental aspects (Berka, 2001). It is necessary for the spraying equipment to be reliable; the treatments should be performed with low consumptions of fuel and toxic solution, while increasing the quality of the opperating proces in terms of the efficiency over the phytopathogenic agents. In order to achieve these goals a new generation of spraying equipments was developed in the recent years, aiming to increase the effectiveness of the droplets deposition on the leaf surfaces and to reduce the effect of drift (Ozkan et al., 1997). Pesticide runoff and spray drift droplets are studied extensively, but major problems related to the corect application treatments in vineyards and orchards still persist.

Modern equipments use electrostatic spraying methods or use panels (tunnels) to direct airflow in order to reduce spray drift and turbulence occurring around the nozzle during spraying (Ozkan et al., 1997). Deflector panels alter the trajectory of droplets penetrating plant mass, turning to the rows of plants. This prevents the movement of liquid droplets in areas other than those specified for the treatment, contamination of other crops and soil, coating uniformity while increasing plant mass (Dobre, 2010). From this point of view, the spray tunnel and recycling the recovered solution provide reduced consumption of material and increase the effectiveness of treatment (Planas et al., 2002 Baldoin et al., 2008).

The present paper is inscribed in the research context mentioned above, studying the influence of fan speed on the rate of sollution recovery.

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MATERIAL AND METHOD

In order to reduce the cost of performing treatments to control diseases and pests in vineyards and to reduce soil pollution by pesticides, a special equipment was designed and built within the department of agricultural machiner of the University of Agricultural Sciences and Veterinary Medicine of Iasi, aiming to recover the toxic sollution droplets that were not deposited on the surface of the leaves. (*figure 1*). This equipment was mounted on a spraying machine, type TARAL 200 PITON TURBO, used for pest and disease control in vineyards.

The equipment is supported of a metal frame mounted on the sprayer. Two of collapsible supports sustaining two polycarbonate panels are mounted on the metal frame; the collapsible suports are rotated in the transport position and operating position by the means oft wo hydraulic cylinders. The solution recovered by the polycarbonate panels is then collected in tanks using electric pumps. The height of the equipment above ground is adjusted using a rod. Two flowmeters were insterd into the hydraulic circuti fo the spraying equipment in order to measure the flow rate of solution towards the booms.

