RESEARCHES REGARDING THE EFFECT OF AIR FLOW RATE FOR THE RECYCLING OF PESTICIDES ADMINISTERED WITH SPRAYING MACHINE TARAL 200 PITON TURBO-ER

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Abstract

The growth technologies for orchards and vineyards include a large number of treatments for disease and pest control. Without these treatments the production can be reduced by up to 35% or even totally compromised. The pesticides used for performing phytosanitary treatments are toxic substances that can pollute air, water and soil. In addition to their effect on diseases and pests, the pesticides reaching the soil extend their action over microorganisms, leading to quantitative and qualitative changes in both the edaphical population structure and the physiological activities. In the same time the pesticides fallen on the ground can be transferred, without undergoing significant alterations, into plants, fruits, animals and finally humans, causing various diseases. Pest and disease control using phytosanitary treatments is performed by the means of specialized machines, specially designed for this purpose. The treatments are effective when the size of the dispersed droplets is in the range of tens of micrometers, in order to cover as much of the surface of the leaf system as possible. The pneumatic transportation of the droplets is accompanied by the drift phenomenon, which causes a significant amount of toxic substances to land on the soil. One solution to counteract the effect of drift is to recycle the substance that is not retained by plants. Considering this principle a recycling equipment for vineyards was designed and built; the device prevents soil pollution with the substance which is not retained on the surface of the vineyard leaves. The spraying machine was equipped with air entrainment nozzles, which prevent droplets drift due to the fact that large droplets, filled with air bubbles, are transported towards the leaves. The droplets then break easily when coming into contact with the leaves, thus leading to a better covering of the surface. During the experimental tests the effect of the air flow rate over the recycling process was studied; the TARAL 200 PITON TURBO-ER spraying machine, equipped with an axial fan, was used.

Key words: (air flow, air suction nozzles, axial fan, recycling pesticide, spraying machine)

Production losses caused by diseases and pests can be very large. In order to maintain a constant production every year it is absolutely necessary to applying chemical treatments for pest and disease control. These chemical substances are highly toxic and can pollute air, water and soil. Pesticides that reach the ground are transferred into plants, animals, fruits and finally humans, without suffering significant alterations and being extremely harmful for them.

Machines for pest and disease control in vineyards and orchards are among the most complex regarding the construction and their adjustments. When no air jet is used the liquid flow rate may exceed 3000 l/ha. In order to diminish the amount of liquid an air jet is used for the transportation of liquid droplets; the air to liquid ratio is comprised between 10/1 and 20/1 (in volume units). The air flow rate is comprised between 10,000 and 50,000 m³ / h and the air jet velocity at exit is comprised between 160 and 220 km / h. These parameters should be adjusted taking into account the cutting system, canopy width, distance between rows etc. in order to minimize losses (Matthews G.A., 1979; Cross J.V. *et al.,* 2003).

The effects of adjusting the air flow rate were investigated by different researchers (Hall O.D., 1975; Weiner K.L., 1993; Derksen R.C., Gray R.L., 1995; Svensson S.S., 2001; Cross J.V. *et al.,* 2003). Appropriate use of air may improve droplets distribution and the efficiency of liquid deposition on the surface of the leaves. A better balance between liquid deposition on the upper and lower parts of the plantation requires a specific shape of the air jet (Viret O. *Et al.,* 2003; Pergher G., Petris R., 2008). Inadequate air and velocity distribution may damage parts of the canopy (Furness G., Pinczewski W.V., 1985; Pezzi F., Rondelli V., 2000; Gil Y., Sinfort C., 2005). Proper use of the air flow is not an easy task; a jet which is too strong or too weak inadequate liquid deposits in the canopy and lead to environmental pollution (Doruchowski G. *et al*., 1997; Panneton

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B. *et al.,* 2005).

The spraying machines may be equipped with different types of fans: axial, centrifugal, axial-centrifugal, tangential (transversal). The radial, centrifugal and tangential fans achieve an air flow rate of 2000-15000 m³/h at pressures of 4-10 kPa; the axial fans achieve higher air flow rates (1000 - 100,000 m³/h), at lower pressures (1-1,5 kPa) (Scripnic V., Babiciu P., 1979; Bäcker G., 2004; Stahli W., Bungescu S.T., 2005).

