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CALIBRATION OF BATTERY OPERATED HIGH VOLUME SPRAYERS

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Three types of battery operated sprayers (BOS) *viz.*, high volume sprayer without pressure regulator (12V/8AH), with pressure regulator (12V/12AH) and battery cum hand operated Knap sack sprayer with pressure regulator (12V/ 8AH) were calibrated for discharge rate (ml/min), swath width(cm) and spray angle (^{0}) that emitted through different nozzles at medium and high pressures. Among the three battery operated sprayers, BOS (12V/12AH) under high pressure was found efficient in providing optimum discharge rate (1350 ml/min), swath width (80 cm) and spray angle (85^0) and can be operated satisfactorily for four hours. Further, the discharge rate was high compared to the sprayer with 12V/ 8 AH battery.

Key words: Pesticide application technology, battery operated sprayers, calibration

INTRODUCTION

Use of appropriate application equipment is critical in obtaining desired spray characters for uniform coverage on plant canopy which results in effective insect pest management. The selection of proper spray appliances and agricultural chemicals for efficient and practical pest management for quality and quantity crop production has lead to development of many sprayers. The traditional method of pesticide application is time consuming and less effective and in contrast the conventional knapsack sprayers entail the use of hand to throttle or pump to generate pressure at frequent intervals. This causes fatigue on the operators back, shoulder and the hand muscles. Of late, the manual spray techniques have become obsolete due to availability of improved pesticide appliances. The selection of right plant protection appliance is as important as use of recommended pesticides to obtain desired results in pest management. In order to improve the efficiency, ease of application and cost effectiveness plant protection appliances are being improved time to time.Variable rate of pesticide application depending upon the crop and crop growth stage holds great potential in precision farming with high efficiency of pesticide use and minimise environmental contamination, while application efficiency depends on the accuracy of the discharge rate on the target crop. Many researchers and developers of spraying machines reported that requirement for frequent changing of parts, training of the farmers and the cost of sprayers has defeated their earlier efforts. Therefore, it is imperative to develop sprayers that will overcome these deficiencies. Battery operated high volume sprayers are introduced into the market and are being extensively used by the farmers in recent times. No information is available on the efficiency of these sprayers for use on tobacco crop. Hence, studies were conducted to calibrate battery operated sprayers at variable pressure for spray fluid discharge, swath width and spray angle which are important to obtain optimum coverage and avoid wastage of spray fluid.

MATERIALS AND METHODS

Three types of battery operated high volume sprayers (BOS) viz., BOS (12V/8AH) without pressure regulator, BOS (12V/12AH) with pressure regulator and battery cum hand operated knap sack sprayer (12V/8 AH) with pressure regulator were calibrated for nozzle discharge rate, swath width and spray angle that emitted through single nozzle with four orifices (each orifice diameter 840 – 900 µm), double nozzle (680 x 1050 µm), single nozzle with eight orifices (each orifice diameter 750 - 800 µm) and flat fan nozzle (1860 x 300 µm) at medium and high pressure by using fully charged batteries. Nozzle orifice diameter was measured using image analyser with Prog. Res CT3 software. Discharge rate of spray fluid was measured with a graduated measuring

cylinder by collecting the volume of liquid discharged through nozzle orifice in millilitre per minute. Digital timer was used for timing and the results were recorded. Swath width for spray deposition was measured in a closed room without wind interference. The tank was filled up to ten litres capacity and the sprayer was operated. Swath width and spray angle were measured at 30 and 50 cm height above ground level. Swath width was measured with a meter scale as per Mada *et al., (*2013). The procedure was repeated for four times and means were computed. Based on swath width and spray height, spray angle was computed by applying Sine rule (Sine è = Length of opposite side/length of hypotenuse).

RESULTS AND DISCUSSION

Calibration of battery operated high volume sprayer without pressure regulator (12V/8AH)

The initial discharge rate through different nozzles varied from 1150 (single nozzle with 4 orifices) to 1875 ml/ min (single nozzle with 8 orifices) by using fully charged batteries. Thereafter, with continuous spraying for four hours the discharge rate diminished and showed 1100 and 1775ml/min through single nozzle with 4 orifice and single nozzle with 8 orifice, respectively. Whereas, further spraying beyond 4 hours a drastic reduction in discharge rate was recorded (Table1). Initial swath width (cm) and spray angle (^{O}) that emitted through above four nozzles at 30 cm height varied from 60 to 90 cm and 90 to 110 spray angle, respectively (Table 3). In contrast, at 50 cm height swath width ranged from 70 to 130 cm through different nozzles. Swath width and spray angle was relatively high with flat fan followed by single nozzle with 8 orifices. The swath width and spray angle at 50 cm height was more than that recorded at 30 cm height. Its performance remained satisfactory for 4 hours of continuous spraying.

