RESEARCHES REGARDING THE FLOW RATE UNIFORMITY OF THE TARAL 200 PITON TURBO SPRAYING MACHINE FOR DISEASE AND PEST CONTROL IN VINEYARDS AND INTENSIVE ORCHARDS

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Abstract

Pest and disease control is one of the most important technological links, because damages caused by them can be very large. Fruit production can be completely compromised if the application of plant protection products is not done correctly and on time. Chemical control is the main method used in plant protection. To do this, specially adapted spraying equipments are used. Sprayers are equipped with different types of nozzles, made from different materials resistant to corrosion and hydro abrasion produced by the toxic products, leading to the de-calibration of the spray nozzles. Thus the flow rate of chemical solution was affected, increasing the consumption. In order to avoid this phenomenon it is recommended to test the nozzles before each campaign, by measuring the flow rate of the liquid. With this idea in mind the TARAL 200 PITON TURBO spraying equipment was tested; the procedure consisted in collecting the liquid distributed by the nozzles during two minutes; the amount of collected solution was than measured with a graduated cylinder. The experiments were carried out in four repetitions for three rotation speeds of the power take-off shaft (310, 460 to 540 rpm) and different pressures of the liquid (0.2, 0.4, 0.6, 0.8, 1.0, 1, 2 to 1.4 MPa). After determining the flow rate uniformity, it was found that the best result was obtained for rotation speeds of the power take-off shaft of 540 rpm.

Key words: nozzles, spraying machine, TARAL 200 PITON TURBO.

Pest and disease control in vineyards and orchards is one of the most important technological works, without which production would not be of quality and consistent year after year. Without proper and timely implementation of phytosanitary treatments, production could be completely destroyed (Berca, 2001).

Chemical control is the main method of performing this task; however, the increase of the number of treatments applied within one year results in higher costs. Plant protection products are highly toxic and pollute the environment. This is harmful microorganisms in the soil, animals, birds, people and even vegetation, as plants life becomes shorter. Therefore, pest and disease control must take into account technical, economical and ecological aspects equally (Berca, 2001).

The spraying equipments used for pest and disease control must ensure efficient treatment, with superior quality of the operating indices in order to prevent production losses, high pesticide consumptions and to reduce environmental pollution (Nagy et al., 2006; 2007). To this end, the spraying machines are equipped with different constructive types of nozzles, made of stainless steel, brass, plastic and ceramic, materials which are resistant to chemical hydroabrasion of the plant protection products. Despite their resistance to hydro abrasion, the spray nozzle orifice becomes de-calibrated in time. This will cause excessive dispersal of plant solution and uneven spray distribution, with untreated and over treated areas. . In order to avoid this phenomenon it is recommended to test the nozzles before each campaign, by measuring the constant flow rate of the liquid through each nozzle.

The purpose of this study is to evaluate the flow rate uniformity for the TARAL 200 PITON TURBO spraying machine, used for pest and disease control in vineyards and intensive orchards.

MATERIALS AND METHOD

In order to determine the flow rate uniformity for the TARAL 200 PITON TURBO spraying machine (*figure 1*), the flow rate through each nozzle was measured using the volumetric method. Flow rate measurement was achieved by mounting hoses at the end of each nozzle and collecting the distribute

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solution into containers (*figure 2*), during two minutes; a graduated cylinder was used to measure the amount of accumulated solution. The experimental tests were carried out in four repetitions (R1, R2, R3 and R4), for three rotation speeds of the power take-off shaft (310, 460 to 540 rpm) and for different pressures (0.2, 0.4, 0, 6, 0.8, 1.0, 1.2 and 1.4 MPa).

Figure 1. Sprayer for pest and disease control in vineyards and intensive orchards, type TARAL 200 PITON TURBO

Figure 2. Collection of solution sprayed from each nozzle to spray machine type TARAL 200 PITON TURBO

After measuring the flow rate of each nozzle (q_i), the flow rate for the entire equipment (Q_i) was calculated, using the following formula:

$$Q_i = \sum_{i=1}^{i=n} q_i \quad \text{(l/min)},$$

where n is the number of nozzles.

