New challenges about pesticide application equipment in Serbia: Usage of new nozzles types for better deposition and coverage.

Višacki Vladimir[1], Sedlar Aleksandar[1], Bugarin Rajko[1], Radić Petar[2], Turan Jan[1], Ponjičan Ondrej[1], Ivanišević Mladen[1]

[1]University of Novi Sad, Faculty of Agriculture, Department of Agricultural Engineering, Education Developmental Center for Pesticide Application Equipment, Sq. D. Obradovića 8, 21000 Novi Sad, Serbia
[2]Cooperative Union of Vojvodina, Blvd M. Pupina 25, 21000 Novi Sad, Serbia

Summary

Unofficial results of inspections of pesticide application equipment stands out several parts of field crop sprayers. One of them are nozzles. Many producers (more then 90%) have bad nozzles. These elements are not in accordance with standard which means they have bigger flow rate and uneven horizontal distribution. Farmers don't change anything on field crop sprayers from the time of buying. For them there is only one nozzle type for all kind of pesticide applications in different crops. As nozzles plays major roll in coverage and deposition, new problem was indentified due to worn nozzles. New problem in Serbia became weeds and their herbicide resistance.

If one field has to be sprayed up to nine times, it is obviously that there is a problem. Using appropriate herbicides in acceptable weather conditions don't lead to weeds eradication. During many field tests and sprayers inspections, suspicions were confirmed. Main reason of presence of weeds resistance is exploitation factors and nozzles. It is better to say, many years of using non appropriate nozzles in combinations of unacceptable exploitation factors lead to poor and unacceptable coverage and total depositions on weeds. For Serbian farmers there is only one nozzle, T nozzle. Several years ago, for richer farmers air injector nozzle with single flat fan known as anti wind nozzle became a star. They are using this nozzle for everything as poor farmers using single flat fan T nozzle. Additionally, low pressure between 2 bar and 3 bars enlarge the effect and small amount of droplets doesn't make good coverage especially in high speed as 10 to 15 km/h. In combinations of mentioned speed and pressure, nozzles deposition was between 23 to 37% of total amount of pesticide. Remaining amount was drifted to non target, soil or evaporated.

Due to that, Faculty of Agriculture in Novi Sad and Educational developing centre of PAE started with field testing of new brand nozzles, double flat fan low drift and air injector double flat fan nozzles. Research were conducted in open fields in many crops such as, corn, soya, sunflower, wheat by changing of nozzles, traveling speed and working pressure. At any time, suggested pesticide dosage was used. Combinations of aforementioned factors gave as results better coverage and bigger deposit on weeds. Due to higher pressure more droplets cause better coverage, less drift due to anti drift nozzles and air injector nozzles, resulting as bigger deposit up to 78%.

Key words: weeds, nozzles, coverage, pressure, deposit

Introduction

Economic agricultural production can not be imagined without use of plant protection products. The use of pesticides reduces the population or suppresses weeds, insects and pests. In recent years, the climate in Serbia has been favorable to the intensive growth of weeds and the development of various insects and diseases. Increased air humidity of more than 70% and temperatures up to 35 °C during the day and tropical nights are the main characteristics of spring and summer months in Serbia. Additionally, short splashes also favor development of diseases and pests as well as weeds. Faced with such weather conditions, farmers are increasingly applying different pesticides in wheat, soybean or corn, and application of pesticides in sugar beets is every week.

Additional pressure on farmers is a very short period of days suitable for the application of pesticides as well as large agricultural areas under different cultures. For this reason, in order to protect all surfaces, the application of pesticides is carried out at high speeds of movement between 10 and 15 km/h. Self-propelled machines range from 15 km/h to 23 km/h, which is extremely fast. As the operator's training is at an extremely low level on the basic principles of efficient and economical application of pesticides in the framework of sustainable agricultural production, often exploitation parameters are very unsuitable. At the given speeds of movement, the same nozzles are used as in the previous application. By increasing the working speed, working pressure is increased in order to satisfy the given norm, which is usually between 150 and 180 l/ha. So the operating pressure very often comes to the level of 8 bar and sometimes 10 bar. Valve locks and breaks of working fluid lines are everyday situation in the field. The second indication is much more problematic than the first one. It is about the amount of pesticide deposits, or the amount of active substance that reach the target surface. The quantity of active substance, ie the amount of deposits, is in direct correlation with the efficiency of the pesticide application. With increasing speed, there is an increase in air turbulence behind the sprayer, and often this turbulence reaches a speed of 7 m/s, which is beyond the acceptable drift drift limits for the most common nozzles with one flat fan. The droplet spectrum of a spray nozzles with a flat fan at a pressure of up to 5 or 6 bar can only be such that the droplets are very fine. Very fine droplets of a medium volume diameter below 150 µm are ideal for drifting with wind and evaporative drift.

