Univerzitet u Beogradu
Poljoprivredni fakultet
Institut za poljoprivrednu tehniku
Naučni časopis
POLJOPRIVREDNA TEHNIKA
Godina XL
Broj 1, 2015.
Strane: 61 – 71

University of Belgrade
Faculty of Agriculture
Institute of Agricultural Engineering
Scientific Journal
AGRICULTURAL ENGINEERING
Year XL
No. 1, 2015.
pp: 61 – 71

UDK: 66.069.832

Originalni naučni rad
Original scientific paper

COMPARATIVE EVALUATION OF SPRAYING TECHNOLOGY IN COTTON BELT OF PUNJAB (INDIA)

Mahesh Kumar Narang*, Abhinab Mishra, Vijay Kumar, Surinder Singh Thakur, Manjeet Singh

Punjab Agricultural University, College of Agricultural Engineering and Technology, Department of Farm Machinery and Power Engineering, Ludhiana, Punjab, India

Abstract: With advancement of spray technology and sprayers used on farmer's field will vary significantly from each sprayer in terms of droplet size which ultimately determines its efficacy. Therefore, it is required to standardize and validate the efficient spray technology for enhancing the effectiveness of pesticides in cotton. For tractor operated gun sprayer, the field capacity was found higher due to its large coverage area around covering six to seven rows during one pass on one side i.e. 5.4 to 6.3 m. The operator speed was found to be around 1-1.6 $km \cdot h^{-1}$ and VMD, NMD and UC were found to be 125.71 μm, 33.91 μm, 3.73 respectively. Lesser droplets reach the lower side of the upper leaves where usually the white flies reside.

The $cost \cdot h^{-1}$ for electrostatic sprayer may be high but the deposition efficiency and also the spatial distribution of deposited droplets throughout the plant canopy, particularly under plant leaves application where pests usually hide and reside was found maximum. Thus results in better bio-efficacy. The droplet sizes i.e. VMD, NMD and UC were found to be 52.66 μm, 21.79 μm and 2.54 respectively. Tractor mounted boom sprayer is a recommended technology and showed best results in terms of uniformity, droplet sizes, bio efficacy and high field capacity having VMD, NMD and UC of 124.12, 43.94 and 2.75 respectively. Battery operated knapsack sprayer have VMD, NMD and UC of 137.80μm, 37.01μm and 3.58 respectively but its field capacity was found to be least.

Key words: *Tractor operator gun sprayer, electrostatic sprayer, boom sprayer, knapsack sprayer, droplet size, uniformity coefficient*

* Corresponding author. Email: maheshnarang@pau.edu

INTRODUCTION

Cotton popularly known as 'white gold' is the main kharif crop of south-western Punjab which includes Faridkot, Firozepur, Bhatinda, Mansa, Abhor and Mukatsar. The total area under cotton cultivation in Punjab was $5.05 \cdot 10^5$ ha during 2013-14 with total production of $21.0 \cdot 10^5$ bales and yield of 707 $kg \cdot ha^{-1}$ [1]. It is found that about 55% of the total pesticide is being consumed on cotton in India against 5% of total cultivable land accounting for 40% of total production costs. This fact signifies the impact of insect pests and the increased agrochemical use in cotton production. Better management is required for realizing better cotton yields which can be achieved by effective spraying and improved application methods. In order to attain uniform deposition and distribution of chemical spray on top, middle, bottom and on the undersides of plant canopy the leaves are of utmost importance for effective control of pests [2]. Farmers in south-west Punjab are using knapsack sprayer which has low application accuracy and require serious safety precautions. Performance depends on skill of operator; manual application often results in an uneven distribution of the pesticide [9]. Earlier the farmers were using tractor operated boom sprayer, but according to their view, either space to be left for moving the tractor or two lines are affected due to less ground clearance of tractor and their yield is affected. The tractor operated boom sprayer consists of a centrifugal pump, a tank, a pressure regulator valve and a boom with nozzles and spray gun fitted on a frame. The sprayer is mounted on the 3 point linkage of the tractor and drive is given through from tractor PTO through asset of gears. Boom height can be adjusted from 10 to 225 cm from ground to suit different crop height. It can cover up to 1200 cm width and has a capacity of about 1.6 $ha \cdot h^{-1}$ at a field speed of 2.5 $km \cdot h^{-1}$.