The average flow rate of the spraying machine (Q_m) was calculated for several repetitions, using the relation:

$$Q_m = \frac{\sum_{i=1}^{i=n} Q_i}{n} \text{ (l/min)},$$

where:

Q_i – the flow rate for each repetition;

n – the number of tests performed (repetitions).

Flow rate uniformity (C_d) was calculated with the relationship:

$$C_d = \left[1 - \frac{\sqrt{\dfrac{\sum_{i=1}^{i=n}(Q_i - Q_m)^2}{n(n-1)}}}{Q_m} \right] * 100 \text{ (\%)},$$

where:

Q_i – the flow rate for each repetition;

Q_m – the average flow rate;

n – the number of tests performed (repetitions).

RESULTS AND DISCUSSION

For the determination of the average flow of fluid to the spraying machine (Q_m), to the three rotation speeds of the power take-off shaft and at different working pressures, to determine the volume of fluid machine (Q_i) in four repetitions. The experimental data were summarized in *table 1.*

The flow rate uniformity (C_d) was calculated with the relationship presented above and the results were plotted against the operating pressure, as shown in *figure 3*.

The chart shows that, for the nominal speed of the power take-off shaft, the pressure variation did not significantly affect the flow rate uniformity, which was higher than 94% (94.55±0.185 for all the pressure ranges).

For lower speeds the flow rate uniformity was significantly affected by the operating pressure (96.95±0.732% at 460 rpm; 97.96±0.288%), probably due to the flow rate variations which are characteristic for the positive displacements pumps, especially at lower rotation speeds.

Table 1

The flow rate uniformity of the TARAL 200 PITON TURBO

Pressure (MPa)	Repetitions	Rotation speeds of the power take-off shaft (rpm)								
		310			460			540		
		Q_i (l/min)	Q_m (l/min)	$Q_i - Q_m$ (l/min)	Q_i (l/min)	Q_m (l/min)	$Q_i - Q_m$ (l/min)	Q_i (l/min)	Q_m (l/min)	$Q_i - Q_m$ (l/min)
0,2	R1	1,15	1,15	0	1,54	1,40	0,140	1,58	1,66	-0,085
	R2	1,18		0,030	1,34		-0,060	1,55		-0,115
	R3	1,15		0	1,35		-0,050	1,70		0,035
	R4	1,12		-0,030	1,37		-0,030	1,83		0,165
0,4	R1	1,18	1,24	-0,067	1,69	1,54	0,142	1,94	1,80	0,137
	R2	1,31		0,062	1,44		-0,107	1,93		0,127
	R3	1,24		-0,007	1,63		0,082	1,85		0,047
	R4	1,26		0,012	1,43		-0,117	1,49		-0,312
0,6	R1	1,32	1,37	-0,052	1,90	1,72	0,175	2,20	2,27	-0,070
	R2	1,40		0,027	1,58		-0,145	2,67		0,400
	R3	1,31		-0,062	1,90		0,175	2,06		-0,210
	R4	1,46		0,087	1,52		-0,205	2,15		-0,120
0,8	R1	1,41	1,45	-0,0400	2,18	2,05	0,125	2,31	2,58	-0,275
	R2	1,51		0,050	1,94		-0,115	2,96		0,375
	R3	1,39		-0,060	2,23		0,175	2,57		-0,015
	R4	1,50		0.040	1,87		-0,185	2,50		-0,085
1,0	R1	1,57	1,62	-0,050	2,35	2,39	-0,040	2,42	2,82	-0,402
	R2	1,62		0	2,31		-0,080	3,21		0,387
	R3	1,58		-0,040	2,48		-0,090	2,89		0,067
	R4	1,71		0,090	2,42		0,030	2,77		-0,052
1,2	R1	1,71	1,76	-0,052	2,46	2,51	-0,057	2,57	2,96	-0,392
	R2	1,68		-0,082	2,49		-0,027	3,33		0,367
	R3	1,79		0,027	2,59		0,072	3,05		0,087
	R4	1,87		0,107	2,53		0,012	2,90		-0,062
1,4	R1	1,84	1,84	0	2,57	2,96	-0,050	2,70	3,15	-0,457
	R2	1,75		-0,090	2,66		0,040	3,57		0,412
	R3	1,85		0,010	2,61		-0,010	3,32		0,162
	R4	1,92		0,080	2,64		0,020	3,04		-0,117

