UDC (UDK) 632.934.1(497.6)

Zoran MALIČEVIĆ, Branislav RAILIĆ,
Siniša MITRIĆ, Dijana MIHAJLOVIĆ, Mladen BABIĆ [1]

THE IMPORTANCE OF CALIBRATION OF ATOMIZER AND MEASURES OF INCREASING EFFICIENCY ON APPLICATION IN YOUNG PLANTATIONS

SUMMARY

The biggest problems (losses) in sprinkling orchards appear because of drift, especially with young plantations. Presence of drift decreases efficiency of protection measures, indirectly increases using expensive pesticides and causes illegal environmental pollution.

The study presents the results of exploitation research of calibrated and precisely adjusted atomiser on application of pesticides of young apple plantation. The application analysed shows data of land and air drift and cover of face and backside of leaf in certain zones of crowns.

The researches aim to determine possibilities to save pesticides on the one side and to protect the environment from the aspect of decreasing land that is air drift on the other side.

The aim of those researches was to develop appropriate methods for adjusting atomisers with classical axial ventilator in order to make their application good to follow the orchard's needs. The researches have to indicate on possibility of application of small norms in our conditions, what is not the case in accordance to the available data. In addition, the task of the research is to make the application of pesticides in the area of The Srpska Republic closer to completing conditions given by European standards and regulations. By appropriate equipment in accordance with the abovementioned standards, we approached examining the following: pumps, sprinkler, and manometer, the speed of cardan shaft, ventilator capacity and visual control.

The results obtained show that only well adjusted; calibrated device can fulfil the conditions of controlled application, application of small norms and so satisfies valid norms and standards. That is also confirmed by the research results which record in many cases irregularity of sets (manometer, sprinklers, pumps, misalignment of ventilator) and from which in great part depend the efficiency of treatment.

Keywords: efficiency, small norms, atomiser, calibration, pesticide, controlled application

INTRODUCTION

A special attention on cultivating orchard is with protection from pests, diseases and weed. From all the measures for plant protection, nowadays the most common one is chemical protection.

[1] Zoran Maličević, (corresponding author: zoranmali@yahoo.com), Branislav Railić, Siniša Mitrić, Dijana Mihajlović, Mladen Babić, Faculty of Agriculture of the University of Banja Luka, Repubika Srpska.

Chemical protection of orchard is mainly done by atomisers. Kind and type of atomisers in orchard protection influence the work quality, and by that the efficiency on pesticide application.

Decreasing liquid per hectare is actual in the world, that is treating orchards with small norms of 150 to 500 *l/ha* or even less of 150 to 250 *l/ha*. In our practice we still use middle norms of 500 to 1.000 *l/ha* or big norms of 1.000 to 1.500 *l/ha*.

Efficient application of small norms demands modern, qualitative, precise and well-adjusted atomisers. On losses of working liquid, with that also on pesticides, treatment norm has a huge impact, also, beside of that some plant singularities, as: space between rows and distance in a row, shape and height of crone, cultivation way and other. During each orchard treatment, significant part of pesticides is going out of treating object. Drops produced by atomisers reach, not only on plants, between the rows where machine is passing through, but also on the plants in the second, third and further rows. Besides additional covering of plant-s parts, a part of pesticides is falling down on land surface, what represents land's drift. Smaller part stays in the air longer, during the transportation a part of the smallest drops evaporate, the rest of drops are going out of treatment place, and all this represents air drift.

In some countries, depending on toxicity of preparation, minimal distance of treated surface from surface waters has been regulated, it goes from 20, 50 or 100 *m*, Schmidt quotes (1990).

Kaul et al (2002) write on working liquid distribution at the dewing in the fruit growing, saying that in practical work during many tests, at the atomisers with optimal adjusted device for treating, 20% of resources reach the land.

Regular calibration and working correctness control on technique correctness for pesticide application is a necessary measure in modern agriculture production because of the huge pesticide use (Sedlar, 2006.).Because of big number of treating which are implemented with atomisers in an orchard during a year, it is very important to reduce the costs for protection. For an example, number of treating which are implemented during a year in a apple planted is from 10 up to 12, but during of some years even 15 times.2008 year was very difficult for protection because of the light winter what is good for diseases, so the treating number was 20 times. Such a huge sprayer usage means big expenses including human work, machine engagement, fuel consumption, pesticide and water use.

