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Discharge Available by Different Sizes of Nozzles at Various Speeds of Spinning Disc

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Abstract:

Agriculture is the backbone of developed and developing countries of the world. About 70% of the Indian population depends on agriculture for livelihood. Plants provide about 95% of the world's food either directly or indirectly. The pests reduce 35 % of yield especially in developing countries. Chemical pesticides have played and will continue to play a major role in the rapid advancement of agriculture. The controlled droplet application technique means producing only the optimum sizes of spray droplet for a particular application is used in spinning disc sprayer. Controlled droplet application offers the way forward in improving spraying efficiency, eliminating waste and safeguarding the environment. Since there is no need to operate pump, the operator can spray more quickly, effectively and constantly on difficult terrain. Spinning disc provides a means of applying crop protection chemicals at volume rates lower than those possible with hydraulic nozzles. Hand-carried spinning disc sprayer, have been used *successfully to apply several standard wettable powder and emulsifiable concentrate formulations diluted in water for control of weeds, insects, pests and diseases on many crops (Matthews, 1982). The main aim of these sprayers is to reduce the need to carry large quantities of water and chemicals. These types of sprayers are mainly used in semi-arid tropic regions. Spinning disc sprayers are mainly used for cotton, groundnut, pigeon pea, sorghum, millet, tomatoes and tobacco crops. The minimum and maximum discharge was found 22.99 and 132.00 ml/min at rotational speeds 528 and 1583 m/min, respectively. The minimum and maximum application rate was found 8.97 and 48.53 l/ha at rotational speeds 528 and 1583 m/min, respectively. The minimum and maximum droplet size was found 153 and 250 µm at rotational speeds 1583 and 528 m/min, respectively. Though droplet size (153 µm) and droplet density (167) per cm² were reasonable at disc speed of 6000 rev/min with the nozzle opening of 0.9 mm the application rate 12.17 l/ha is very less which will require very high concentration of pesticide.*

Key words: Sprayer, spinning disc sprayer, controlled droplet application sprayer, hand sprayer, low volume sprayer etc.

1. Introduction

The importance of plant protection measures for stepping up agricultural production has been widely accepted all over the world. The pests reduce 35% of yield especially in developing countries. Biological, physical, mechanical or chemical methods are used for the control of insects, plant diseases and weed. Among these methods of pest's control, chemical method is the most effective. Chemical pesticides have played and will continue to play a major role in the rapid advancement of agriculture. The main purpose of plant protection equipment is to apply the pesticides, insecticides and herbicides for better growth of the plants by controlling insects, plant diseases and weed. The success of modern agriculture crop production can be partly attributed to the improving of pests and disease control.

In a properly organized system, crop protection, therefore, is one of the most important means of increasing crop productivity. The problem of controlling insect pests and plant disease makes it necessary for large percent of farmers and orchardists to include in their farming equipment machines for applying either liquid or dust insecticides and fungicides. The concentration and quantity of the spray fluid or dust material depend upon the type of application machinery. The spray fluid may be applied as sprays (very coarse sprays, coarse sprays, medium sprays or fine sprays). It is important to minimize the pesticide application rates and at the same time increase the application efficiency. The pesticides, insecticides, herbicides must be applied with suitable equipment in order to apply proper dose, to reduce the requirements of labour and hazards involved in application to provide comfort and to operate efficiently. To eliminate the problems of health hazards, environmental pollution and drudgery that are associated with high volume sprayers; low volume and ultra low volume sprayers were developed. The chemicals used for spraying are costly, so appropriate and effective equipment for uniform and effective application is essential.

Liquid chemicals include fertilizers, pesticides and other growth regulating hormones. These may be water emulsions, solutions or suspensions of wettable powder. The liquid pesticides may be either contact or systematic type. Contact pesticides kill insects, weed, fungi etc by coming in contact with them. Contact type chemicals always require full coverage and normally achieved by small droplets produced by spraying machines. However, the systematic type of pesticide is taken in by the plant and full coverage is not required. The basic problem is to apply the required quantity of chemicals at the desired target with minimum wastage. Sprayers are more efficient than dusters in attacking a target with less application of the chemicals. However, it is generally seen that while spraying with knapsack, aerial, foot and rocker sprayers large amount of water is required and more quantity of chemicals are used to cover a specified area. Rotary atomizers are well suited for the application of pesticides because of uniform production of droplet size, more pesticides on target, narrow droplet spectrum and lower application costs. The Controlled droplet application (CDA) technique is used in spinning disc sprayer. Controlled droplet application means producing only the optimum sizes of spray droplet for a particular application. CDA offers the way forward in improving spraying efficiency, eliminating waste and safeguarding the environment.