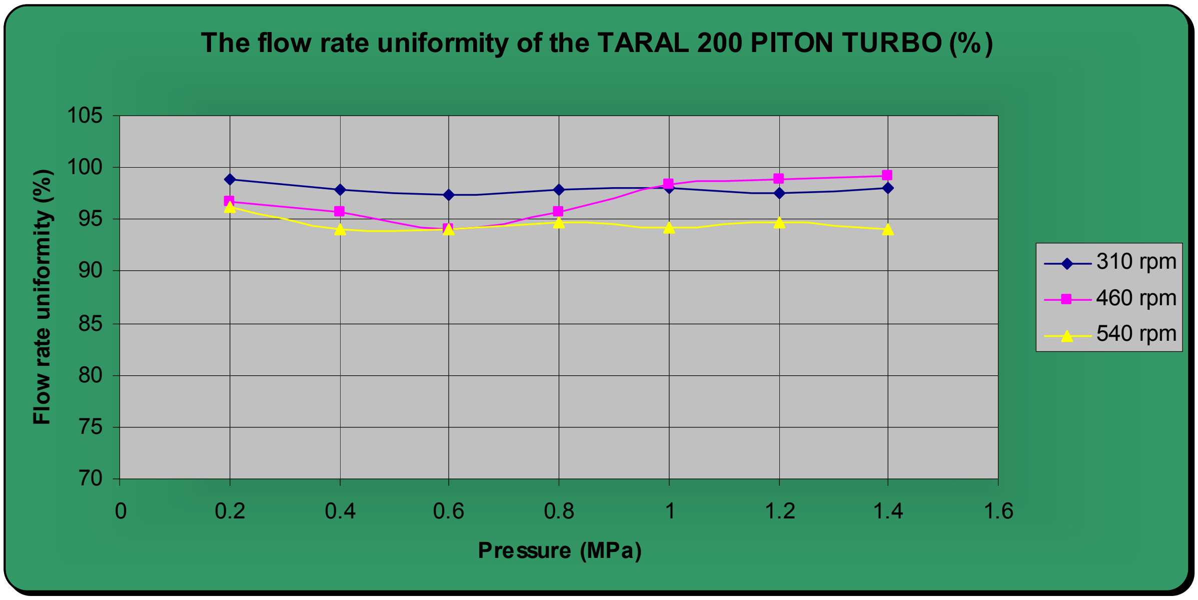

Figure 3 **Flow rate uniformity spraying machine for pest and disease control in vineyards and intensive orchards TARAL 200 PITON TURBO**

CONCLUSIONS

The results of researches conducted in laboratory conditions regarding the flow rate uniformity of the TARAL 200 PITON TURBO spraying machine for pest and disease control in vineyards and intensive orchards type, led to the following conclusions:

- the flow rate uniformity reached values higher than 94% for all the tested operating regimes;
- significant variations of the flow rate uniformity, depending upon the operating pressure, were recorded for speeds of the power take-off shaft lower that the nominal one (540 rpm);
- operating the equipment at the nominal speed of the power take-off shaft resulted in minor deviations of the flow rate uniformity over the entire pressure range (94.55±0.185%).

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