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Analyze of drift loses in plum and apple orchards and measures for their reducing

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Abstract

In this paper work are shown results of ground drift losses during plum and apple orchard chemical protection. Measure of drift losses was on quantity level with measuring plates. Plum and apple are two most commonly grown types of fruit in Serbia, so ground drift was measured in these orchards. Generally all orchard treatment following important losses because drift which depend of many factors: weather condition, shape and size of orchards, fruit sort, air assisted sprayer features, nozzle types, application rate and capability of agregate drivers.

From the aspect of quantity, results shown that smaller application rate means less liquid to reach the ground but this reduction will be pointless unless all working parameters and weather conditions are adjusted. Weather conditions under which the treatment is performed (wind speed, temperature and relative air humidity) along with the size of droplets are the most important factors influencing the liquid loss and treatment efficiency. Wind strength is especially important because it can cause large motions and poor coverage inside the tree.

Key words: drift, plum and apple orchard, air assisted sprayer.

Introduction

Very important agro technical measure in the fruit production is the mechanized chemical protection against diseases, pests and weeds. As regards the crops and vegetables, they are generally treated from a smaller distance, while fruits, which medium or large part is treated, are treated at variable distances from air assisted sprayer and a number of protection treatments (apple) are required, ranging from 12 and more treatments during a year (Bugarin, 2011).

Quality and precision of chemical protection are preconditions for efficiency, cost-effectiveness and drift, which is the occurrence of loss of liquid over the ground and outside the treated area.

Negative effects of drift can often result in: increased costs of protection, inefficient treatment, less time and possibilities for adequate treatment and protection of environment, with especial attention paid to soil contamination. Out of all chemicals sprayed by air assisted sprayer during the treatment of one orchard is minimum 20% and goes up to 40% of pesticides which falls on the ground (Kaul et al., 2002). 15 to 20% goes into air and 5% evaporates.

For drift loses it is especially important applying of medium and low application rate because there characterization is spray with fine and extra fine drops and higher concentration of pesticides comparing with high application rate treatment (Bugarin et al. 2010).

In Serbia, medium (500 – 100 l/ha) and high application rates (over 1000 l/ha) are typically used, and small application rates (below 500 l/ha) are still not fully exploited. Treating with large droplets can reduce drift but also reduce plant coverage's and efficacy because of that applying of medium and low application rate demands nozzles who have better technical characteristics and less drift potentials (Sedlar et al., 2008).

Plum and apple are two most commonly grown types of fruit in Serbia, so ground drift was measured in these orchards.

Material and method

Loss of liquid in apple and plum orchards due to ground drift was tested with a standard air assisted sprayer „Caffini" model Orange 1000, Figure 1, mounted onto a tractor „IMT – 539".

Figure 1. Air assisted sprayer „Caffini"- model Orange 1000

The tested air assisted sprayer had cone nozzles, 2 x 6 pieces manufactured by „Albuz" with three different capacities (lower D10 x 1, middle D12 x 4, upper D15 x 1). In the treatment, the used application rates were high, 1289 l/ha, and medium, 801 l/ha, with aggregate's travel speed of 6.16 km/h, operating pressure of 15 and 8 bar.

The investigation was performed in private apple and plum orchards on July 6, 2011. At the time of research, the apple orchard was 7 years old and plum orchard was 5 years old. There were several apple varieties in the apple orchard: idared, granny smith, golden delicious, red delicious and jonagold, and in the plum orchard čačanska variety prevailed. Average height of the apple trees at the time of treatment application was 3.43 m, average width of tree crown was 2.31 m. Average plum tree height was 3.33 m, and tree crown was 2.40 m.

The treatment was performed at 24^0C, relative air humidity was 85%, and the wind was blowing occasionally at a speed of 0.9 – 1.3 m/s during the treatment in the apple orchard, and 1.5 to 3 m/s during the plum orchard treatment.

Liquid losses due to ground drift were measured in special vessels with dimensions of 500 x 100 mm. The measuring vessels were positioned in special order at a distance of 1-7 m from the central part of air assisted sprayer, Figure 2, before the aggregate passed.