The most effective treatments are performed with small droplets because they have the ability to uniformly spread over the leaf. However the phenomenon of drift that directs the droplets in different areas than the ones aimed at, causing soil pollution.

In order to prevent the drift effect and soil pollution, sprayers are equipped with air entrainment nozzles and recycling tunnel booms.

In the present paper the effect of the air flow rate over the recycling rate was studied. The TARAL 200 PITON TURBO spraying machine for vineyards and intensive orchards was used ; a recycling equipment was mounted on the spraying machine and air entrainment nozzles were used.

MATERIAL AND METHOD

A solution recycling equipment was designed and built, aiming to reuse the solution that was not retained by the foliar system of the vineyard plantation. The equipment was mounted on the TARAL 200 PITON TURBO spraying machine, equipped with air entrainment, flat jet nozzles (type LECHLER IDK 120-02) and axial fan (*figure 1*).

The equipment consists of the collapsible support and polycarbonate panels fitted with troughs at the base. The hinged supports with recycling panels use a hydraulic cylinder in order to place the panels either in the operating position (on each side of the vineyard row) or in the transportation position. The recovered solution drips down into the gutters; from here it flows towards two measuring cylinders. Flow meters were mounted on the hydraulic circuits of the equipment.

The laboratory experiments were performed at different operating pressures (0.2; 0.4; 0.6; 0.8; 1.0; 1.2 and 1.4 MPa), at different heights of the panels above the ground (300, 500 and 700 mm) and distances from the axis of the spraying machine (1500, 1700, 1900 and 2100 mm) and at different speeds of the axial fan (800, 1100 and 1400 rev / min). The recycling rate was calculated as the ration between the flow rate of the recycled liquid and the hydraulic pump flow rate.

A hot wire anemometer (TROTEC TA300) was used in order to measure the air speed and air flow rate.

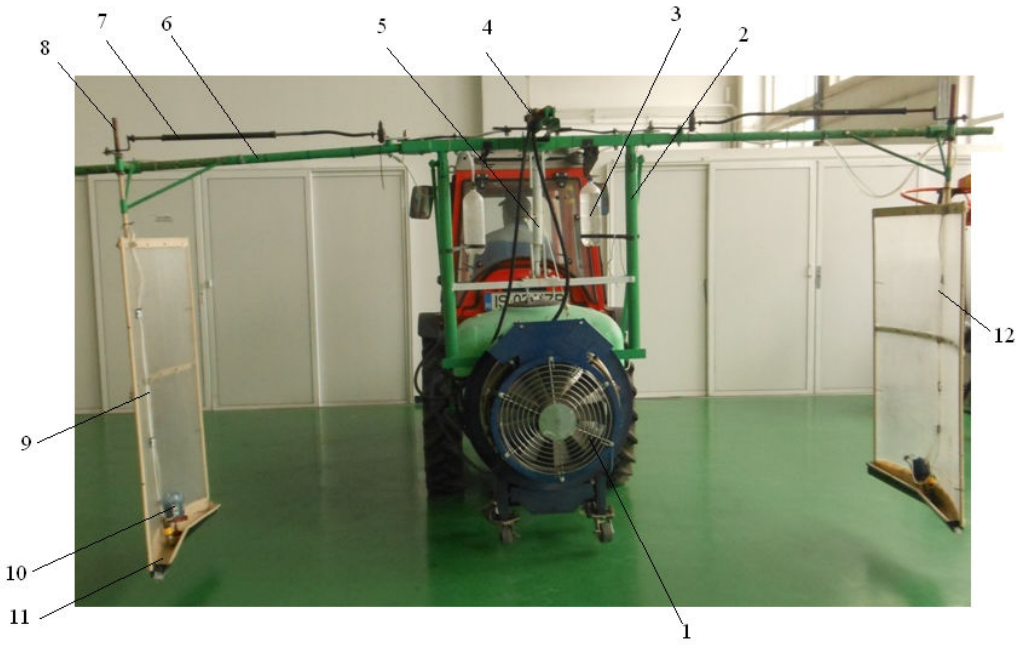

Figure 1 **Sprayer unit with equipment for recovering sprayed solution: 1 - machine sprayer; 2 - the metal frame; 3 - graduated cylinders; 4 - hydraulic cylinder; 5 - thrusts; 6 - collapsible support; 7 - parallelogram mechanism; 8 - rods; 9:12 - panels; 10 - pumps; 11 - gutters.**