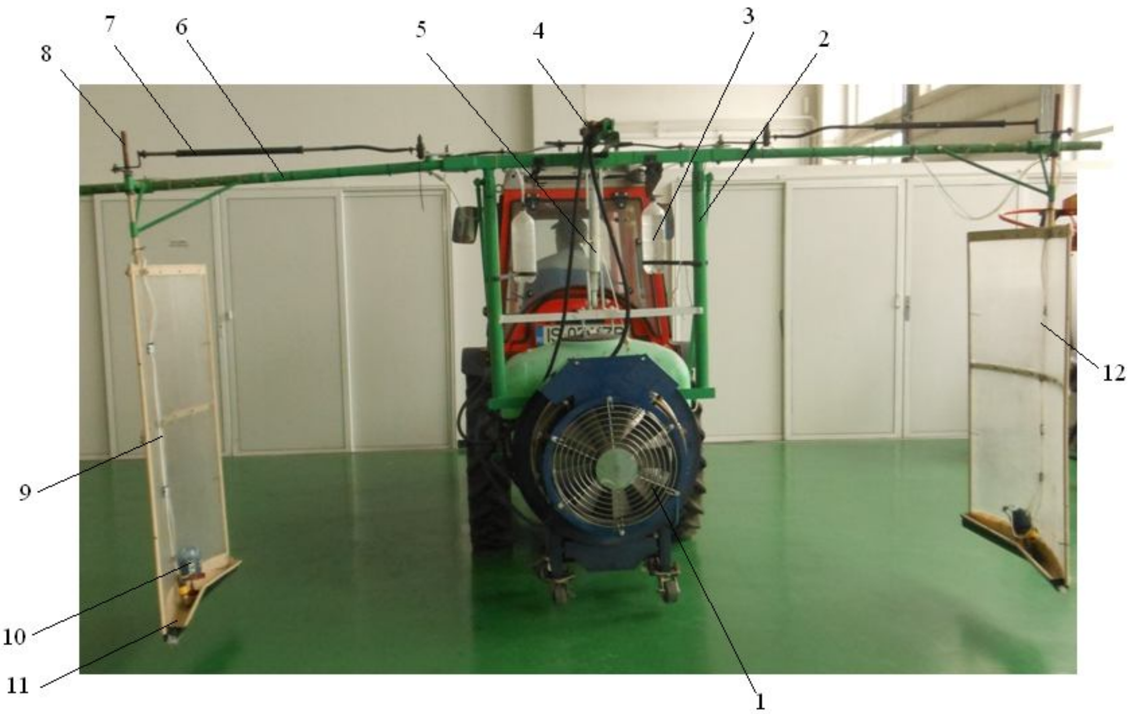

Figure 1 **Spraying machine for pest and disease control with equipment for the retrieval of droplets: 1 – spraying machine; 2 – frame of the droplets retrieval equipment; 3 – graduated glass cylinders; 4 – hydraulic cylinder; 5 – tensional bar for height adjustment; 6 – swinging swivels; 7 – parallelogram mechanism; 8- supporting rods; 9, 12 – polycarbonate panels; 10 – electric pumps; 11 – gutters for droplets retrieval.**

The equipment was tested in laboratory conditions in order to evaluate the amount of solution recovered for different speeds of the fan (different airflow rates). The tests were carried out for different airflow ratea of the fan, corresponding to the fan speeds of 800, 1100 and 1400 rev/min. The experimental tests were performed at different pressures (0.2, 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 MPa), while the recovery pannels were positioned at a distance 1500, 1700, 1900 and 2100 mm from the axis of the spraying machine and at heights 300, 500 and 700 mm above the ground.

For the the above mentioned fan rotation speeds the air speed was measured by the means of an anemometer.

RESULTS AND DISCUSSION

For the three fan rotation speeds the average air velocity, in the vicnity of the nozzles, was asa follows: 8.27 m/s for 800 rpm, 11,71 m/s for 1100 rpm and 14.32 m/s for 1400 rpm.

Using the air speed data the average air flow rate was calculated, taking into account a cross-sectional area of the fan of 0.41 m^2 and the following results were obtained: 12204 m^3/h at 800 rpm, 17280 m^3/h at 1100 rpm and 21132 m^3/h at 1400 rpm.

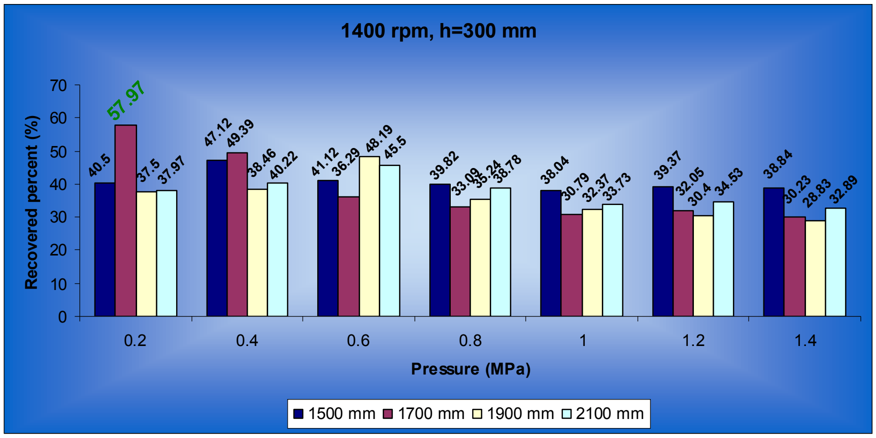

Figure 2 **The recovery of the solution sprayed on the operating pressure, the arrangement height of the panel to 300 mm, and fan speed of 1400 rpm.**