Figure 2. Measuring vessels

Immediately after the pass of the aggregate labeled measuring vessels were collected and measured on electronic scales that measure the third decimal. After the measuring, the labeled vessels were wiped with a dry cloth and returned to specified positions for repeated measuring. Measuring was repeated three times and the result is expressed in liters, considering the specific weight of water and prepared liquid.

Results and discussion

Table 1 shows average liquid losses from all measurings during the treatment of apple and plum orchards with high application rates (1289 l/ha).

In the apple orchard, which was quite a dense one, average liquid loss measured on the left side of the aggregate was 1.81 ml per vessel, 32.53 m l/m^2, that is 325.3 l/ha or 25.24% of the application rate. On the right side of the aggregate, average liquid losses were much lower amounting 133 liters. This result was the consequence of wind blowing direction which was from the right to the left side, with respect to the aggregate's movement.

During the plum orchard treatment, wind strength was increased so the exposure of orchard was different and recorded losses on the left side of the aggregate were lower than on the right side. Liquid loss on the right side was 231.2 liters which was 17.9% with respect to the treatment rate.

By reducing the application rate (801 l/ha) much better results related to ground drift were recorded, Table 2. Average loss in the apple orchard was 50.3 l/ha, and in the plum orchard the loss was 172.7 l/ha.

From the aspect of application rate, liquid losses due to ground drift in apple orchard were only 6.3% of the application rate. However, those losses were higher in case of plum orchard and they were 21.5% of the application rate. When compared to high application rate in the plum orchard, medium application rate had 6.05% more ground drift. Average value of liquid loss in case of high application rate was 15.45%.

The increase in percentage can be expected with reduced application rate because smaller application rate means more small droplets in the jet. From the aspect of quantity, smaller application rate means less liquid to reach the ground but this reduction will be pointless unless all working parameters and weather conditions are adjusted.

Table 1. Spray drift depozit on the soil treating with high volume application rate

	liquid losses- left			liquid losses - right		
Drift loses in apple orchard						
Position the measuring vessel	The vessel (ml)	ml/m^2	(l/ha)	The vessel (l)	(ml/m^2)	(l/ha)
1	1.2	21.57	215.7	0.59	10.61	106.1
2	0.1	1.80	18.0	0.09	1.62	16.2
3	2.8	50.34	503.4	0.19	3.42	34.2
4	1.8	32.36	323.6	1.7	30.56	305.6
5	3.0	53.93	539.3	2.07	37.21	372.1
6	1.6	28.76	287.6	0.01	0.18	1.8
7	2.16	38.83	388.3	0.5	8.99	89.9
Average	1.81	32.53	325.3	0.74	13.30	133.0
Drift loses in plum orchard						
Position the measuring vessel	The vessel (ml)	ml/m^2	(l/ha)	The vessel (l)	(ml/m^2)	(l/ha)
1	1.16	23.04	230.4	1.28	23.04	230.4
2	0.96	17.28	172.8	1.66	29.97	299.7
3	1.22	21.96	219.6	1.31	23.67	236.7
4	0.91	16.47	164.7	1.2	21.60	216.0
5	0.92	16.65	166.5	1.47	26.55	265.5
6	0.48	8.37	83.7	1.25	22.59	225.9
7	0.71	12.87	128.7	0.8	14.4	144.0
Average	0.93	16.70	167.00	1.28	23.12	231.20

The best example for that is the medium application rate that apple orchard was treated with. The treatment was performed during nice weather with adjusted air current of a fan and travel speed, thus resulting in a loss of only 50.3 l/ha. Still, plum orchard did not show the same results with medium application rate because the wind was blowing up to 3 m/s during the treatment. Weather conditions under which the treatment is performed (wind speed, temperature and relative air humidity) along with the size of droplets are the most important factors influencing the liquid loss and treatment efficiency. Wind strength is especially important because it can cause large motions and poor coverage inside the tree. In larger orchards and with air assisted sprayers that have more fan capacity treatment is possible even with the winds blowing 3 m/s, and in smaller orchards with treatment performed by sprayers of smaller capacity the allowed wind speed is up to 2 m/s.