2. Material and Method:

a) **Nozzle opening:** The function of the nozzle in spinning disc sprayer is to spray the liquid of required quantity. The nozzles fabricated were tightly fitted into the spray head to prevent leakage of chemicals. Since the opening provided by manufacturer was 1.5 mm, five nozzle openings 0.9, 1.2, 1.5, 1.8 and 2.1 mm were selected for the study. Specifications of nozzles fabricated for the study are given below:

Total length: 35 mm
Base diameter: 16 mm
Diameter of opening: 0.9, 1.2, 1.5, 1.8, 2.1 mm
Material used: Nylon rod

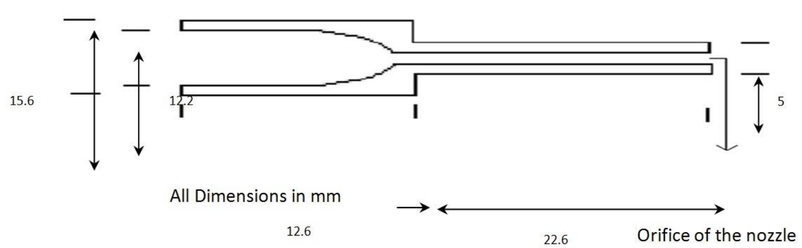

Fig. 1 Nozzle used in spinning disc sprayer

b) Discharge: Nozzle discharge is the volume of spray liquid discharged per unit time from the nozzle orifice. Nozzle discharge is the function of orifice size and the operating pressure of the sprayer. However, in case of spinning disc sprayer the pressure for the movement of liquid is developed in the system due to gravity. Therefore, the increase in the nozzle opening increases the discharge of the fluid through the nozzle. The procedure followed for the determination of discharge was as follows:

- The sprayer was fitted with nozzles of 0.9, 1.2, 1.5, 1.8 and 2.1 mm diameter and operated at the selected speeds of 2000, 3000, 4000, 5000 and 6000 rev/min with the help of potentiometer.
- The bottle was filled with water up to the 1000 ml mark by using a measuring jar and attached to the sprayer.
- The sprayer was switched on after checking the connection of the wire cords with the battery.
- The sprayer was kept in working position such that the bottle remains in vertical position.
- The water was allowed to pass through the nozzle by gravity into a tank and the time taken to empty the bottle was noted down with the help of stopwatch for each speed.
- The experiment was repeated three times.
- The discharge was calculated by using the formula:

$$\text{Discharge, ml/min} = \frac{\text{Volume discharged, ml}}{\text{Time, min}} \tag{1}$$

c) Disc speed: The production of droplets of uniform size requires a constant disc speed. The discharge of the spinning disc sprayer is affected by the rotational speed of the disc and liquid viscosity. For the experimental work five speeds ranging from 2000 to 6000 rev/min were selected (2000, 3000, 4000, 5000, and 6000, rev/min). The variation in speed of the spinning disc sprayer was achieved with the help of potentiometer and measured with a non-contact tachometer. A small piece of shining reflector was sticked on the rotating surface of the disc. The tachometer was switched on and placed at some distance above the reflector and held constant until the display shows a constant reading. The light from the tachometer falling on the reflector gets reflected and is collected by the sensor on the tachometer. The corresponding speed of the rotating object under measurement is displayed. The rotational speed of the disc were converted into peripheral speed by using the following formula:

$$v = \pi D N \quad \text{...(2)}$$

Where,

v = Peripheral speed of disc, m/min

D = Diameter of disc, m

N = Rotational speed of disc, rev/min

3. Results and Discussion:

a) **Effect of nozzle opening and disc speed on discharge:** The openings of the nozzle were varied from 0.9 to 2.1 mm to vary the discharge of the liquid. It is seen from the Table:2 and Fig: 2 that the discharge of the liquid increased with increase in opening of the nozzle and rotational speed of the disc. The discharge and peripheral speed of the disc followed a linear relationship of following form

$$Q = \beta_o s + \beta_1 \quad \text{.......................................(3)}$$

$$R^2 = 0.93 \text{ to } 0.99 \quad \text{.....................................(4)}$$