Recently, the manufactures have launched their own tractor mounted sprayers, fitted with guns having pipe length of 60-100 m very attractive to them. The gun spraying is becoming popular on account of its multipurpose use for cotton, paddy and horticultural crops. Such wide range of coverage of crops from cotton to perennial tall horticultural crops is attained by using the spray guns of different types and specifications. In field, tractor operated gun sprayer required four persons of which two persons are required for handling the pipe, with tractor standing outside the field. In this technique, there may be a chance of over dosage of pesticide which may lead to many problems such as chemical waste and environmental pollution from spray drift. There is no adequate data about its droplet size and coverage etc. Due to its popularity among the farmers the sprayer was evaluated in the field. Electrostatic technique in the agricultural spray is a new technique toward prevention of chemical waste and environmental pollution [5] support the hypothesis that air-assisted electrostatic spray application can be utilized to reduce the quantity of the pesticide active ingredient dispensed into a given crop canopy as compared to conventional high volume hydraulic spraying. It not only improves the deposition efficiency but also the spatial distribution of deposited droplets throughout the plant canopy, particularly under leaf application where pests usually hide and reside, hence increasing the bio-efficacy [6]. For the above said reasons, electrostatic spraying technology has been a concern in research and development for beneficial agricultural applications [4][7]. The quality of spraying machine work is affected by several technological, technical and climatic factors, the most important of which include the type of sprayer, choice of nozzles, appropriate spray parameters, temperature and humidity as well as the instructions of plant protection producer [3]. A comparison study of the conventional and adapted sprayer showed that 37% of the pesticide used was saved using the adapted sprayer whereby the efficacy of the treatments was identical. Pesticide residues on the soil between the fruit trees were negligible pointing to efficient environmental protection [10].Therefore, it is required to standardize and validate the efficient spray technology for enhancing the effectiveness of pesticides with most commonly used sprayers in cotton. The present study was undertaken in the cotton belt of south – west Punjab to evaluate the spraying technology of tractor operated gun type sprayer used by the farmers along with the recommended technology of battery operated knapsack sprayer, boom type sprayer and electrostatic sprayer (new technology in India) under field conditions and to determine the comparative performance of their spraying based on range of droplet size, droplet density and volume of spray deposition using droplet analyzer, bio-efficacy and cost economics were compared.

MATERIAL AND METHODS

The experiments were conducted out at farmer's field Village Khepawalli, District Abhor, Punjab located at 30.137°N latitude and 74.20°E longitude in the month of August and September, 2013. Four sprayers were selected for the experiments i.e. Battery operated Knapsack, boom type, tractor operated gun type and electrostatic sprayers. An Electrostatic sprayer was procured from department of farm machinery and power engineering, PAU, Ludhiana for evaluation at farmer's field. The details specifications of the sprayers are given in Tab. 1. The sprayers were evaluated on an area of 1.2 ha for the selected location. The plot selected was divided into three parts for each sprayer and replications were done. The plot size for each replication was 60 x 20 m. Observations like (*VMD*, *NMD*), uniformity coefficient, droplet density and no. of white flies were taken for evaluating four sprayers. Parameters like wind velocity ($km \cdot h^{-1}$), temperature (°C), field capacity ($ha \cdot h^{-1}$), speed of operation ($km \cdot h^{-1}$) and economics of the four technologies were also recorded / calculated.