Apart from the wind, the second factor causing the increased liquid loss in plum orchard was inter-row distance (4.5x4m) which was larger in comparison to the apple orchard (3.6x1.2 m), which means more space between the trees.

Person who decides on the protection measures and aggregate's operator should take this into consideration and, accordingly, specify the capacity of air current, travel speed and type of nozzles. If speed of the wind is high, injection nozzles should be used. By using venturi air injection nozzles, larger drops resistant to drift are formed with air bubbles.

Table 2. Spray drift depozit on the soil treating with medium volume application rate

	liquid losses- left			liquid losses - right		
Drift loses in apple orchard						
Position the measuring vessel	The vessel (ml)	ml/m^2	(l/ha)	The vessel (ml)	(ml/m^2)	(l/ha)
1	1.27	22.83	228.3	0.07	1.26	12.6
2	0.1	1.80	18.0	0.38	6.83	68.3
3	0.21	3.78	37.8	0.24	4.31	43.1
4	0.15	2.70	27.0	0.25	4.49	44.9
5	0.05	0.90	9.0	0.08	1.44	14.4
6	0.03	0.54	5.4	0.28	5.03	50.3
7	0.03	0.54	5.4	0.78	14.02	140.2
Average	0.26	4.67	46.7	0.30	5.39	53.9
Drift loses in plum orchard						
Position the measuring vessel	The vessel (ml)	ml/m^2	(l/ha)	The vessel (ml)	(ml/m^2)	(l/ha)
1	1.15	20.79	207.9	1.11	19.98	199.8
2	1.07	19.35	193.5	1.11	20.97	209.7
3	0.92	16.65	166.5	1.31	23.58	235.8
4	0.77	13.95	139.5	1.05	18.90	189.0
5	0.77	13.86	138.6	0.92	16.56	165.6
6	0.66	11.97	119.7	1.06	19.17	191.7
7	0.70	12.69	126.9	0.76	13.68	136.8
Average	0.86	15.60	156.00	1.05	18.94	189.40

When in contact with a plant, larger drops break into lots of smaller drops, thus ensuring good coverage of plant (Sedlar et al., 2009). Size of the drops can be selected from large to very small, depending on the pressure, and waving can be reduced up to 90% (Agrotop Spray Technology, Banaj et al., 2010).

Conclusion

Out of all chemicals sprayed by air assisted sprayer during the treatment of one orchard is minimum 20% of pesticides which falls on the ground and facts in this paper confirm that. During treatment of apple orchards with high (1289 l/ha) and medium (801 l/ha) application rate drift loses on the ground was 229.15 l/ha and 199.1 l/ha. During treatment in plum orchard with medium application rate drift loses was 172.7 l/ha.

So reducing of application rate was not enough alone to provide drift decrease. Reducing of application rate also mean higher number of smaller droplets in spray which means higher drift potential. So if we wont to reduce drift losses it should harmonize a lot of factors and measures like: doing chemical treatments in good wether condition, using of inspected calibrated air assisted sprayer, precise pesticide application with correct application rates and using of antidrift nozzles. The best example for that is the medium application rate that apple orchard was treated with. The treatment was performed during nice weather with adjusted air current of a fan and travel speed Thus resulting in a loss of only 50.3 l/ha.

Plum orchard did not show the same results with medium application rate because the wind was blowing up to 3 m/s during the treatment and as notice before weather conditions under which the treatment is performed is one of the most important factors. Apart from the wind, the second factor causing the increased liquid loss in plum orchard was inter-row distance (4.5x4m) which was larger in comparison to the apple orchard (3.6x1.2 m), which means more space between the trees. Person who decides on the protection measures and aggregate's operator should take this into consideration and, accordingly, specify the capacity of air current, travel speed and type of nozzles.

Aknowlegement
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