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INFLUENCE OF THE TYPE OF THE SPRAYING ON SOME TECHNOLOGICAL AND ECONOMIC INDICATORS IN PESTICIDE TREATMENT OF VINEYARDS

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Abstract:

The aim of the present study is to compare some technological and economic parameters in the treatment of vines with pesticides using: axial and tangential fan sprayers. The following indicators are the degree of coverage of the leaf mass, the degree of penetration of the pesticide into the canopy of the vines and the price of the sprayers. From the experiments, calculations and analyzes conducted so far, it can be concluded that both sprayers meet to a very good extent the technological requirements after mandatory treatment of each vine row on both sides. The degree of coverage of the leaf mass with drops is about 65% for axial and about 78% for tangential sprayers. The difference is due to the more concentrated and directed jet (from air and solution) in the tangential sprayer. This allows for good mixing and passing through the leaf mass. Regarding the other technological indicator - penetration rate - the results are approximately the same. Given the small difference in prices, this is a reason to recommend working with a tangential sprayer when treating vineyards with pesticides.

***Key words**: axial and tangential fan sprayers, degree of coverage, degree of penetration.*

INTRODUCTION

The main part of the fan spray system is the fan. Often in the upper and lower part of its outlet hinge deflector plates are hinged, which direct the created air flow in a certain direction. Pipelines are attached on both sides of the fan. At their upper end they are closed. The nozzles are mounted to them at a certain interval. Depending on the design of the fan outlet, two types of spray systems are observed:

- classic - In this case, the air jet created by an axial fan hits a reflector, turns 90° and spreads evenly 360° on the plane of the reflector. The movement of the air jet, together with the working upwards sprayed by the nozzles, is limited by deflectors, which when spraying vines, low-stemmed orchards and shrubs are placed in a horizontal position, and when spraying tall stems are inclined to a vertical position depending on the size of the crown. and the height of the trees.

To improve the quality of work and reduce the loss of working fluid in the air (Godyn A., 2008) as a variant of the classical two-fan systems are made with vertical arrangement of the two fans. Dual fan sprayers have not yet been well studied. Only prototypes and prototypes have been created without entering mass production and use in fruit growing practice. From the authors' research it can be concluded that these machines and spraying systems are efficient and with good quality of work at the height of the orchards up to 4 m.

- cantilever ("tower" type) - The difference with the classic system is that here the fan is covered by a metal casing, with two narrow slotted holes on the side (up to 10 cm wide). The height of these holes varies from 100 to 250 mm depending on the height of the treated plants. The other difference is that the pipes are straight and not arched as in the classic system. Due to the small area of the outlets, the air flow, respectively the working fluid carried with it, moves at a higher speed, has greater kinetic energy and penetrating force. Cantilever sprinklers have the added advantage of directing the airflow at the top of the tower downwards, which reduces the amount of solution released irreversibly into the atmosphere (Fox R. et al., 2008).

In addition to fan sprinkler systems, pneumatic and frame twin systems are used in the treatment of perennials.

- pneumatic spray systems. They are known as "spider", "octopus" and others. In them, the crushing of the working fluid and the transfer of the droplets is carried out by an air flow with a speed of 80-100 $m.s^{-1}$. Monodisperse dispersion is achieved, with an average droplet diameter between 50-80 μm. The flow is created by a centrifugal fan or compressor and is characterized by high speed. It is supplied to the sprinklers via special air ducts, which are very often flexible and allow the individual positioning of the spray nozzles (diffusers) in height and in the sides. This in turn leads to better directing of the working fluid to the treated object. Sprinklers during operation are at a short distance from the plants - from 0.5 to 2 m. Although with a small mass, the droplets move at high speed (that of air flow), due to which they have a great penetrating force and easily enter the habitat of plants.

- frame (tunnel) twin system - (Panneton B. et al., 2005; Świechowski W. et al., 2004) The main difference between conventional frame systems and this is that in addition to the frame with nozzles located above it, a sleeve is mounted in which high pressure air is supplied. Holes are made just above the nozzles in the sleeve, through which the compressed air flows at high speed. It absorbs the sprayed working fluid, further breaks it into smaller drops and transports it to the crown and inside it on the treated fruit trees. A disadvantage of this system is the loss of working fluid on the ground, which in some cases reaches 18% (Molari G. et al., 2005), which necessitates the creation of improved structures with traps of excess fluid for more complete its use (Wenneker M., J. van de Zande, 2008).

The authors (Doruchowski G. et al., 2002; Świechowski W. et al., 2004) observed the operation of three orchard sprayers for the amount of working fluid supplied, the losses and the biological efficiency depending on the spraying system. Sprayers with classical, column (cantilever) and pneumatic spraying systems have been studied. During the research 3 layers were observed in the crown of the treated trees: layer 1 - outer, closest to the sprayer; layer 2 - central; layer 3 - outer, furthest from the sprayer. In the case of the sprayer with a classic sprayer system, there is a clear tendency to reduce the volume of air in the individual layers, as the distance from the sprayer increases. There is no such clear trend for the other two sprayers. There are no differences in the delivered average amount of working fluid in the individual spray systems. However, the pneumatic sprayer delivers more inside the crop crown and less at the tips than the conventional sprayer. This excellent crown penetration in the pneumatic sprayer is combined with 50% lower air volume, which is a prerequisite for lower energy consumption. The loss of working fluid in the soil is not significantly different with individual sprayers, while the loss of air in a conventional sprayer is several times greater than that obtained when using sprayers with column or pneumatic systems.