RESULTS AND DISCUSSIONS

The average air velocity at the level of each nozzle was as follows: 8.27 m/s at the speed of 800 rev/min, 11.71 m/s at 1100 rev/min and 14.32 m/s for 1400 rev/min. In the fan cross-section area (0.41 m^2) the air flow rate was: 12204 m^3/h at 800 rev / min, 17280 m³/h at 1100 rev/min and 21132 m³/h at 1400 rev/min.

It was noted that, for a mounting height of the panels of 300 mm the highest recycling rate was achieved when the panels were placed at 1500 mm from the machine axis; the recycling rate decreases when the distance increases. For all the distances taken into account (1500, 1700, 1900 and 2100 mm) the recycling rate increases when the operating pressure decreases; the best results were achieved for 0.2, 0.4 and 0.6 MPa. There were no changes of the recycling rate for the operating pressures of 0.8 and 1.4 MPa.

The recycling rate increased when the fan speed was increased; for the speed of 800 rev/min the highest recycling rate (40%) was achieved at a pressure of 0.2 MPa and a distance of 1500 mm between the panel and the machine axis (*figure 2*). For the same conditions as the ones mentioned above when the speed increased to 1100 rev/min and then to 1400 rev/min the recycling rate increased to 63.41% (*figure 3*) and 75.61% (*figure 4*).

When the height was increased to 500 mm the recycling rate also increased with fan speed, as follows: 35.12% at 800 rev/min (*figure 5*), 38.54% at 1100 rev/min (*figure 6*) and 41.22% at 1400 rev/min (*figure 7*). The best recycling rate was attained when the panels were placed at 1500 from the machine axis and the operating pressure was 0.2 MPa.

When the panels were placed at a height of 700 mm above the ground the results concerning the recycling rate were the following: 30% at 800 rev/min (*figure 8*), 34.99% at 1100 rev/min (*figure 9*) and 37.07% at 1400 rev/min (*figure 10*). The best recycling rate was also attained when the panels were placed at 1500 from the machine axis and the operating pressure was 0.2 MPa.

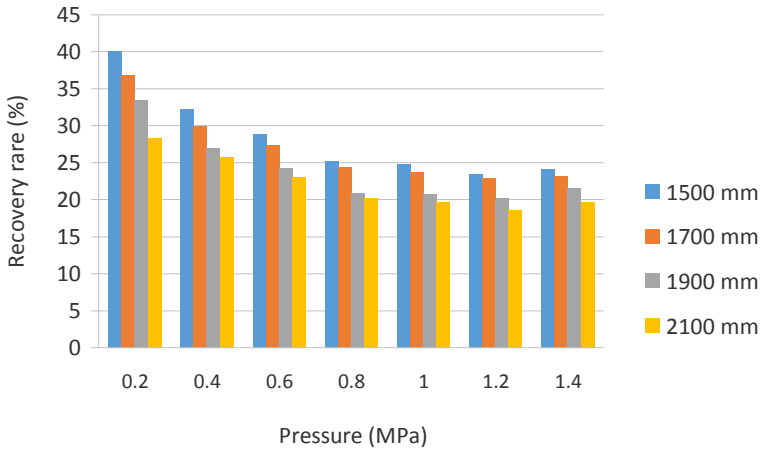

Figure 2 **Recycling rate vs. operating pressure: fan speed 800 rev/min, height 300 mm**