Where

Q = Discharge, ml/min
s = Peripheral speed, m/min, and
β_o and β_1 are coefficients

The values of the coefficients β_o, β_1, β_2 and β_3 are given in Table 1. The correlation coefficient varies from 0.98 to 0.99, which shows a very strong correlation between droplet size and disc speed. The minimum and maximum droplet sizes were found to be 153 and 250 µm at rotational speeds 1583 and 528 m/min, respectively. The droplet size was larger for 2.1 mm and smallest for 0.9 mm nozzle opening. Droplet size between 150 to 250 µm may be considered as good for spraying in most of the field crops.

Table: 1 values of coefficients β_o and β_1 of equation

Nozzle opening	Values of coefficients	
	β_o	β_1
0.9	0.00033	21.015
1.2	0.0196	24.548
1.5	0.0205	42.875
1.8	0.0315	58.191
2.1	0.0321	81.431

Table: 2 Effect of disc speeds and nozzle openings on discharge

Nozzle opening, mm	Rotational speed, m/min	Discharge, ml/min
0.9	528	22.99
	792	23.55
	1056	24.31
	1319	24.87
	1583	26.64
1.2	528	36.79
	792	39.21
	1056	43.31
	1319	49.58
	1583	57.48
1.5	528	55.79
	792	58.21
	1056	62.31
	1319	69.00

	1583	77.48
1.8	528	76.06
	792	81.88
	1056	90.17
	1319	101.00
	1583	108.00
2.1	528	98.00
	792	107.87
	1056	114.23
	1319	124.53
	1583	132.00

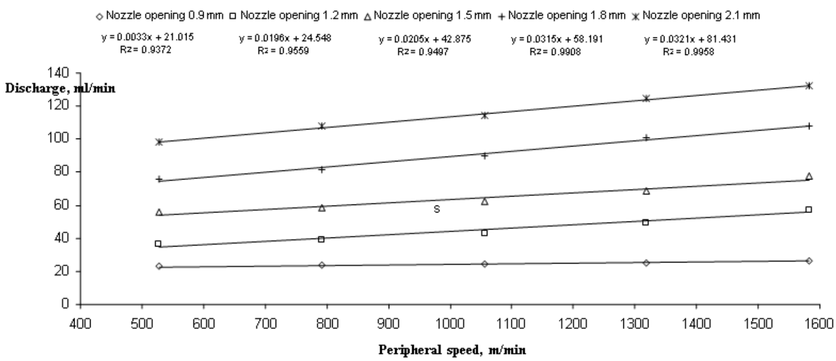

Fig. 2 Effect of disc speeds on discharge for different nozzle openings

The values of coefficients β_o and β_1 are given in Table 1. The correlation coefficient (R^2) varied from 0.94 to 0.99 indicating that the equation fitted well in the linear relationship.

The minimum and maximum discharges were found to be 22.99 and 132.00 ml/min at rotational speeds 528 and 1583 m/min respectively. The discharge was minimum for 0.9 mm and maximum for 2.1 mm nozzle opening respectively.

For nozzle opening 0.9 mm and rotational speed 528 m/min the minimum and maximum area covered by droplets was 0.016 and 0.275 mm^2, respectively, with mean of 0.052 mm^2. The minimum and maximum major diameter of droplet was 127 and 932 µm, respectively, with mean of 246 µm. The minimum and maximum minor diameter of droplet was 127 and 508 µm, respectively, with mean of 166 µm. The minimum and maximum roundness was 1.197 and 3.615, respectively, with mean of 1.32. The minimum and maximum droplet size was 127 and 522 µm, respectively with mean of 212 µm.