Specific problem in orchard spraying is danger of contamination of fruits because of often treatments as well of environment pollution danger because of drift, working liquid disappearing by wind.

Solution of mentioned problems is calibration and adjusting what does not need big financial means, but the use of modern sprayers with electronic norm regulation would be even better, but more expensive solution. Excellent solution represents sensor usage, which would be adapted on sprayers, and they could give data on plant size and health condition (Gil, 2007). It would provide for machine user to put exact quantity on treated plant with minimal losses because of drift. Small treating norms will, beside the energy savings, what understands protection expenses, increase output, productivity of human and machine work.

MATERIAL AND METHODS

In order to make closer pesticide use in orchard to the actual trends in European countries, and to implement efficiently treating of medium and small norms, it is necessary to apply concept of the controlled pesticide application. It understands parameters control such as rpm of cardan shaft, pump capacity, nozzle capacity, air stream speed of ventilator and manometer correctness.

Measuring of revolutions on cardan connections are done by non-contact tachometer and reflecting stamps. Measuring range is from 100 – 99999 *o/min*.

If atomiser implement the task in a quality and efficient way, all device assemblies must function smoothly. Therefore, if pump provide the necessary flow it must have necessary revolution numbers which come from cardan shaft.

For pump flow, control a flow measurer was used produced by A.A.M.S. BELGIUM. Pump capacity was measured at the nominal revolution number of the connecting shaft of 540 *o/min*. Flow measurer was equipped with a display where you may read the value of the flow depending on the pressure. Measuring range is from 5 up to 400 *l/min*, but the measurement range of the pressure value is going from 1 up to 25 *bars*. Thanking to the possibility to have flow reading depending of the pressure, reading of pump flow was done taking three pressure values (5, 10 and 15 *bars*).

The best way to determine the nozzle detritions is compare of old flow with new one (same type and size).Laboratory has mechanical flow measurer which is consist of 12 transparent menzura which have been connected by adapter for atomizer. Adapters are constructed in such a way to fit for all atomizers types. After connecting, sprayer is put in function in duration of 1 minute with most common used working pressure after that follows the reading and comparison.

Checking was done at the end of June when the plants are in full vegetation. Atomizer, which has been used, had 7 sprayers on both sides. Adjustment of necessary parameters has done for four norms (variants) of treating.

All atomizers have been included in Variant I ATR 80 220, norm was 945 *l/ha*, but in Variant II only 8 atomizers were included, and the norm was 540 *l/ha*, or less for 42,86 %. In the Variant III albuz atomizers were used, but with yellow coding ATR 80 212, and norm was 507 *l/ha*. Varijant IV was consist of ATR 80 212, but only atomizers 8 were used, norm was 290 *l/ha*. The speed was for all four variants 6 *km/h*, but the space between rows was 3,2 *m*.

Beside the mentioned equipment, water-sensitive leaves with yellow base were used and holders for it for measuring of land, that is air drift. Plates are set in krone on 5 different heights on the periphery, on two sites in the krone on each 80 cm from first branch height. The first plate is on the periphery of the first branch that is 40 cm from land. The next are put in each 60 cm, one by one per height, but the last one is on the top of krone and it is 280 cm above the land what is the height of krone, width is 0.8 m, but he space between rows is 3.20 m, space in the row is 0.8 m. It is apple sort ‘'Jonagold’’, plant 3 years old. Plates for land drift checking are situated in the same and other two next rows, each on 80 cm. Air drift checking is done by holders of 6 m height, with space of 1 m from land where the plate is put. Holders are

put on both sides of atomizers in the next row. For reading of plate covering that is the intensity of drift, program Image was used. Wind intensity was followed in the orchard by manometer, and it was from 0.5 up to 0.2 *m/sthat is wind was blowing intermittently.*

RESULTS AND DISCUSSION

In order to provide adequate functioning of atomizers (disintegration of the drop with size of 50 do 150 μm) it is necessary to have proper pump flow, that is the pump has to have corresponding revolution number from tractor cardan shaft which should be 540 *o/min*. Catalogue value of the pump flow on the checked atomizer is 70 *l/min*.