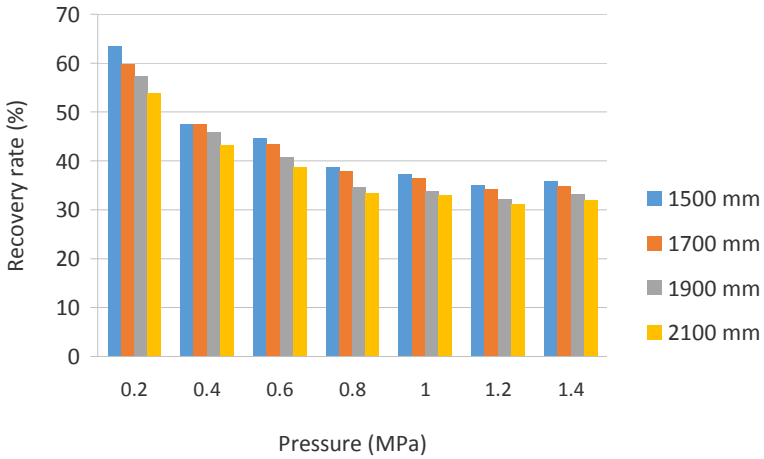

Figure 3 **Recycling rate vs. operating pressure: fan speed 1100 rev/min, height 300 mm**

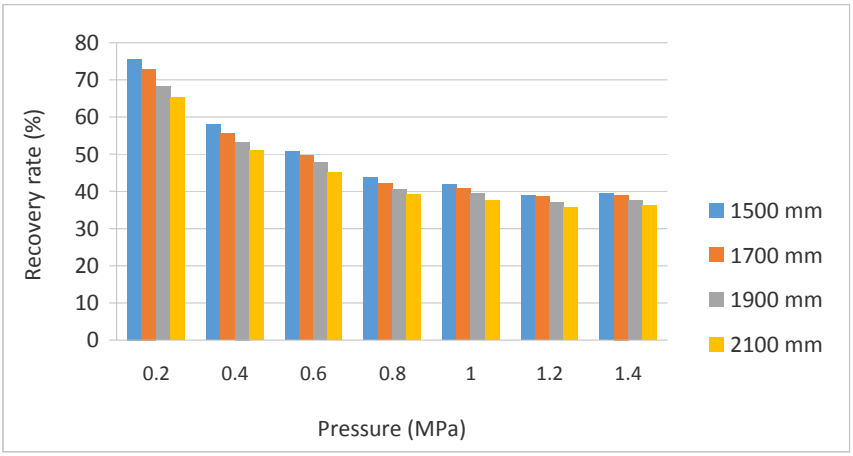

Figure 4 **Recycling rate vs. operating pressure: fan speed 1400 rev/min, height 300 mm**

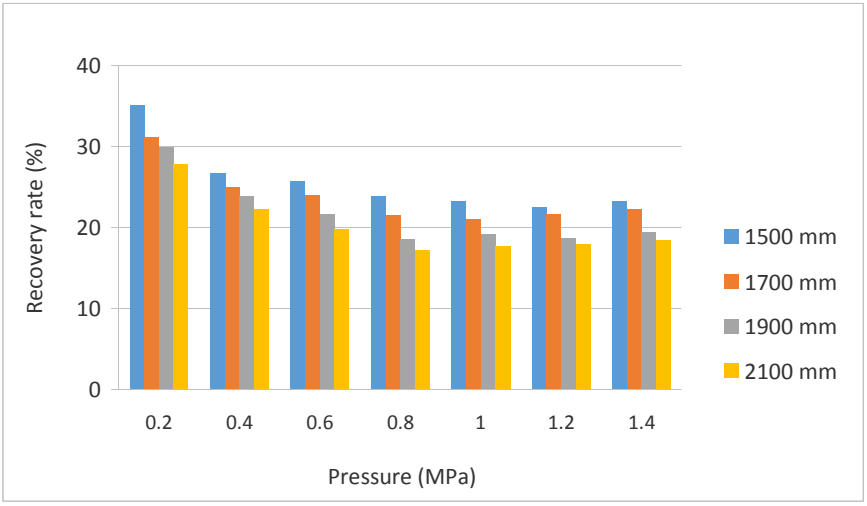

Figure 5 **Recycling rate vs. operating pressure: fan speed 800 rev/min, height 500 mm**