For nozzle opening 0.9 mm and rotational speed 792 m/min the minimum and maximum area covered by droplets was 0.016 and 0.352 mm^2, respectively, with mean of 0.031 mm^2. The minimum and maximum major diameter of droplet was 127 and 936 µm, respectively, with mean of 198 µm. The minimum and maximum minor diameter of droplet was 127 and 595 µm, respectively, with mean of 137 µm. The minimum and maximum roundness was 1.197 and 3.013, respectively, with mean of 1.30. The minimum and maximum droplet size was 127 and 591µm, respectively with mean of 167 µm.

For nozzle opening 0.9 mm and rotational speed 1056 m/min the minimum and maximum area covered by droplets was 0.016 and 0.410 mm^2, respectively, with mean of 0.030 mm^2. The minimum and maximum major diameter of droplet was 127 and 938 µm, respectively, with mean of 196 µm. The minimum and maximum minor diameter of droplet was 127 and 620 µm, respectively, with mean of 132 µm. The minimum and maximum roundness was 1.197 and 2.799, respectively, with mean of 1.29. The minimum and maximum droplet size was 127 and 499 µm, respectively with mean of 159 µm.

For nozzle opening 0.9 mm and rotational speed 1319 m/min the minimum and maximum area covered by droplets was 0.016 and 0.454 mm^2, respectively, with mean of 0.026 mm^2. The minimum and maximum major diameter of droplet was 127 and 1112 µm, respectively, with mean of 180 µm. The minimum and maximum minor diameter of droplet was 127 and 684 µm, respectively, with mean of 131 µm. The minimum and maximum roundness was 1.197 and 2.763, respectively, with mean of 1.28. The minimum and maximum droplet size was 127 and 641 µm, respectively with mean of 155 µm.

For nozzle opening 0.9 mm and rotational speed 1583 m/min the minimum and maximum area covered by droplets was 0.016 and 0.465 mm^2, respectively, with mean of 0.025 mm^2. The minimum and maximum major diameter of droplet was 127 and 1216 µm, respectively, with mean of 179 µm. The minimum and maximum minor diameter of droplet was 127 and 713 µm, respectively, with mean of 130 µm. The minimum and maximum roundness was 1.197 and 2.422, respectively, with mean of 1.27. The minimum and maximum droplet size was 127 and 693 µm, respectively with mean of 153 µm.

For nozzle opening 1.2 mm and rotational speed 528 m/min the minimum and maximum area covered by droplets was 0.016 and 0.625 mm^2, respectively, with mean of 0.036 mm^2. The minimum and maximum major diameter of droplet was 127 and 1379 µm, respectively, with mean of 261 µm. The minimum and maximum minor diameter of droplet was 127 and 862 µm, respectively, with mean of 178 µm. The minimum and maximum roundness was 1.197 and 3.899, respectively, with mean of 1.32. The minimum and maximum droplet size was 127 and 775 µm, respectively with mean of 219 µm.

For nozzle opening 1.2 mm and rotational speed 792 m/min the minimum and maximum area covered by droplets was 0.016 and 0.655 mm^2, respectively, with mean of 0.032 mm^2. The minimum and maximum major diameter of droplet was 127 and 1225 µm, respectively, with mean of 214 µm. The minimum and maximum minor diameter of droplet was 127 and 761 µm, respectively, with mean of 149 µm. The minimum and maximum roundness was 1.197 and 3.691, respectively, with mean of 1.31. The minimum and maximum droplet size was 127 and 673 µm, respectively with mean of 168 µm.

For nozzle opening 1.2 mm and rotational speed 1056 m/min the minimum and maximum area covered by droplets was 0.016 and 0.710 mm^2, respectively, with mean of 0.030 mm^2. The minimum and maximum major diameter of droplet was 127 and 1450 µm, respectively, with mean of 211 µm. The minimum and maximum minor diameter of droplet was 127 and 768 µm, respectively, with mean of 143 µm. The minimum and maximum roundness was 1.197 and 3.590, respectively, with mean of 1.29. The minimum and maximum droplet size was 127 and 730 µm, respectively with mean of 161 µm.