Table 1. Specification of the sprayers

Specifications	*Gun*	*Knapsack*	*Electrostatic*	*Boom Type*
Tank capacity (l)	*500*	*15*	*15*	*500*
Power source	*Above 35 HP*	*Manual*	*Manual*	*Above 35 HP*
Operating pressure ($kg \cdot cm^{-2}$)	*10-25*	*3.5-4.5*	*4.2-4.9*	*15-25*
Hose pipe length (m)	*60-100*	*-*	*30*	*-*
No of nozzles	*1*	*1*	*Single/twin*	*16*
Types of nozzle	*Gun*	*Hollow cone*	*Hollow cone with electrode at the tip*	*Hollow cone*
Cost	*35.000-55.000*	*2.500-5.000*	*40.000*	*30.000*

Measurements of droplet size, droplet density and uniformity coefficient

For spray deposition, plants were randomly selected in the field, water sensitive paper strips of size 7.5 x 2.5 cm were placed on the selected plants and divided into 5 portions viz. upper, upper lower, middle, lower canopy and ground surface. The sprayed strips were further analyzed in the laboratory with a droplet analyzer with software installed on computer called as 'USB Digital Scale'. Droplet analyzer consists of microscope, CCD camera, PC and a monitor to control the analyzed picture (The numbers of droplets were noted under each classified range of intervals of 50 microns up to 500 microns [3]. Using the number of droplets and diameter of the droplet in the particular size range graphs were plotted between actual diameter and cumulative percentage of volume; the droplet size at which cumulative percentage of volume contributed reached 50 percent was taken as the Volume Median Diameter (*VMD*) of the sprayed particles and the droplet size at which cumulative percentage number of droplets reached 50 percent was taken as the Number Median Diameter (*NMD*) of the sprayed particles. Uniformity coefficient (*UC*) was calculated by dividing *VMD* by *NMD*. The number of drops in one square centimeter area of glossy paper was obtained on each card and termed as droplet density [8].

Bio-efficacy

For calculation of bio-efficacy in the field, number of pests in the field was counted from 10 randomly selected plants. The pests were counted from a total of 3 leaves of a plant i.e. upper and lower side was recorded before and after the spray. The pest count was further recorded on 1st, 3rd 7th and 10th day after spraying. The difference of number of pests before and after the spray was noted to calculate the percentage reduction of pests. The insecticide used was solution with a recommended dose of 600 ml·acre^{-1}.

Statistical analysis

The results obtained during experiment were statistically analyzed by software SAS 9.3 for verifying their significance of relationship.

RESULTS AND DISCUSSION

This section presents the analysis and interpretation of experimental results obtained during the course of study; relationships between independent variables and dependent variables, shown in table 2-4.

Determination of droplet size and uniformity coefficient

The average volume median diameter (*VMD*) and average number median diameter (*NMD*) was 125.71 µm, 33.91 µm respectively for gun type sprayer. For battery operated knapsack sprayer, the average volume median diameter (*VMD*) and average number median diameter (*NMD*) was 137.80 µm 37.01 µm respectively. Average uniformity coefficient was found to be 3.73 and 3.58 for gun and knapsack sprayers respectively.

While for boom sprayer, the average volume median diameter (*VMD*) and average number median diameter (*NMD*) was 124.12 µm, 43.94 µm respectively with an average uniformity co-efficient of 2.75. For electrostatic average the volume median diameter (*VMD*) was 52.66 µm, and average *NMD* was 21.79 µm. Average uniformity coefficient was 2.54. From table 2 it was cited that both knapsack and gun sprayer gives highest volume median diameter (*VMD*) as compared to other two sprayers. It was also observed that the droplets are more uniform in case of gun sprayer. Tractor mounted boom sprayer also showed uniformity over droplets size as compared to other sprayers as it is not affected by operator's performance. The *VMD* for electrostatic sprayer was the least, due to high air pressure and resisted passage of nozzle the liquid atomized into smaller sizes. This is a main cause for its uniformity coefficient and gives more uniform size particles. In case of gun and knapsack the spraying fully depend upon operator's uniformity and speed of operation. Nozzle orifice diameter and pressure are also the major factors which played a vital role in the uniformity of droplets.