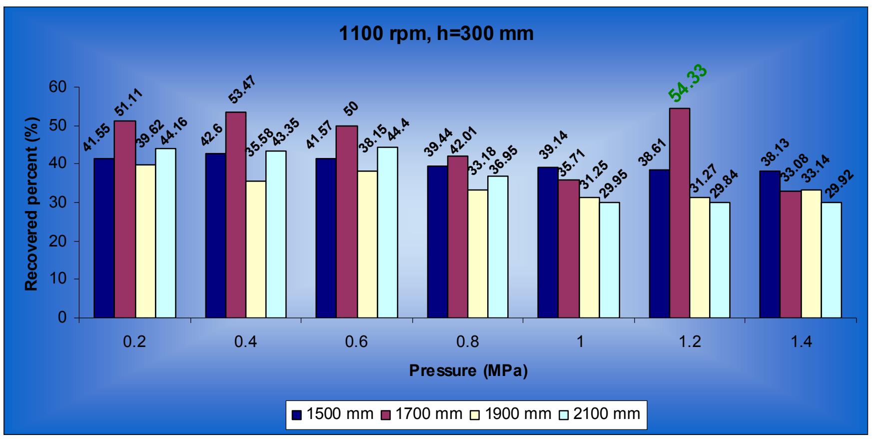

Figure 3 **The recovery of the solution sprayed on the operating pressure, the arrangement height of the panel to 300 mm, and fan speed of 1100 rpm.**

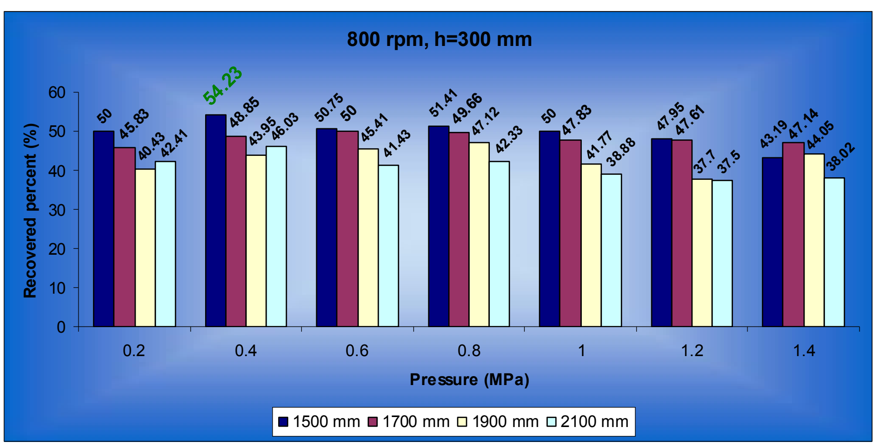

Figure 4 **The recovery of the solution sprayed on the operating pressure, the arrangement height of the panel to 300 mm, and fan speed of 800 rpm.**

The best result was obtained at the speed of 1400 rpm (21132 m^3/h), followed by 1100 rpm (17280 m^3/h) and then to 800 rpm (12204 m^3/h) front panel height the ground 300 mm and the width thereof to the machine axis 1700 mm and 1500 mm.

For a width of 1700 mm, to a rate of 57.97% recovered from the solution sprayed at the speed of 1400 rpm and a pressure of 0.2 MPa (*figure 2*) and 54.33% at 1100 rpm at 1.2 MPa (*figure 3*). For a width of 1500 mm, 54.23% recovered from the 800 rpm and 0.4 MPa (*figure 4*). The reason why a better recovery is obtained at a higher fan speed is due to the fact that the air flow has the strength to carry a greater number of drops of toxic solution to the recovery panels.

For the height of 500 mm, the recovery rate increased while decreasing the fan speed. Thus, at the speed of 800 rpm, a recovery rate of 51.73% was obtained at a pressure of 0.2 MPa (*figure 5*). At 1100 rpm, the recovery rate was 43.78% of the total amount of the solution sprayed at 0.4 MPa (*figure 6*). For a fan speed of 1400 rpm and the same pressure of 0.4 MPa, a recovery rate of 35.56% was obtained (*figure 7*). These values were recorded when the panels were placed at distance of 1500 mm from the axis. It was found that the recovery rate increased when the distance from the axes decreases, due the greater droplets transport distance achieved when the pane was further away from the equipment; as a result fewer droplets reach the recovery panels.