For nozzle opening 1.2 mm and rotational speed 1319 m/min the minimum and maximum area covered by droplets was 0.016 and 0.725 mm^2, respectively, with mean of 0.028 mm^2. The minimum and maximum major diameter of droplet was 127 and 1235 µm, respectively, with mean of 196 µm. The minimum and maximum minor diameter of droplet was 127 and 766 µm, respectively, with mean of 142 µm. The minimum and maximum roundness was 1.197 and 3.570, respectively, with mean of 1.29. The minimum and maximum droplet size was 127 and 635 µm, respectively with mean of 158 µm.

For nozzle opening 1.2 mm and rotational speed 1583 m/min the minimum and maximum area covered by droplets was 0.016 and 0.740 mm^2, respectively, with mean of 0.026 mm^2. The minimum and maximum major diameter of droplet was 127 and 1661 µm, respectively, with mean of 193 µm. The minimum and maximum minor diameter of droplet was 127 and 756 µm, respectively, with mean of 140 µm. The minimum and maximum roundness was 1.197 and 3.442, respectively, with mean of 1.28. The minimum and maximum droplet size was 127 and 734 µm, respectively with mean of 157 µm.

For nozzle opening 1.5 mm and rotational speed 528 m/min the minimum and maximum area covered by droplets was 0.016 and 1.029 mm^2, respectively, with mean of 0.074 mm^2. The minimum and maximum major diameter of droplet was 127 and 1997 µm, respectively, with mean of 278 µm. The minimum and maximum minor diameter of droplet was 127 and 1019 µm, respectively, with mean of 191 µm. The minimum and maximum roundness was 1.197 and 4.071, respectively, with mean of 1.34. The minimum and maximum droplet size was 127 and 1010 µm, respectively with mean of 230 µm.

For nozzle opening 1.5 mm and rotational speed 792 m/min the minimum and maximum area covered by droplets was 0.016 and 1.080 mm^2, respectively, with mean of 0.034 mm^2. The minimum and maximum major diameter of droplet was 127 and 1527 µm, respectively, with mean of 232 µm. The minimum and maximum minor diameter of droplet was 127 and 848 µm, respectively, with mean of 162 µm. The minimum and maximum roundness was 1.197 and 3.485, respectively, with mean of 1.32. The minimum and maximum droplet size was 127 and 687 µm, respectively with mean of 174 µm.

For nozzle opening 1.5 mm and rotational speed 1056 m/min the minimum and maximum area covered by droplets was 0.016 and 1.086 mm^2, respectively, with mean of 0.033 mm^2. The minimum and maximum major diameter of droplet was 127 and 1953 µm, respectively, with mean of 229 µm. The minimum and maximum minor diameter of droplet was 127 and 977 µm, respectively, with mean of 156 µm. The minimum and maximum roundness was 1.197 and 3.677, respectively, with mean of 1.31. The minimum and maximum droplet size was 127 and 931 µm, respectively with mean of 171 µm.

For nozzle opening 1.5 mm and rotational speed 1319 m/min the minimum and maximum area covered by droplets was 0.016 and 1.324 mm^2, respectively, with mean of 0.029 mm^2. The minimum and maximum major diameter of droplet was 127 and 1230 µm, respectively, with mean of 213 µm. The minimum and maximum minor diameter of droplet was 127 and 593 µm, respectively, with mean of 154 µm. The minimum and maximum roundness was 1.197 and 3.509, respectively, with mean of 1.30. The minimum and maximum droplet size was 127 and 568 µm, respectively with mean of 161 µm.

For nozzle opening 1.5 mm and rotational speed 1583 m/min the minimum and maximum area covered by droplets was 0.016 and 1.388 mm^2, respectively, with mean of 0.028 mm^2. The minimum and maximum major diameter of droplet was 127 and 1442 µm, respectively, with mean of 209 µm. The minimum and maximum minor diameter of droplet was 127 and 720 µm, respectively, with mean of 151 µm. The minimum and maximum roundness was 1.197 and 3.501, respectively, with mean of 1.30. The minimum and maximum droplet size was 127 and 622 µm, respectively with mean of 159 µm.

For nozzle opening 1.8 mm and rotational speed 528 m/min the minimum and maximum area covered by droplets was 0.016 and 1.490 mm^2, respectively, with mean of 0.067 mm^2. The minimum and maximum major diameter of droplet was 127 and 2501 µm, respectively, with mean of 297 µm. The minimum and maximum minor diameter of droplet was 127 and 1695 µm, respectively, with mean of 196 µm. The minimum and maximum roundness was 1.197 and 3.703, respectively, with mean of 1.37. The minimum and maximum droplet size was 127 and 1492 µm, respectively with mean of 239 µm.