Table 2. Droplet size, µm (VMD, NMD & UC)

S.NO.	Type of sprayer	LS Mean VMD	LS Mean NMD	LS Mean UC
1.	Gun Type	125.71	33.91	3.73
2.	Knapsack(battery operated)	137.80	37.01	3.58
3.	Electrostatic	52.66	21.79	2.54
4.	Boom sprayer	124.12	43.94	2.75

Analysis of variance of volume median diameter (*VMD*)

Tab. 3 shows that the replication was non-significant at 5 per cent level of significance but the individual effect of sprayer for *VMD* was highly significant at 1 % level of significance while effect of place was found to be significant at 7% level of significance. Whereas the combined effect of place and sprayer was found non-significant at 5 % level of significance. It was also indicated that the overall F test is significant at 5% level indicating that the model as a whole accounts for a significant portion of the variability in the dependent variable. The F values indicate that the *VMD* can be varied and dependent on the type of sprayer used and different places of the plant.

Table 3. Analysis of variance of VMD on different sprayers and places

Source	DF	Mean Square	F Value	Pr > F
Replication	2	500.33282	0.26	0.7707
Place	4	11519.01019	6.04	0.0007
Sprayer	3	22533.74381	11.81	<0.0001
Place*sprayer	12	2802.66008	1.47	0.1789
Model	21	7062.37420	3.70	0.0002
Error	38	1907.66870		

**Places indicate water sensitive paper positions i.e. top upper, top lower side, middle, lower and ground.*

Analysis of variance of number mean diameter (*NMD*)

The analysis of variance (Tab. 4) indicates that neither the replication nor the combined effect of place and sprayer are significant to the variation of *NMD*. But it was found the individual effect of sprayer for *NMD* as independent parameter was significant at 6 % level of significance. The overall *F* test is non significant at 5% level indicating that indicating that the model as a whole doesn't accounts for a significant portion of the change with the dependent variable at 5% level.

Table 4. Analysis of variance of NMD on different sprayers and places

Source	DF	Mean Square	F Value	Pr > F
Replication	2	237.546402	0.48	0.6200
Place	4	346.741684	0.71	0.5924
Sprayer	3	1283.827202	2.62	0.0650
Place*sprayer	12	583.045486	1.19	0.3260
Model	21	605.242240	1.23	0.2800
Error	38	490.700210		

Analysis of variance of uniformity co-efficient

The (Tab. 5) indicates that combined effect of sprayer and place was found to be non-significant at 5 per cent level of significance, except effect of place as an individual parameter found to be significant at 5 % level. The overall *F* test for the model was found to be non- significant at 5% level indicating that the model as a whole accounts for a non-significant portion of the change with the dependent variable.

Table 5. Analysis of variance of uniformity coefficient on different sprayers and places

Source	DF	Mean Square	F Value	Pr > F
Replication	2	0.41037500	0.17	0.8428
Place	4	6.48088917	2.71	0.0442
Sprayer	3	5.26907111	2.21	0.1033
Place*sprayer	12	1.90811139	0.80	0.6493
Model	21	3.1166122	1.30	0.2326
Error	38	2.3891680		

Droplet density

Three replications were compared between the sprayers in the field and LS mean from SAS 9.3 software was calculated, it was found that for Gun sprayer the droplet density was 173 at top upper portion of the leaf while droplet density was 56 on the under side of the leaves. The middle portion of the leaves was observed to have highest density with 364 drops. It was observed the no. of drops at the lower and ground portion was found to be 172 and 164 respectively. The non-uniformity may be due to operator's uneven method of the spraying. The droplet density for knapsack was found to be 106 on top portion while 10 droplets were found on upper lower side and droplet density were seen to vary from 97-124 on lower and ground portion of the leaf. Due to air assisted spray and electrically charged particles complete and uniform coverage of droplets were seen for electrostatic sprayer on the total plant canopy. For top portion the droplet density was found to be 336, on the top lower portion 241 droplets were found while on lower and ground portion of the leaf 96 and 70 drops were observed respectively. The boom sprayer showed a droplet density of 239 on top portion of the leaf while 37 droplets were observed for top lower portion. While the middle, lower and ground portion droplet density varied from 159, 96 and 70 respectively.