Derksen R. et al., 2004, observed two sprayers - a classical and a column sprayer system. They found significant differences in the average amounts of working fluid for the two sprayers. Statistical estimates also show that the conventional sprayer delivers significantly larger amounts in the upper and middle parts of the crown. The column sprayer delivers a significantly larger amount in the upper than in the middle. In general, however, the differences in the amount of working fluid deposited in height are smaller for the column sprayer compared to the conventional sprayer

MATERIALS AND METHODS

The aim of the present study is to compare some technological and economic parameters in the treatment of vines with pesticides using: axial and tangential fan sprayers.

The following indicators are the degree of coverage of the leaf mass, the degree of penetration of the pesticide into the canopy of the vines and the price of the sprayers.

The experiments were performed in a vineyard with a row spacing of 3 m, a row distance of 1.2 m, a row length of 200 m, a spray rate of 450 $l.ha^{-1}$ and a movement speed of 6.8 $km.h^{-1}$. The leaf mass was located in a belt with a height of 1.05 m to 1.83 m.

Two mounted, fan sprayers were used: axial AGP 440 and tangential AGP 440U with a tank of 450 l each.

To determine the monitored technological indicators along the row, in 5 randomly selected places (in the middle of the belt), water registration papers (Figure 1) are attached on the front and back sides of selected sheets. During the research 3 layers were observed in the vine: layer 1 - outer (positions 1 and 2), closest to the sprayer; layer 2 - central (positions 3 and 4); layer 3 - outer (positions 5 and 6), furthest from the sprayer. The first working stroke is performed with the sprayer, after which the area covered with droplets on the 6 water registration papers is counted with a planimeter at each of the 5 points in a row. The sprayer passes on the other side of the sprayed row and the second stroke is performed. Again, the area covered with droplets is reported. This operation is performed for each of the two observed sprayers.

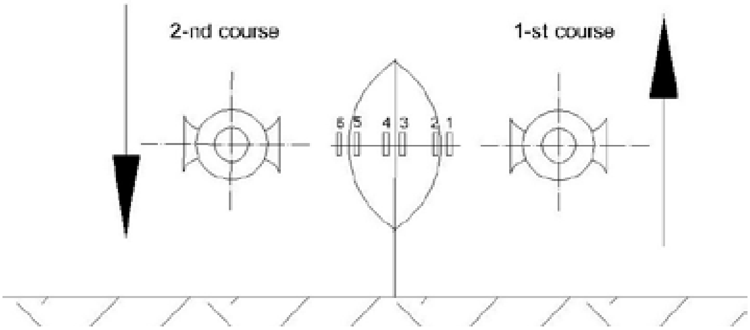

Figure 1. Scheme of the experiment

In the first stroke, position 1 is closest to the sprayer and position 6 is furthest away. In the second stroke it is exactly the opposite.
The degree of coverage is determined according to formula 1:

(1) $$M_s = \frac{S_1}{S}$$

S - area of the water registration paper, cm^2; S_1 - area covered with drops, cm^2.
The degree of penetration provides information about the possibility of uniform saturation of the entire leaf mass of the vine with a solution of the preparation. Determined by formula 2:

(2) $$M_{n=\frac{M_{S1}}{M_{S5}}}$$

M_{S1} - degree of coverage in item 1 (Figure 1), M_{S5} - degree of coverage in item 5. The closer to 1 the value obtained, the better the solution penetrates the leaf mass.
In terms of economic indicators, most of them are derived from the price of the sprayer. For this reason, in the present work, its price is indicated as an economic indicator.

RESULTS AND DISCUSSIONS

Water-registered papers measuring 7 x 5 cm were used in the experiments. The results obtained are reflected in the following tables.

Table 1 Area covered with drops after operation with axial fan sprayer, cm^2

Position of water registration paper	first work move, points of row					second work move, points of row				
	1	2	3	4	5	1	2	3	4	5
1	16,8	16,1	17,2	16,5	15,6	6,2	4,3	6	6,1	5
2	12	10,2	10,9	12	11,3	12,1	13	12,2	12,4	11,5
3	14	13,4	13,4	14	13	9	9,5	7,8	9	9,3
4	9	9,5	7,8	8,8	9,5	14,1	12,5	13,6	14,2	13,2
5	12	12	12,3	12,3	11,6	12	10,1	11	11,9	11,5
6	6,3	4,2	5,6	6	4,9	16,7	16,2	16,9	16,4	15,7

By moving the sprayer away from the observed layers of the leaf mass, a reduction of the area covered with drops is reported both on the front (positions 1, 3, 5) and on the reverse side (positions 2, 4, 6). The total area covered with drops after passing the sprayer on both sides of the row is obtained by summing the results for each position of each stroke (Table 2). There is a leveling of the area with delayed drops on both the front and back of the leaf.