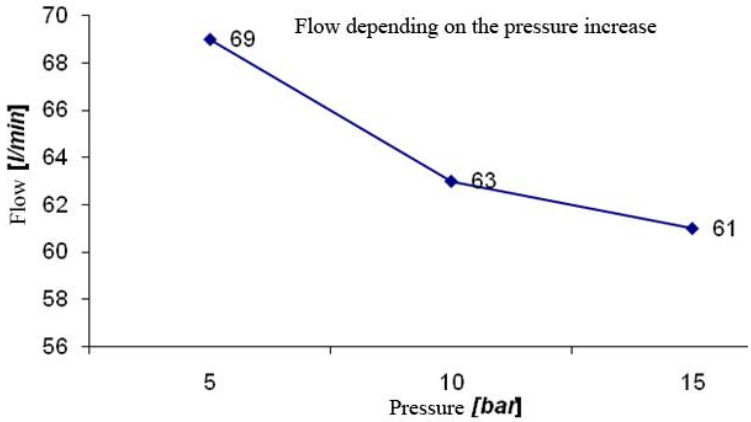


Figure 1. Diagram of the pump flow depending on the pressure increase

Ability of the pump to hold corresponding flow is important characteristics, but on the picture 1. Diagram shows fall of flow for 11,59 % at the pressure of 15 *bars and is satisfied the standards.* Measured speed of thee air stream produced by ventilator is 22 *m/s*, what is also corresponding to the treatment conditions.

Protection efficiency depending on the condition and type of the atomizer. During the checking albuz ATR 80 220 atomizers – red codation and ATR 80 212-yellow codation. Using the procedure, which understands GlobalGap standards, is confirmed that there is no bigger deviation from nominal capacities.

Therefore, it is confirmed that atomizer ATR80 220 at the pressure of 12 *bars* with average flow of 2,07 *l/min* what is in the limits of permitted deviations. Atomizer ATR 80 212 yellow codation has the flow of 1,1 *l/min* at the pressure of 12 *bars*.

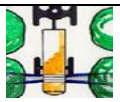
Considering that atomizers which have not been exploited for long time it was necessary cleaning of smaller number of it in order to have the same flow identical catalogue values.

After all necessary measures and adjustments we have started the checking in the field conditions.

Land drift

In the table 1 results of plates covering was shown which are on the land and register the loss of preparation on the land (land drift).

Table 1. Land drift

Covering of plates – left from atomizer [%]						Covering of plates – right from atomizer [%]				
5	**4**	**3**	**2**	**1**	**0**	**1**	**2**	**3**	**4**	**5**
Variant I										
16	28	52	73	71	67	61	54	22	12	3
Variant II										
2	4	3	11	10	7	8	6	2	4	2
Variant III										
10	18	37	52	40	37	31	22	7	9	3
Variant IV										
2	1	3	2	5	3	4	2	1	2	-

In our conditions, mostly atomizers with axial ventilator have been used. About 10% of devices are equipped with routers of air stream what improve the protection efficiency. Beside of that, from table 1 you may see that big part of the preparations fall on the land in the shape of land drift.

Atomizer used for checking was equipped with 14 sprayers, the closest to the land is 50.5 *cm*, and the next one is 67.5 *cm*. That is a fact that low installed sprayers contribute the increase of the land drift.

At these atomizers, a big problem is moving of air stream produced by axial ventilator, but the result is that from one side air stream increases, but on the other side has falling that is bending and preparations bending depending of the ventilator rotation side. This is especially expressed during the treating of the plants on sloping terrains.

Used atomizers has been equipped with air stream router and ventilator which has opposite clockwise, so on the basis of covering of water-sensitive plates we may see that land drift on the left side is more conspicuous. At the Variant I on the left side, the average covering is 40 %, but the plates covering on the right side is 25,33 % or less for 63,33 %. Left side of Variant II has average plates covering of 5 %, on the right side is smaller and it is 3,66 %. Average covering of the Variant II is 4,91 % taking into consideration a plate, which is in the middle of row, at the same time covering of the Variant I was 38,25 %.

At the Variant III average covering on the left side is 26,16 %, but measuring plates covering on the right side of aggregate is 12 %. Average plates covering for land drift at the Variant III is 22,16 %.