Table 6. Droplet density (droplets·cm^{-2})

S. No.	Type of sprayer	Position of water sensitive paper on the plant				
		Top upper portion	Top lower	Middle	Lower	Ground
1	Tractor operated gun type sprayer	173	56	364	172	164
2	Knapsack (battery operated)	16	140	83	124	97
3	Electrostatic sprayer	336	241	824	380	521
4	Boom sprayer	239	37	159	96	70

Bio-efficacy results

Tab. 7 revealed that different treatments did not differ significantly before spray. After three days of spray, electrostatic spray was found to be more effective in reducing the whitefly population to 8.58 followed by tractor mounted boom sprayer, tractor operated gun sprayer and knapsack spray 13.28, 16.08 and 18.97 per three leaves, respectively. However, all the treatments were better than control. After 7 DAS whitefly population was significantly lower in Electrostatic spray, Gun spray and tractor mounted boom sprayer (5.45, 5.78 and 6.44 per three leaves) followed by Knapsack spray (12.67 per three leaves). After 10 DAS, whitefly population was significantly lower in electrostatic spray, gun sprayer and tractor mounted sprayer (5.67, 6.33 and 7.00 per three leaves) followed by Knapsack spray (13.22 per three leaves). However, all the treatments were better than control.

Table 7. Efficacy of different treatment against whitefly (Bemisia tabacion) on BT cotton

Treatment	Pre-treatment	3 DAS*	7 DAS	10 DAS
Tractor operated gun type sprayer	35.11	16.08 (4.12)**	5.78 (2.60)	6.33 (2.70)
Boom sprayer	37.33	13.28 (3.78)	6.44 (2.72)	7.00 (2.82)
Knapsack (battery operated)	37.44	18.97 (4.46)	12.67 (3.69)	13.22 (3.77)
Electrostatic sprayer	34.53	8.58 (3.09)	5.45 (2.54)	5.67 (2.58)
Control	35.11	39.11 (6.33)	41.67 (6.53)	46.78 (6.90)
CD (p=0.05)	NS	(0.47)	(0.29)	(0.37)

* Days after spraying, **Square root transformation

Cost of spraying

The cost of spraying were compared between the four sprayers and it was found that the total cost·h^{-1} including fixed and variable, for gun sprayer was around Rs.381/- including tractor cost of Rs. 302/-. The field capacity was found to be around 0.8 ha·h^{-1}. For electrostatic sprayer, total cost·h^{-1} was found to be Rs.323/- with a field capacity of 0.1 ha·h^{-1}, while knapsack on the other hand had minimum cost of Rs. 27.5 per hour due to its labor requirement factor and have a field capacity of 0.08 ha·h^{-1}. For boom sprayer the total cost·ha^{-1} was 330/- including tractor cost of Rs. 302/- with field capacity of 1.6 ha·h^{-1}. While, the spraying cost·ha^{-1} for gun type sprayer, battery operated knapsack sprayer, electrostatic sprayer, and tractor operated boom sprayer were found to be Rs. 476.0, 344.0, 3233, 208.0 respectively (shown in Fig. 1).