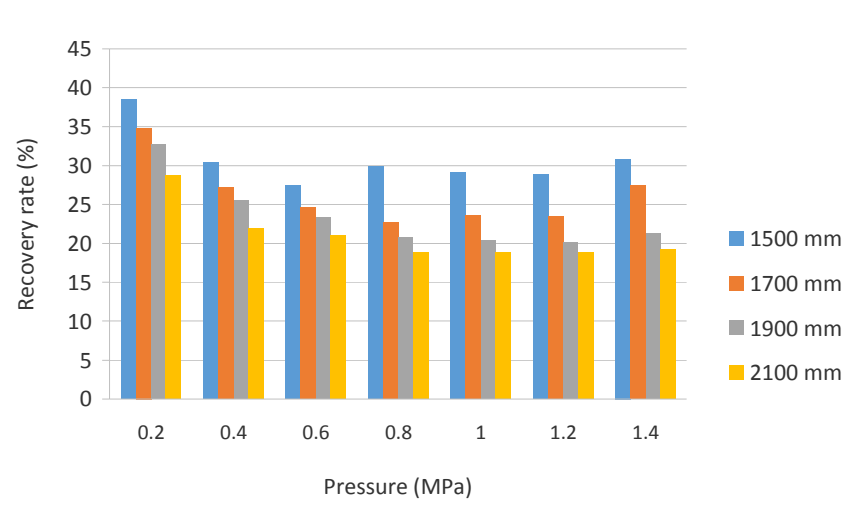

Figure 6 **Recycling rate vs. operating pressure: fan speed 1100 rev/min, height 500 mm**

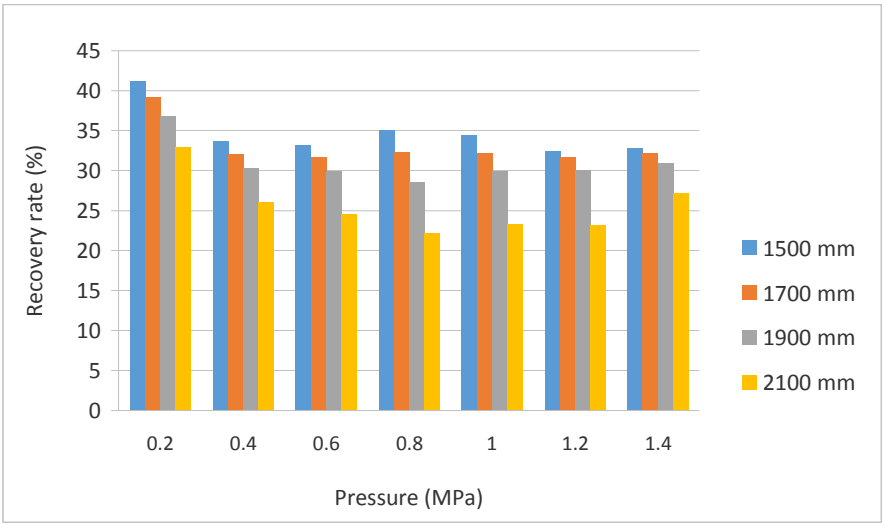

Figure 7 **Recycling rate vs. operating pressure: fan speed 1400 rev/min, height 500 mm**

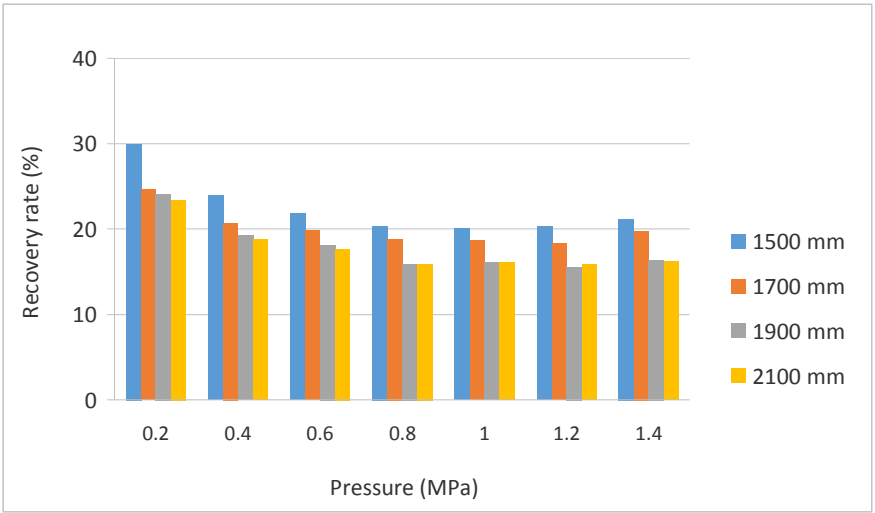

Figure 8 **Recycling rate vs. operating pressure: fan speed 800 rev/min, height 700 mm**