Left side of the Variant IV has an average plates covering for land drift of 2,16 %, but the covering on the right side is 1,50 %, but average covering is 2,08 %.

Air drift

During the checking, intensity of air drift was measured what might decrease treating efficiency, in particular at atomizers, which are equipped with axial ventilator. In the Table 2. The data on drops number and covering of water sensitive plates, which are installed on the holders on the marked heights. Movable holders are set in the row left and right, but the distance from middle axis of atomizer was 4,80*m*.

In the table 2 air drift values are shown for all four Variants.

Table 2. Air drift

Position of measuring plate	Left side of atomizer		Right side of atomizer	
	Number of drops per cm^2	Covering of plate surface [%]	Number of drops per cm^2	Covering of plate surface [%]
I Variant				
1 m	36	4,23	28	3,86
2 m	71	21,42	59	19,63
3 m	85	29,34	82	32,34
4 m	75	20,17	76	22,18
5 m	52	12,74	50	15,68
6 m	46	4,32	48	5,86
II Variant				
1 m	11	1,56	19	1,88
2 m	51	12,35	23	6,82
3 m	54	15,24	46	11,27
4 m	49	8,75	52	10,21
5 m	37	3,21	24	2,53
6 m	18	0,27	32	0,82
III Variant				
1 m	27	3,24	18	2,83
2 m	50	12,56	43	8,26
3 m	55	17,61	52	15,34
4 m	56	11,87	62	14,46
5 m	26	1,25	39	6,58
6 m	24	0,73	37	2,34
IV Variant				
1 m	22	2,12	15	1,93
2 m	33	4,26	17	2,32
3 m	44	8,72	46	9,28
4 m	41	3,86	44	5,87
5 m	13	0,69	34	2,35
6 m	0	0	12	0,67

At the Variant I average plates covering on the left side is 15,37 %, but on the right side the value is bigger 16,59 %. Analysing the table, it is clear that in all variants the most expressed drift is on the height of 3 *m*, but on the height of 6 m it is much lower or there does not exist. At the Variant IV where the norm is the smallest, atomizer is properly adjusted, that is nozzles which cause drift are off, on the left side on the height of 6 m drift was not recorded. At the Variant II where the sprayers are

off 1 and 2 (the lowest) from the left side, 6 and 7 (the highest) from the right side, from the aspect of drift better results were recorded. An average plates covering from the right side is 6,89 %, from the right side covering is 5,58 %. At the Variant III norm is 507 *l/ha* and average plates covering on the left is 7,87 %, but on the right 8,30 %. Turning off 4 determined sprayers as at the variant II we got V where the norm is 290 *l/ha*. Drift, that is an average plates covering at the Variant IV, on the left side was 3,27 %, but on the right 3,73 %.

Considering the covering of front and back of leaf in the same krone there was not relevant deviation. An average covering of front leaf at the Variant I was 72,34%, but at the back 68,24%.

At Variant II average covering of front leaf was 71,58%, at back leaf 69,37%. Variant III has smaller average covering what is logical considering it is smaller norm, leaf covering was 62,78%, at back leaf 61,85%, what is not so bad result considering that drift was significantly reduced. With correction and turning off determined sprayers at the Variant IV leaf covering is slightly reduced, but air and land drift was significantly reduced. Covering of back leaf at the Variant IV was 60,83%, at back leaf 58,94%. It is necessary to stress that all shown results of protection quality were checked based on walkthrough.

CONCLUSIONS

At the disease protection of perennial plants, weeds and pests the biggest difficulty are the losses of working liquids drops in the shape of air and land drift, in particular at the first growing phase.

Obtained results clearly show that with some corrections even existing devices may get efficient and quality protection with minimal losses of working liquid in the shape of drift. At the actual researches it is obvious that we have cases where plates covering on the land is bigger than in the krone.For an example at Variant I (plates 1. and 2. from left side are away from atomizer axis 80 *cm*, that is 160 *cm*, covering is 71% that is 73%). With additional adjustment plates covering on the same position were 10 that are 11%, what is excellent result considering that leaf covering in the krone was not significantly damaged.