For nozzle opening 1.8 mm and rotational speed 792 m/min the the minimum and maximum area covered by droplets was 0.016 and 1.342 mm^2, respectively, with mean of 0.035 mm^2. The minimum and maximum major diameter of droplet was 127 and 1355 µm, respectively, with mean of 251 µm. The minimum and maximum minor diameter of droplet was 127 and 889 µm, respectively, with mean of 176 µm. The minimum and maximum roundness was 1.197 and 3.523, respectively, with mean of 1.32. The minimum and maximum droplet size was 127 and 697 µm, respectively with mean of 180 µm.

For nozzle opening 1.8 mm and rotational speed 1056 m/min the minimum and maximum area covered by droplets was 0.016 and 0.586 mm^2, respectively, with mean of 0.033 mm^2. The minimum and maximum major diameter of droplet was 127 and 1487 µm, respectively, with mean of 248 µm. The minimum and maximum minor diameter of droplet was 127 and 850 µm, respectively, with mean of 169 µm. The minimum and maximum roundness was 1.197 and 3.990, respectively, with mean of 1.32. The minimum and maximum droplet size was 127 and 711 µm, respectively with mean of 172 µm.

For nozzle opening 1.8 mm and rotational speed 1319 m/min the minimum and maximum area covered by droplets was 0.016 and 0.509 mm^2, respectively, with mean of 0.031 mm^2. The minimum and maximum major diameter of droplet was 127 and 1374 µm, respectively, with mean of 231 µm. The minimum and maximum minor diameter of droplet was 127 and 902 µm, respectively, with mean of 165 µm. The minimum and maximum roundness was 1.197 and 3.744, respectively, with mean of 1.31. The minimum and maximum droplet size was 127 and 763 µm, respectively with mean of 164 µm.

For nozzle opening 1.8 mm and rotational speed 1583 m/min the minimum and maximum area covered by droplets was 0.016 and 0.564 mm^2, respectively, with mean of 0.030 mm^2. The minimum and maximum major diameter of droplet was 127 and 1829 µm, respectively, with mean of 228 µm. The minimum and maximum minor diameter of droplet was 127 and 765 µm, respectively, with mean of 160 µm. The minimum and maximum roundness was 1.197 and 3.645, respectively, with mean of 1.31. The minimum and maximum droplet size was 127 and 741 µm, respectively with mean of 161 µm.

For nozzle opening 2.1 mm and rotational speed 528 m/min the minimum and maximum area covered by droplets was 0.016 and 1.042 mm^2, respectively, with mean of 0.076 mm^2. The minimum and maximum major diameter of droplet was 127 and 1783 µm, respectively, with mean of 318 µm. The minimum and maximum minor diameter of droplet was 127 and 1062 µm, respectively, with mean of 203 µm. The minimum and maximum roundness was 1.197 and 3.277, respectively, with mean of 1.37. The minimum and maximum droplet size was 127 and 1013 µm, respectively with mean of 250 µm.

For nozzle opening 2.1 mm and rotational speed 792 m/min the minimum and maximum area covered by droplets was 0.016 and 1.183 mm^2, respectively, with mean of 0.046

mm^2. The minimum and maximum major diameter of droplet was 127 and 2150 µm, respectively, with mean of 271 µm. The minimum and maximum minor diameter of droplet was 127 and 1101 µm, respectively, with mean of 185 µm. The minimum and maximum roundness was 1.197 and 4.328, respectively, with mean of 1.37. The minimum and maximum droplet size was 127 and 1053 µm, respectively with mean of 189 µm.

For nozzle opening 2.1 mm and rotational speed 1056 m/min the minimum and maximum area covered by droplets was 0.016 and 0.899 mm^2, respectively, with mean of 0.041 mm^2. The minimum and maximum major diameter of droplet was 127 and 1844 µm, respectively, with mean of 268 µm. The minimum and maximum minor diameter of droplet was 127 and 1115 µm, respectively, with mean of 179 µm. The minimum and maximum roundness was 1.197 and 4.687, respectively, with mean of 1.35. The minimum and maximum droplet size was 127 and 941 µm, respectively with mean of 181 µm.