Table 2 Total area covered with drops after operation with axial fan sprayer, cm^2

Position of water registration paper	Point of row					Mean
	1	2	3	4	5	
1	23	20,4	23,2	22,6	20,6	21,96
2	24,1	23,2	23,1	24,4	22,8	23,52
3	23	22,9	21,2	23	22,3	22,48
4	23,1	22	21,4	23	22,7	22,44
5	24	22,1	23,1	24,2	23,1	23,3
6	23	20,6	22,5	22,4	20,6	21,82

The results of the operation of the tangential fan sprayer are presented in Tables 3 and 4. They are similar to the operation of the axial sprayer, with the difference that the area covered with drops is larger.

Table 3 Area covered with drops after working with a tangential fan sprayer, cm2

Position of water registration paper	first work movee, points of row					second work move, points of row				
	1	2	3	4	5	1	2	3	4	5
1	17,3	17,4	17,6	17,2	17,6	10,7	10,3	10,2	10,6	10,9
2	13	11,5	11,8	12,8	12,7	13,9	13,8	14,3	14,7	15,1
3	16	15,9	16,1	15,7	15,8	13	10,9	12,4	11,7	10,7
4	12,5	11	10,8	11,3	10,7	16,1	15,8	16,2	16	15,7
5	14,7	14,7	15,6	14,9	15,2	13	11,7	12	12,6	12,8
6	10,8	10,2	9,5	10,5	10,6	17,5	17,1	17,6	17,3	17,6

Table 4 Total area covered with drops after operation with tangential fan sprayer, cm^2

Position of water registration paper	Point of row					Mean
	1	2	3	4	5	
1	28	27,7	27,8	27,8	28,5	27,96
2	26,9	25,3	26,1	27,5	27,8	26,72
3	29	26,8	28,5	27,4	26,5	27,64
4	28,6	26,8	27	27,3	26,4	27,22
5	27,7	26,4	27,6	27,5	28	27,44
6	27,9	27,3	27,1	27,8	28,2	27,66

Degree of coverage

According to formula 1, the degree of coverage on the front and back of the sheet is determined after the first stroke and after the final treatment of the row for the two sprayers used (Table 5).

Table 5. Degree of coverage, %

Position of water registration paper	Axial fan sprayer		Tangential fan sprayer	
	After firs work move	After final processing	After firs work move	After final processing
1	**47**	**62,7**	**49,8**	**79,9**
2	35	67,2	35,3	76,3
3	**42,2**	**64,2**	**45,4**	**79**
4	28,3	64,1	32,2	77,8
5	**37,8**	**66,6**	**42,9**	**78,4**
6	16,9	62,3	29,5	79

- The results on the front of the sheet are indicated in bold

It can be seen that after 1 move:
With the axial fan sprayer, the degree of coverage decreases with distance of the observed position from the spray system from 47% for position 1 to 37.8 for position 5 from the front of the leaf and from 35 to 16.9% for the back of the leaf. There is a significant difference in the degree of coverage of the front and back of the sheet. This is due to the large

scattering of the air jet and the reduction of its penetrating force.
When working with the tangential fan sprayer, the same picture is observed for the degree of coverage of the front and back of the sheet. Due to the small outlet, the air stream is more concentrated, penetrates with greater force into the leaf mass and mixes it well. This allows for better coverage on both the front and back of the sheet

After the second (final processing) move:
In both sprayers there is an equalization in the degree of coverage of both the front and back of the sheet. The degree of coverage when working with the tangential sprayer is about 10% higher. This is due to the more concentrated direction of the air flow.

Degree of penetration

It is determined using formula 2. The results of the calculations are shown in Table 6.

Table 6 Degree of penetration

Axial fan sprayer		Tangential fan sprayer	
After first move	After final processing	After first move	After final processing
0,79	**0,94**	**0,86**	**0,98**

Both sprayers have a good degree of penetration both in the first stroke and in the final treatment of the row. Due to the above reasons for the specifics of the air flow and this indicator, the results are better with tangential sprayers. What has been said so far confirms the work of Derksen R. et al., 2004 regarding pesticide treatment of perennials and in particular orchards.
Price. There is a small difference in the prices of the two sprayers. For the axial fan sprayer AGP 440 it is BGN 4332, and for the tangential AGP 440U - BGN 5112 (Traktor Invest, 2022).

CONCLUSIONS

From the experiments, calculations and analyzes conducted so far, it can be concluded that both sprayers meet to a very good extent the technological requirements after mandatory treatment of each vine row on both sides. The degree of coverage of the leaf mass with drops is about 65% for axial and about 78% for tangential sprayers. The difference is due to the more concentrated and directed jet (from air and solution) in the tangential sprayer. This allows for good mixing and passing through the leaf mass. Regarding the other technological indicator - penetration rate - the results are approximately the same. Given the small difference in prices, this is a reason to recommend working with a tangential sprayer when treating vineyards with pesticides.

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