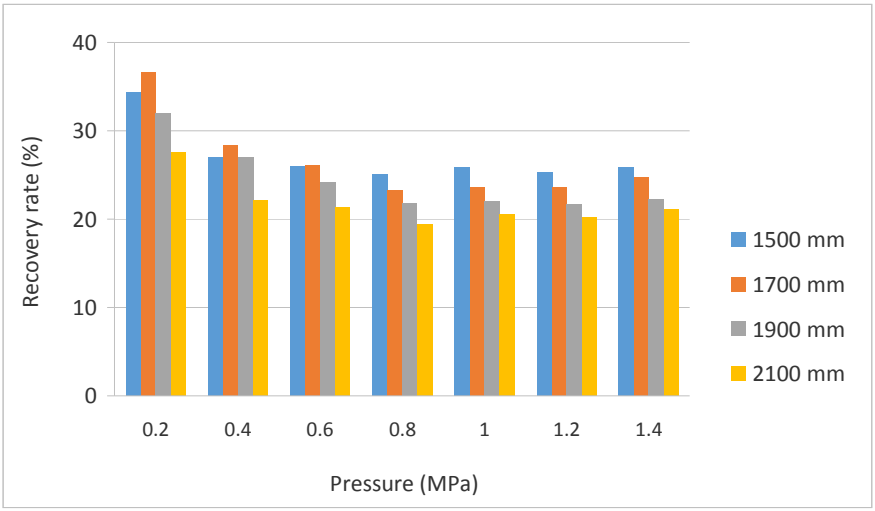

Figure 9 **Recycling rate vs. operating pressure: fan speed 1100 rev/min, height 700 mm**

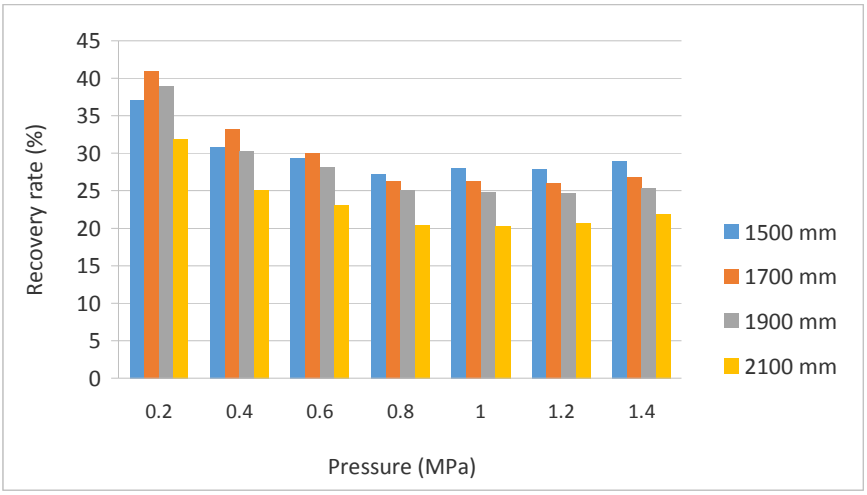

Figure 10 **Recycling rate vs. operating pressure: fan speed 1400 rev/min, height 700 mm**

The recycling rate decreased when the panels were placed at higher heights because of the limitation introduced by the angle of the air jet; as a result the liquid dispersed by the nozzles placed at the lower part of the machine was no longer intercepted by the recycling panels.

CONCLUSIONS

The results of the laboratory test led to the conclusion that the fan air flow rate affects the recycling rate; the best results (highest recycling rates) were obtained in the following conditions:

- fan speed 1400 rev/min;
- panel height above the ground: 300 mm;
- panel distance from the machine axis: 1500 mm;
- operating hydraulic pressure: 0.2 MPa.

ACKNOWLEGMENTS

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