For nozzle opening 2.1 mm and rotational speed 1319 m/min the minimum and maximum area covered by droplets was 0.016 and 0.646 mm^2, respectively, with mean of 0.035 mm^2. The minimum and maximum major diameter of droplet was 127 and 1617 µm, respectively, with mean of 251 µm. The minimum and maximum minor diameter of droplet was 127 and 894 µm, respectively, with mean of 173 µm. The minimum and maximum roundness was 1.197 and 4.711, respectively, with mean of 1.33. The minimum and maximum droplet size was 127 and 785 µm, respectively with mean of 171 µm.

For nozzle opening 2.1 mm and rotational speed 1583 m/min the minimum and maximum area covered by droplets was 0.016 and 0.626 mm^2, respectively, with mean of 0.033 mm^2. The minimum and maximum major diameter of droplet was 127 and 1673 µm, respectively, with mean of 248 µm. The minimum and maximum minor diameter of droplet was 127 and 987 µm, respectively, with mean of 170 µm. The minimum and maximum roundness was 1.197 and 4.846, respectively, with mean of 1.32. The minimum and maximum droplet size was 127 and 801 µm, respectively with mean of 170 µm.

Table 3 Effect of disc speeds and discharge on droplet size

Nozzle opening, mm	Rotational speed, m/min	Discharge, ml/min	Major diameter, µm (Mean)	Minor diameter, µm (Mean)	Droplet size, µm (Mean)
0.9	528	22.99	246	166	212
	792	23.55	198	137	167
	1056	24.31	196	132	159
	1319	24.87	180	131	155
	1583	26.64	179	130	153
1.2	528	36.79	261	178	219
	792	39.21	214	149	168
	1056	43.31	211	143	161
	1319	49.58	196	142	158
	1583	57.48	193	140	157
1.5	528	55.79	278	191	230
	792	58.21	232	162	174
	1056	62.31	229	156	171
	1319	69.00	213	154	161
	1583	77.48	209	151	159
1.8	528	76.06	297	196	239
	792	81.88	251	176	180
	1056	90.17	248	169	172
	1319	101.00	231	165	164
	1583	108.00	228	160	161
2.1	528	98.00	318	203	250
	792	107.87	271	185	189
	1056	114.23	268	179	181
	1319	124.53	251	173	171
	1583	132.00	248	170	170

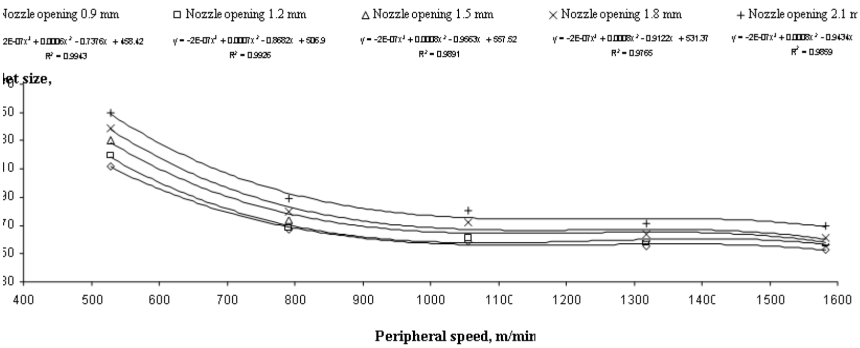

Fig. 3 Effect of disc speed on droplet size for different nozzle openings

Conclusions:

1. The maximum and minimum discharge was found 132.00 and 22.99 ml/min at rotational speeds of 1583 and 528 m/min respectively. The maximum discharge was at 2.1 mm and minimum at 0.9 mm nozzle opening.
2. The droplet size varied from 153 to 250 µm at disc rotational speeds of 1583 to 528 m/min.
3. The maximum and minimum droplet density was found 329 and 21 droplets per cm^2 at rotational speeds 1583 and 528 m/min respectively. The high droplet density indicated very dense droplet pattern resulting in overdozing of pesticides.

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