Calibration of battery operated high volume sprayer (12V/12AH)

The discharge rate under high pressure varied from 1410 to 2275 ml/ min through single nozzle with 4 orifices (1410), double nozzle (1825), single nozzle with 8 orifices (2275) and flat fan nozzle (1510) by using fully charged batteries. Data on discharge rate showed satisfactory performance and varied between 1350 to 2000 ml/ min till four hours of continuous spraying. Thereafter drastic reduction in discharge rate was recorded (Table 1). Swath width emitted through single nozzle with 4 orifice (65), double (90), and single nozzle with 8 orifices (65) and flat fan nozzle (140) at 30 cm height varied considerably and in contrast it was relatively higher at 50 cm height (Table 4). Its performance remained optimum for 4 hours of continuous spraying**.** In contrast under medium pressure initial discharge rate was considerably low as compared to that under high pressure and varied from 1050 to 1400 ml/ min through different nozzles (Table 2) and showed satisfactory performance till 6 hours of continuous spraying**.** Initial swath width (cm) pertaining to different nozzles varied from 50-120 to 60-140 at 30 and 50 cm height, respectively through different nozzles. Later on with continuous spraying optimum performance was recorded till 6 hours (Table 5).

Calibration of battery cum hand operated Knap sack sprayer (12V/8AH)

Calibration studies indicated that discharge rate through different nozzles under high pressure varied from 1200 to 1800 ml/ min through single nozzle with 4 orifices (1200), double nozzle (1650), single nozzle with 8 orifices (1800) and flat fan nozzle (1350) and exhibited satisfactory performance till three hours of continuous spraying (Table 1). Initial swath width at 30 cm height was low and ranged between 50 and 80 cm than that recorded at 50 cm height (65 and 100 cm) and showed satisfactory performance till 6 hours of continuous operation (Table 6). Under medium pressure, the initial discharge rate varied from 975 to 1300 ml/ min and it was relatively low when compared to discharge rate under high pressure through different nozzles and exhibited satisfactory performance till 6 hours of spraying (Table 2). Initial swath width and spray angle emitted through the above nozzles at 30 cm height varied from 45 to 70 cm and 80 to 110 spray angle respectively. In contrast, at 50 cm height swath width was high and ranged from 60 to 90 cm emitted through different nozzles. Swath width and spray angle was relatively high with flat fan

Table 1: Spray fluid discharge rate through battery operated sprayers (BOS)

	BOS without pressure regulator (12V/8AH)			BOS (12V/12AH) under high pressure			Battery cum KS sprayer under high pressure (12V/8AH)		
	Discharge rate ml/ min after								
Nozzle	**Initial**	**4 hr**	**5 hr**	**Initial**	**4 hr**	**5 hrs**	**Initial**	**3 hr**	**4 hr**
Single nozzle with 4 orifice	1150	1100	800	1410	1350	1200	1200	1150	1025
Double nozzle	1575	1500	950	1825	1800	1300	1650	1600	1250
Single nozzle with 8 orifice	1875	1775	1000	2275	2000	1650	1800	1650	1300
Flat fan nozzle	1275	1200	850	1510	1450	1180	1350	1340	1100

Table 2: Spray fluid discharge rate through battery operated sprayer

	BOS undermedium pressure (12V/12AH)			Battery cum KS sprayer under medium pressure (12V/8AH)		
	Discharge rate ml/ min after					
Nozzle	**Initial**	**4 hr**	**6 hrs**	**Initial**	**4 hr**	**6 hr**
Single nozzle with 4 orifice	1050	1000	980	975	975	950
Double nozzle	1280	1225	1175	1275	1100	1050
Single nozzle with 8 orifice	1400	1300	1250	1300	1150	1150
Flat fan nozzle	1075	1050	1000	1050	950	950

Table 3: Swath width as influenced by nozzle height of the BOS without pressure regulator (12V/ 8AH)