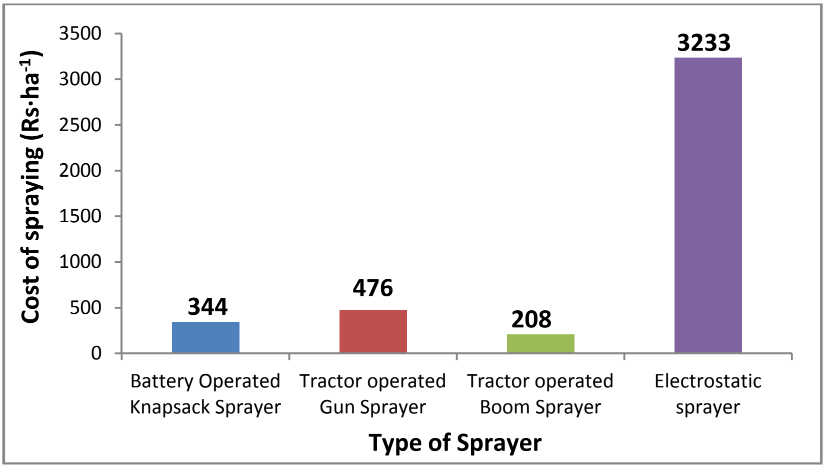

Figure 1. Cost of spraying of different sprayers

The cost·ha^{-1} for tractor operated boom sprayer was found to be least because of its high field capacity. For tractor operated gun sprayer, four persons are required for spraying operation in the field. Out of four, two persons are required for handling the discharge pipe, one for spraying with gun and one near the tractor. While three persons were employed in case of electrostatic sprayer, of which two persons are required for handling the discharge pipe and spraying with gun and one near the engine for its movement in the field. For knapsack sprayer, only single person is required for the spraying operation, but it is time consuming, tedious and does not provide effective coverage.

CONCLUSIONS

From the above parameters like quality, field capacity, cost economics and bio-efficacy results it can be inferred that the *VMD* and *NMD* of different sprayers vary significantly showing the differences in their droplet sizes. The uniformity coefficient was found to be non significant for different sprayers. For tractor operated gun sprayer, the field capacity was found higher due to its large coverage area around covering six to seven rows during one pass on one side i.e. 5.4 to 6.3 m. The operator speed was found to be around 1-1.6 $km \cdot h^{-1}$, but the quality results showed that the *VMD* and *NMD* were within the range. The droplet density on the lower side of the leaf was found to be less as compared to electrostatic sprayer where most of the white flies reside. Bio efficacy is found to be under control. The high discharge and ergonomically method of spraying are the major disadvantages with this technique. The battery operated knapsack sprayer had droplet size within the recommended range having minimum field capacity and time consuming. Bio efficacy was found to be lower among other sprayers but cost of spraying was found least. Tractor mounted boom sprayer was a recommended technology and showed best results in terms of uniformity, droplet sizes, bio efficacy and high field capacity. For electrostatic sprayer, higher droplet density was observed and cost of spraying per ha was highest but its deposition efficiency and bio efficacy was best among the four sprayers. The spatial distribution of deposited droplets throughout the plant canopy, particularly under leaf application where white flies usually hide and reside was found to be highest i.e. 241 $droplets \cdot cm^{-2}$.

BIBLOGRAPHY

[1] Anon. 2013. *Cotton IPM and Its Current Status*. CICR Technical Bulletin No: 8. Available through: http://www.cicr.org.in.htm [Accessed date: 20.12.2013.].

[2] Anon. 2014. *Current cotton scenario*. Available through: http://cotcorp.gov.in/current-cotton.aspx?pageid=4 [Accessed date: 20.06.2014.].

[3] Koszel, M. 2012. Ecology and work quality of fan flat nozzles. *Agricultural Engineering*, No. 1. p.p. 93-99.

[4] Laryea, G.N. 2004. Electrostatic Spray and Atomization for Agricultural Application. *Atomization. No.* 14. p.p. 33-53.

[5] Law, S.E., Cooper, S.C., Getting, R.D. 1992. *Advances in Air Assisted Electrostatic Crop Spraying of Conductive Spraying*. ASAE Paper No. 92-1062.