At the dewing of young plants the losses caused by drift could be reduced: with selection of the most appropriate treating method, treating at the best weather conditions (moderate air temperature and wind speed), using bigger drops, reduction of distance between atomizers and plant parts, with application of modern sprayers, adaptation and precise adjustment of the existing and use of optimal jet router.

The biggest decrease of drift may be reached with use of modern atomizers of new generation as; tunnel sprayers with recirculation of working liquid for local treating with sensors. Stated solutions of atomizers provide the savings in pesticide and water consumption, decreasing of drift on needful minimum with minimal environment protection.

Most of the stated effects we may reach with application of the existing atomizers with some adaptations and precise adjustment based on measuring and control of the parts what have been shown in this work.

With control of working correctness of the same, their correct calibration, use of anti-drift devices, the small norm are applicable in our conditions, especially for young plants.

REFERENCES

Buyers R.E, Hickey K.D, Hill C.H. (1971). Base gallonage per acre. Virginia fruit 60: 19-23.

Gil E. Escola A. 2007. Variable PPP dose rate application controlled by crop identification system based on ultrasonic sensors in vineyard; SuProFruit, Alnarp, Sweden

Kaul P, Gebauer S, Rietz S, und Henningt H. 2002. Pflanzenschutzmittel – Verteilungsvorgange beim Spruhen im Obstbau. Nachrichtenbl. Deut. Pflanzenschutzd, 54(5): 110-117.

Sedlar A. 2006. Analiza metoda za testiranje prskalica, Magistarski rad, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad.

Schmidt K. 1990. Tehnika aplikacije zaštitnih sredstava u voćarstvu, teškoće i razvojne tendencije, (prevod iz časopisa: Obst und Garten 1990, preveo Ivan Bratović).

Zoran MALIČEVIĆ, Branislav RAILIĆ,
Siniša MITRIĆ, Dijana MIHAJLOVIĆ, Mladen BABIĆ

ZNAČAJ KALIBRACIJE ATOMIZERA I MJERE POVEĆANJA EFIKASNOSTI PRI APLIKACIJI U MLADIM ZASADIMA

SAŽETAK

Najveći problemi (gubici) pri orošavanju voćnjaka se javljaju zbog drifta, naročito mladih zasada. Prisustvo drifta smanjuje efikasnost zaštitne mjere, indirektno povećava potrošnju skupih pesticida i prouzrokuje nedozvoljeno zagađenje životne sredine.

Rad predstavlja rezultate eksploatacionog ispitivanja kalibrisanog, baždarenog i precizno podešenog atomizera pri aplikaciji pesticida mladog zasada jabuke. Analiza aplikacije prikazuje podatke zemljišnog i vazdušnog drifta te same pokrivenosti naličja i lica lista u određenim zonama krune.

Ispitivanja imaju za cilj da utvrde mogućnosti uštede pesticida s jedne strane i zaštita okoline s aspekta umanjenja zemljišnog, odnosno vazdušnog drifta s druge strane.

Cilj ovih istraživanja je bio da se razviju odgovarajuće metode za podešavanje atomizera sa klasičnim aksijalnim ventilatorom kako bi njihova primjena što bolje pratila potrebe voćnjaka. Ispitivanja imaju zadatak da ukažu na mogućnosti primjene malih normi u našim uslovima, što nije slučaj prema dostupnim podacima. Takođe, zadatak ispitivanja je da aplikaciju pesticida na području Republike Srpske približi ispunjavanju uslova koje nalažu evropski standardi i normativi. Odgovarajućom opremom u skladu sa pomenutim standardima pristupilo se ispitivanjima: pumpe, rasprskivača, manometra, broja obrtaja kardanskog vratila, kapaciteta ventilatora i vizuelne kontrole.

Dobijeni rezultati pokazuju da samo dobro podešen, kalibrisan i baždaren uređaj može da ispuni uslove kontrolisane aplikacije, primjenu malih normi te zadovolji važeće normative i standarde. To potvrđuju i rezultati ispitivanja koji u velikom broju slučajeva bilježe neispravnost sklopova (manometar, rasprskivači, pumpa, nepodešenost ventilatora) od kojih u velikoj mjeri zavisi efikasnost tretiranja.

Ključne riječi: efikasnost, male norme, atomizer, kalibracija, pesticid, kontrolisana aplikacija