For the height of 700 mm it was also found that the recovery rate increased when the fan speed decreased. At 800 rpm, the best recovery rate (44.76% of the total flow) was obtained for a distance of 1500 mm and a pressure of 0.4 MPa, (*figure 8*). At speeds of 1100 and 1400 rpm, the optimum distance in terms of recovery rate was 1700 mm: 40.27% for a pressure of 0.4 MPa and 1100 rev/min (*figure 9*), and 34.83% for 0.2 MPa and the speed of 1400 rpm (*figure 10*) .

The recovery rate decreased when the height of the panel increased. This might be due to the fact that the angle of the spray nozzle at the base of the spraying machine is not in the coverage area of the panel.

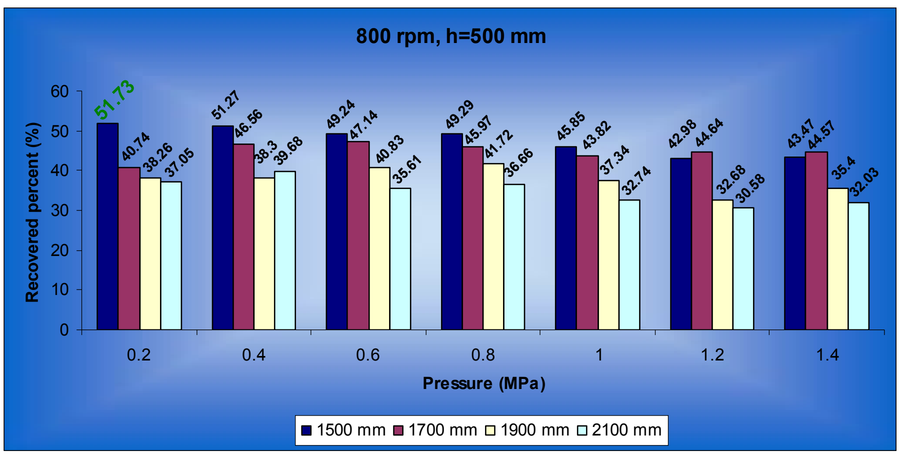

Figure 5 **The recovery of the solution sprayed on the operating pressure, the arrangement height of the panel to 500 mm, and fan speed of 800 rpm.**

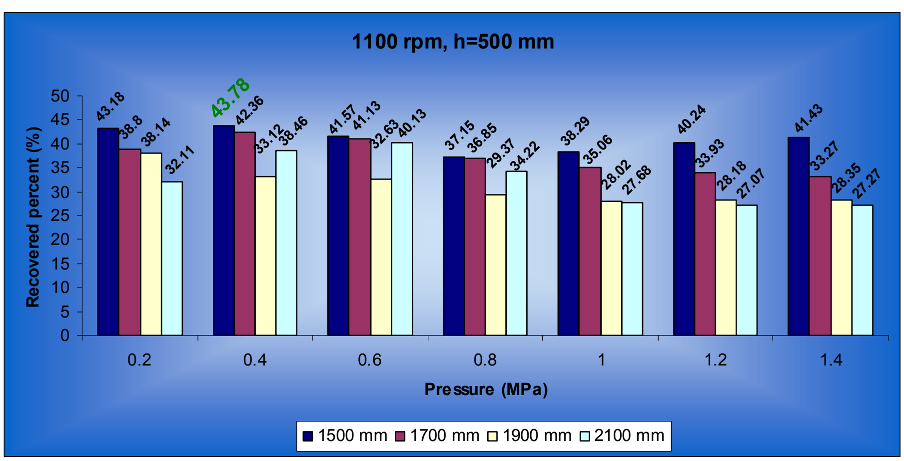

Figure 6 **The recovery of the solution sprayed on the operating pressure, the arrangement height of the panel to 500 mm, and fan speed of 1100 rpm.**