[6] Mamidi, R.V., Ghanshyam, C., Kumar, P.M., Kapur, P. 2013. Electrostatic Hand Pressure Knapsack Spray System with Enhanced Performance for Small Scale Farms. *Journal of Electrostatics*. 71(4). p.p. 785-790.

[7] Oerke, E. 2006. Crop Losses to Pests. *J Agric. Sci.* No. 144. p.p. 31-43.

[8] Singh, G., Kumar, S.S., Dixit, A., Manes, G.S., Singh, A. 2011. Spray Distribution Pattern of Different Sprayers on Cotton Using Droplet Analyzer. *Journal of Research, SKUAST-J* 10. p.p. 33-40.

[9] Wandkar, S.V., Mathur, S.M., Gholap, B.S., Jadhav, P.P. 2013. Development of air assisted sprayer for greenhouse floriculture crops. *Agricultural Engineering,* No. 3. p.p. 57-72.

[10] Urosevic, M., Zivkovic, M., Komnenic, V. 2006. Use of automatic regulation systems with the aim of reducing pesticide loss in fruit growing. *Agricultural Engineering,* No. 1. p.p. 67-71.

KOMPARATIVNO ISPITIVANJE TEHNOLOGIJE PRSKANJA U POJASU PAMUKA U PENDŽABU (INDIA)

Mahesh Kumar Narang, Abhinab Mishra, Vijay Kumar, Surinder Singh Thakur, Manjeet Singh

Poljoprivredni univerzitet Pendžaba, Fakultet za poljoprivrednu tehniku i tehnologiju, Institut za poljoprivredne i pogonske mašine, Ludhiana, Pendžab, India

Sažetak: Sa unapređenjem tehnologije prskanja i prskalica koje farmeri koriste na terenu, veličina kapljice, koja odlučujuće određuje efikasnost rada mašine, značajno se razlikuje kod svake prskalice. Zato je potrebno da se standardizuju i procene efikasne tehnologije prskanja za unapređenje efikasnosti primena pesticida u pamuku. Kod traktorskog rasprskivača utvrđen je viši poljski kapacitet zbog velike oblasti pokrivanja od šest do sedam redova u jednom prohodu na jednoj strani, odnosno 5.4 do 6.3 m. Radna brzina je iznosila 1-1.6 $km \cdot h^{-1}$, a *VMD*, *NMD* i *UC* su iznosili 125.71 μm, 33.91 μm i 3.73, redom. Manje kapljice stigle su do naličja gornjih listova gde obično žive bele muve.

Troškovi na čas rada elektrostatičke prskalice mogu biti visoki, ali efikasnost taloženja i prostorna distribucija deponovanih kapljica po celoh biljci, posebno ispod lišća gde se štetočine obično kriju, bili su maksimalni. Ovo dovodi i do bolje bio-efikasnosti. Veličine kapljica, odnosno *VMD, NMD* i *UC* iznosili su 52.66 μm, 21.79 μm i 2.54, redom. Nošena traktorska prskalica se preporučuje jer je pokazala najbolje rezultate u smislu ujednačenosti, veličina kapljica, bio-efikasnosti i visokog poljskog kapaciteta, a *VMD*, *NMD* i *UC* su iznosili 124.12, 43.94 i 2.75, redom. Leđna prskalica sa baterijskim napajanjem je imala *VMD*, *NMD* i *UC* od 137.80 μm, 37.01 μm i 3.58, redom, ali je njen poljski kapacitet bio najmanji.

Ključne reči: *traktorski rasprskivač, elektrostatički rasprskivač, prskalica, leđna prskalica, dimenzije kapljice, koeficijent ujednačenosti*

Prijavljen: *Submitted*:	11.07.2014.
Ispravljen: *Revised*:	26.02.2015.
Prihvaćen: *Accepted*:	07.03.2015.