		Swath width (cm) and Spray angle (^{o})					
Nozzle	**Height cm**	**Swath width Spray angle Initial**		**After 4 hrs**		**After 6 hrs**	
		Sw	**Sa**	**Sw**	**Sa**	**Sw**	**Sa**
Single nozzle with 4 orifice	30	60	90	45	70	40	55
	50	70		65		50	
Double nozzle	30	85	110	75	100	60	85
	50	110		100		90	
Single nozzle with 8 orifice	30	60	90	50	80	40	65
	50	85		70		60	
Flat fan nozzle	30	90	110	90	110	75	90
	50	130		120		100	

Table 4: Swath width and spray angle as influenced by nozzle height BOS (12V/12AH) with pressure regulator under high pressure

Nozzle	Height cm	Swath width Spray angle					
		Initial		After 4 hrs		After 6 hrs	
		Sw	Sa	Sw	Sa	Sw	Sa
Single nozzle with 4 orifice	30	65	95	65	85	50	80
	50	80		80		65	
Double nozzle	30	90	115	75	100	60	90
	50	110		95		70	
Single nozzle with 8 orifice	30	65	95	55	80	40	65
	50	75		65		50	
Flat fan nozzle	30	140	135	135	130	100	120
	50	150		140		120	

Table 5: Swath width and spray angle as influenced by nozzle height BOS (12V/12AH) with pressureregulator under medium pressure

Nozzle	Height cm	Swath width Spray angle					
		Initial		After 4 hrs		After 6 hrs	
		Sw	Sa	Sw	Sa	Sw	Sa
Single nozzle with 4 orifice	30	50	90	50	75	40	70
	50	60		60		45	
Double nozzle	30	80	105	75	90	60	80
	50	90		85		70	
Single nozzle with 8 orifice	30	60	80	55	70	45	60
	50	70		65		55	
Flat fan nozzle	30	120	120	110	100	90	85
	50	140		120		100	

Table 6: Swath width and spray angle as influenced by nozzle height BO cum KS (12V/8AH) with pressure regulator under high pressure

Nozzle	Height cm	Swath width Spray angle					
		Initial		After 4 hrs		After 6 hrs	
		Sw	Sa	Sw	Sa	Sw	Sa
Single nozzle with 4 orifice	30	50	90	50	80	40	70
	50	65		60		50	
Double nozzle	30	75	110	70	95	60	80
	50	90		90		75	
Single nozzle with 8 orifice	30	60	80	55	75	45	60
	50	75		70		60	
Flat fan nozzle	30	80	120	75	100	70	85
	50	100		100		85	

Table 7: Swath width and spray angle as influenced by nozzle height BO cum KS (12V/8AH) with pressure regulator under medium pressure

Nozzle	Height cm	Swath width Spray angle					
		Initial		After 4 hrs		After 6 hrs	
		Sw	Sa	Sw	Sa	Sw	Sa
Single nozzle with 4 orifice	30	45	80	45	80	40	65
	50	60		60		45	
Double nozzle	30	70	100	70	100	50	75
	50	80		80		70	
Single nozzle with 8 orifice	30	50	75	50	75	40	60
	50	65		65		50	
Flat fan nozzle	30	70	110	70	100	60	80
	50	90		90		80	

Sw= Swath width; Sa= Spray angle

nozzle followed by single nozzle with 8 orifices. The swath width and spray angle at 50 cm height was more than that recorded at 30 cm height. Its performance was found to be optimum for 6 hours of continuous spraying (Table 7).

On critical perusal of data, it is evident that among the three batteries operated sprayers, the discharge rate, swath width and spray angle emitted through BOS (12V/12AH) were relatively high under high pressure and can be operated satisfactorily for four hours. This is in confirmation with Giles *et al.,* (2002), who reported that flow rate and velocity of droplets increased as liquid pressure increased. Further, the droplets travelled at higher speed when liquid pressure increased as a result reached the target earlier. Further, the discharge rate through BOS with 12V/12AH was high as compared to 12V/ 8 AH battery power. Mada *et al.*, (2013) reported that the output of the sprayers depends on the battery strength. It was further evident that swath width and spray angle was high with BOS under high pressure. Similar results were observed by Zhang *et al.*, (1994) and reported that spray angle increased as the pressure increased to all the testing nozzles. This trend is much more distinct with hollow cone nozzles. Battery operated sprayers are more cost effective and gives the effective results with desired battery power and pressure through single nozzle with four orifices on dense canopy crops like tobacco crop 50 days after planting, depending upon the area to be covered in order to obtain better coverage with less drudgery. It can be a practical alternative to the conventional hand operated sprayers. Battery operated sprayers can further be improved by minimizing the weight through use of light weight material and by increasing the duration of battery backup.

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