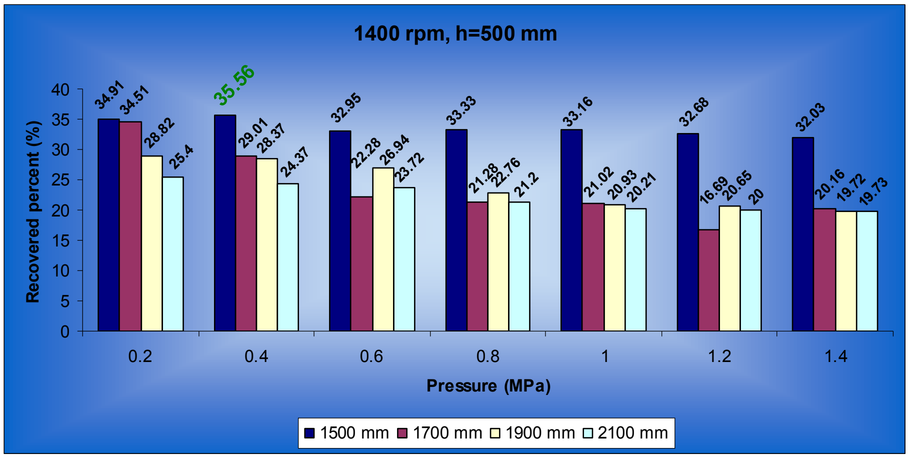

Figure 7 **The recovery of the solution sprayed on the operating pressure, the arrangement height of the panel to 500 mm, and fan speed of 1400 rpm.**

Therefore, high mounting heights of the panels requires a lower flow of air to recover a large amount of solution. From the obtained results, it was observed that the optimal pressure in terms of recovery rate was 0.2 and 0.4 MPa, with an exception for the height 300 mm and the speed of 1100 rpm, when a good recovery rate was achieved for an operating pressure of 1.2 MPa. Increasing the pressure led to the reduction of the recovery rate due to excessive spraying of the solution, which led to the reduction of the droplets size, which do no longer have contact with the panels.

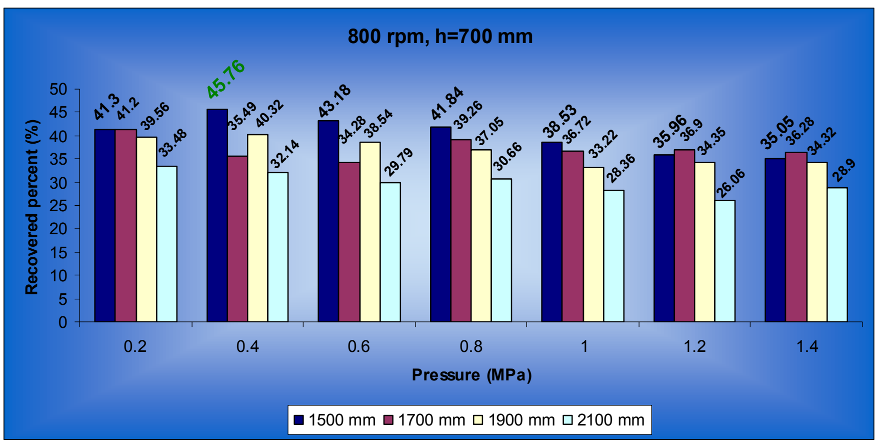

Figure 8 **The recovery of the solution sprayed on the basis of the pressure of the working height of 700 mm from the panel arrangement and the fan speed of 800 rpm.**