It is precisely the drift of use of bad and inadequate nozzles in Serbia. Vieira et al. (2018) states that the use of a single jet nozzles creates drift up to almost 15 m at a treatment norm of 150 l/ha. The satisfactory reduction of the drift is mentioned by the author in his experiment using corn as a barrier, but also by using an injector spray nozzle with a single reflective jet. Cody et al. (2018) obtained results for other types of nozzles, flat spray nozzle, one air injector nozzle, single air injector with single and two flat fan. The test was carried out in corn and soybean during herbicide application. The results of the test related to the amount of deposits showed that the largest deposit was achieved with the use of a single jet spray nozzle in a soybean (28%). In the corn, the best deposit was obtained using T nozzles (50%). Deposition across the row, beginning in-between the row crop and ending in the row of crop was 44%, 18%, and 8% for soybean and 59%, 50%, and 36% for corn. For both crops, more than half of the herbicide application was captured in the crop canopy. Proper nozzle selection for canopy type can increase herbicide penetration and increase the carrier volume will increase penetration proportionally conclude Cody et al. (2018). Given claims are related to Forester et al. (2010) which describe behavior of droplets of many used nozzles. Forest et al. (2012, 2013), in its further research, publishes a model that should predict the penetration of working fluid and the amount of deposits using different sprays in different agricultural cultures.

Material and method of work

The Educational Development Center for Pesticide Application Technology at the Faculty of Agriculture, University of Novi Sad, took concrete measures that are related to the described problems. Thus, measures have been taken in relation to the training of agricultural producers on the use of appropriate nozzles for different weather conditions and exploitation factors.

Firstly, field testing about deposit quality under different operating conditions of different nozzles was performed. The application of pesticides in soybean was performed. Soya was in the flowering stage. The central part of the tree is splintered with formed lateral branches and the rows almost completely closed. Sampling was carried out in 5 repetitions on all the above leaves, on the central and lower leaves. After that, the average values of all deposit measurements were taken.

An overview of the used nozzles is given in the following table:

1 - Turbo Drop ADF (Sl. 1):

Angle of spraying: 2 X 110 °

Operating pressure: 1.5 to 8 bar

Best working pressure: 2 to 6 bar

Nozzle height: 40 to 60 cm

Advantages: Asymmetrical spray jet orientation, easy folding, compactness, good drift control, operation at speeds of 6 to 15 km / h.

2 - Turbo Drop Hi Speed (Sl. 2):

Angle of spraying: 2 X 110 °

Working pressure: 2 to 8 bar

Best working pressure: 3 to 7 bar

Advantages: Asymmetric orientation of spray jets, easy disassembly, durable ceramic parts, need for treatment with fungicides and insecticides, work at speeds up to 30 km / h.

3 – Air Mix (Sl. 3):

Spraying angle: 110 °

Operating pressure: 1 to 6 bar

Best working pressure: 2 to 6 bar (for pesticide), 1 to 2 bar (for mineral fertilizer)

Nozzle height: 40 to 90 cm

Advantages: Reduction of drift up to 90%, no closing,

compact design, easy assembly.

4 – TFA:

Spray angle: 90 °

Operating pressure: 1.5 to 8 bar

Nozzle height: 50 cm

Advantages: High drift reduction, excellent surface coverage, compactness and easy assembly.

In this test, a 8% water solution of brilliant blue tracer was used. The solution is continuously mixed during the test, regardless of the extremely good water soluble solubility. When applied, the solution was collected in petri dish or washed from plants parts and then washed with 0.1 l of deactivated and deionized water. The concentration was read using the Shimadzu UV-Vis 1100 spectrophotometer at a wavelength of 565 ± 2 nm. All tests were done with water whose pH was slightly acidic.