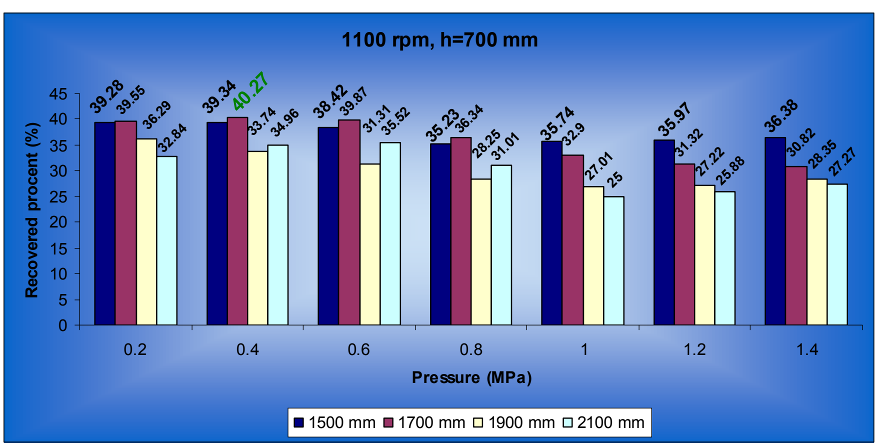

Figure 9 **The recovery of the solution sprayed on the basis of the pressure of the working height of 700 mm from the panel arrangement and the fan speed of 1100 rpm.**

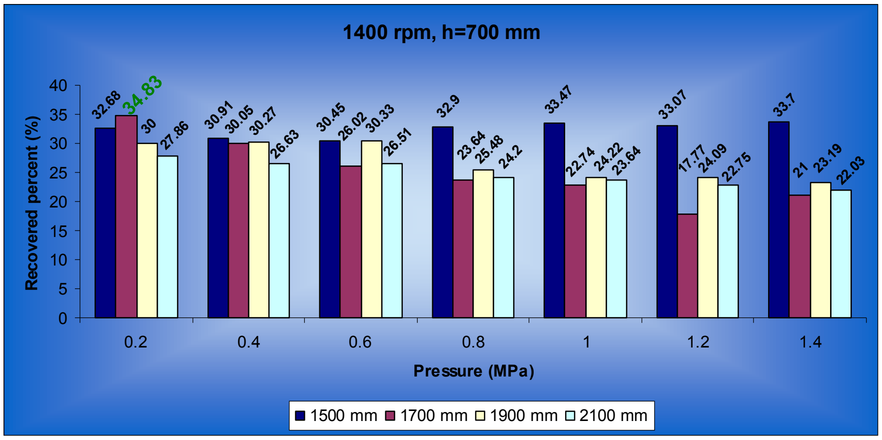

Figure 10 **The recovery of the solution sprayed on the basis of the pressure of the working height of 700 mm from the panel arrangement and the fan speed of 1400 rpm.**

CONCLUSIONS

The results of research conducted in laboratory conditions, the influence of fan airflow on the process of recovering lost after the spray solution by using equipment designed for that scopt and mounted sprayer for pest and disease control in vineyards and intensive fruit type TARAL 200 PITON TURBO, allow us to point out the following conclusions:

- fan air flow affects the recovery;
- fan speed of 1400 rpm with an air flow of 21132 m³/h, which is obtained in a recovery of 57.97% of solution sprayed, at a height above the ground panel and the width of 300 mm from the axis of the machine spraying of 1700 mm;
- fan speed of 1100 rpm with an air flow of 17280 m³/ha achieved a recovery of 54.33% for the same positions of the panels;
- fan speed of 800 rpm with an air flow of 12204 m³/ha obtain a recovery of 54.23%, 51.73% and 44.76% with increasing height of the panel for a width of 1500 mm;
- optimum distance from the axis machine panels for high recovery are 1500 and 1700 mm;
- optimum height above the ground panorama is 300 mm;
- the working pressure has been obtained the best consequential was 0.4 MPa, followed by 0.2 MPa;
- equipment made solution reduce pollution by plant and its recovery;
- equipment reduces fuel consumption by simultaneous treatment of two rows.

ACKNOWLEGMENTS

This paper was *published under the frame of* European Social Fund, *Human Resources Development Operational Programme 2007-2013, project no.* POSDRU/159/1.5/S/132765.

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