In the experiment, Agromehanika AGS 800 sprayer was used, which was aggregated for CASE Farmall 115U tractor. The volume of the sprayer is 800 l and the boom width is 15 m. Swing wings were attached to the frame at one point and two springs are leveling and made up a mechanical system for terrain copying. The low-pressure pump BM 105 of the same manufacturer, type piston-membrane with a capacity of 105 l / min at 20 bar and 540 rpm, powered 30 nozzles with a working fluid and mixes it. The height of the application was 0.5 m, which is the recommended and most frequently adjusted height of the application in Vojvodina. Spray nozzles can carry a maximum of 3 nozzles, triplex carrier. The treatment norms were 150 l/ha, 180 l/ha and 220 l/ha at 10 km/h tractor speed and application pressure of 2 bar, 3 bar and 4 bar. Wind speed was 3-4 m/s. The temperature was around 26 °C, and the air humidity was about 60%. The environmental conditions were not changed during testing. The samples were taken by washing the tracer from parts of the plants.

Results of the discussion with the discussion

Field conditions were fully acceptable for pesticide application. The quantities of the measured deposits shown in the following table are given in percentages. Date values provide information on how much pesticide has reached the target surface or penetrated on the plant. For example, if the value is 40%, this means that only 40% of the total amount of pesticide to be found on this surface (possible 100%) is due. The maximum amount of preparation that can reach this surface is obtained based on the norm and unit area.

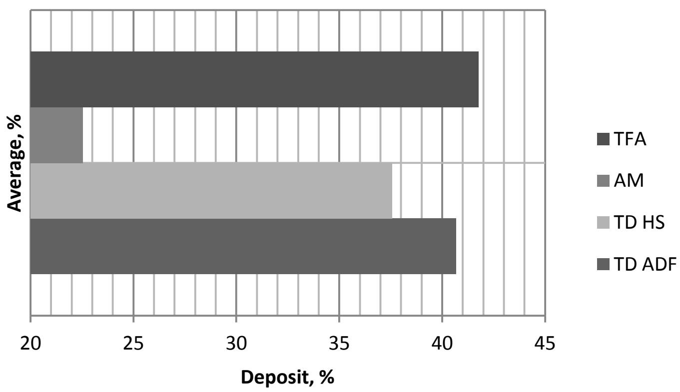
Tab. 1. Pesticide deposit in soybean by using different nozzle types with given coefficient of variation.

No.	Nozzle	Average amount of deposit
1.	TD ADF	40,67 ± 64,16%
2.	TD HS	37,56 ± 67,22%
3.	AM	22,56 ± 77,34%
4.	TFA	41,78 ± 65,79%

Due to the Turbo drop technology, the ADF nozzles does not have the best result since the effect of this nozzles is recorded only at higher speeds. As always, two-jet spray nozzle with 41.78% of the average amount of deposits on the leafs had more quantities upt to 11% of pesticide than of TD HS nozzle. The average coefficient of variation of these nozzles ranged from 64.16% to 67.22%. The smallest deposition had AM nozzles with the average deposit amount of 22.56% and the coefficient of variation of 77.34% which proved to be the worst. This is also to be expected given that the AM nozzles is injector type and has only one jet while all other nozzles have two jets.

The following figure gives a glossy overview of the average amount of deposits on the plants of all tested nozzles.

Fig. 1. Total deposit depending on different nozzles



Conclusion

Agricultural producers must be aware that effective plant protection can be achieved if the work assemblies or elements such as the pump or nozzles are completely correct. This will ensure uniform distribution of pesticides to targeted areas. When selecting a nozzles, they must select the appropriate nozzles for its purpose as well as the operating pressure to reduce the risk of drift and polluted environment. Using modern and improved nozzles, an effective pesticide application is achieved that is in line with the principles of good agricultural practice. An expedient selection of nozzles will increase efficiency and reduce the need for reuse of pesticides. Only in this way will sustaining the sustainability of agricultural production from the aspect of controlling the population of diseases and pests. Continuous training of agricultural producers, as well as research aimed at the local efficiency of various nozzles and the appropriate selection of exploitation parameters will ensure the production of health-safe food.

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