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Research Paper :

Use of constant pressure valve for manually operated Knapsack Sprayer

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ABSTRACT

The main concern in spraying is dose suitability, uniform distribution and optimum droplet size. The existing spraying devices like pump and diaphragm cannot meet the above spraying criteria. In order to overcome the difficulties arising due to pressure and flow variation, a new accessory called as constant pressure valve was designed and used. Constant pressure valve was tested with manually lever-operated sprayer in Aspee Research Institute Malad (W), Mumbai laboratory to find out its suitability in India condition. The set up consists of Aspee Hi-Tech sprayer (SRP-50) with hydraulic hallow cone nozzle (NMD/S 80 450) and 1 kg/cm^2 constant pressure valve. Constant pressure valve was tested at pressures 1,2,3,4 and 5 kg/cm^2. The observations were taken for discharge rate, spray angle, droplet size and volumetric efficiency of pump. It was observed that input pressure increased from 1 to 5 kg/cm^2 for discharged rate increased from 249 to 259 cc/min. Spray angle of 76^0 was always constant when pressure increased from 1 to 5 kg/cm^2. Droplet size (VMD) decreased 454 to 441 mm and NMD 234 to 216 mm with increasing same input pressure of 1 to 5 kg/cm^2. The volumetric efficiency of pump was in the range of 82.52 to 84.61 %.

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Protection of crops from insects, pests, diseases, and weeds has been the main concern of farmers after having grown it by using costly seed, fertilizer and water. With the advance of the pesticide application technology and the availability of information on it, the farmers interest in improvement of spraying quality has also increased considerably, both among big and small growers.

Knapsack sprayers are very widely used because of its simplicity in construction and operation besides flexibility in interchanging of the tips of the standard cone type nozzles, giving a wide range of spray outputs, pattern and quality at low cost.

However, due to the presence of the hydraulic pressurizing system like pump or diaphragm led to the wide variation in sprays pressure and flow which lead to the variation in discharge, non uniform pattern, distribution, droplet size and finally the less of spray material due to drift in wind. Contamination of operator clothes and body is yet another matter of concern.

In order to overcome the difficulties arising due to pressure and flow variations new accessory such as constant pressure valve was designed and used. Constant pressure valve was launched in order to improve the pesticides application quality by providing product saving amounting to approximately 20 per cent. It does not only gain or increase control over the pressure and flow but also maintain accurate and constant flow with predictable spray pattern and droplet spectrum, which ensure optimum deposition.

METHODOLOGY

Experiments were conducted at Aspee Research Institute Malad (W), Mumbai. Aspee (SRP-50) lever operated knapsack sprayer was retrofitted with 1 kg/cm^2 constant pressure valve made of durable plastic and was easily adapted to Aspee knapsack sprayers fitting between the end of the lance and hydraulic nozzle (NMD/S 80 450). The detailed technical specifications of the knapsack sprayer used with 1 kg/cm^2 constant pressure valve are given in Table 1.

The constant flow valve delivers constant flow at the nozzle because of the unique design of the valve. It was attached to the lance of knapsack sprayers and gives constant flow rate from the nozzle regardless of changing input pressure at or above the pre-set operating pressure of constant pressure valve. It was with a view to find out the suitability of this valve retrofitted to an Aspee lever operated knapsack sprayer testing.

Testing included assessment of the quantity of spray solution and determination of the effect of pressure on atomization by the hydraulic hallow cone nozzle of its discharge rate, spray angle and spray droplet size. Laboratory testing procedure was done to determine discharge rate and number of strokes at different pressure with and without constant pressure valve. The sprayer was rigidly mounted on a test bench as desired with

Table 1 : Specification of lever operated knapsack sprayer

Sr. No.	Particulars	Measurement ASPEE HI-TECH
1.	Type of sprayer	LOK Sprayer
2.	Manufacture	ASPEE
3.	Model	SRP-60
4.	Over all dimension	
	i Length (mm)	478
	ii Width (mm)	175
	iii Height (mm)	470
5.	Tank capacity (liters)	16.0
6.	Weight of sprayer with out water (kg)	5.30
7.	Inside diameter of cylinder (mm)	36.5
8.	Stroke length (mm)	50.8
9.	Volume of pressure chamber filled with water (cc)	900
10.	Type of nozzle used	Hollow cone nozzle (NMD/S 80 450)
11.	Length of lance (mm)	610
12.	Weight of lance + nozzle (kg)	0.25
13.	Length (mm)	1100

suitable clamps and filled to its full capacity. A pressure gauge of range 0 to 7 kg/cm^2 was fitted in the discharge line. The sprayer was operated in left hand mode. The handle was operated manually to maintain a pressure of 1, 2, 3, 4 and 5 kg/cm^2 to measure the number of strokes per minute required to maintain above pressures. The spray was directed into the measuring cylinder of 1 litre capacity and volume of water, collected in 1 minute was measured. The observations are given in Table 2 and 3 without and with this constant pressure valve, respectively.

Spray angle :

Spray angle of hollow cone nozzle (NMD/S 80 450) at the pressure of 1,2,3,4 and 5 kg/cm^2 with and without constant pressure valve was noted with the help of angle measuring instrument. The measuring aid consisted of two flat metal strips hinged at one end. The outer sides of strips were folded at right angle adjusted, so that the spray forms the edges of the two arms uniformly drop by drop. This angle was then measured with protractor and recorded in Table 2 and 3.

Spray droplet size :

Olympus series BH system microscope was used for the study of droplet collected on a white glossy paper. It had a built in light source, the intensity of which could be varied with adjustments provided. The software available for droplet size analysis is *i.e.*, "Image Pro" endorsed by Microsoft windows. Program for spray spectrum analysis was in range of 0 to 1500 mm in GW basic.

Seven samples of glossy paper were placed at different intervals at a height of 50 cm from nozzle spray. Solution of the dye was made in 15 litres of water and filled in the sprayer. The pressure was set at 1,2,3,4 and 5 kg/cm^2 with and without constant pressure valve and spraying was started at speed of 2 kmph and passesed the nozzle once over the samples. Samples were collected after spraying. Then samples were inserted in the computerized particle size analyzer for measuring size of droplets. It consists of a camera through which a sample of droplets could be grabbed into the computer. Magnifying glass was used in between the samples and the camera. The image grabbed into the computer was calibrated and an area of interest was selected for analysis to give the number of droplet in the 0 to 1500 mm range from the data VMD, NMD and Uniformity coefficient were calculated.

RESULTS AND DISCUSSION

Using 1 kg/cm^2 constant pressure valve, the observation for discharge rate, spray angle, droplet size (VMD, NMD and Uniformity coefficient) was noted as shown in Table 2 and 3 for increasing pressures 1 to 5 kg/cm^2. If the input pressure varies from 1 to 5 kg/cm^2 discharge rate was found to be varying from 249 to 259 cc per minute. This gives the minimum percentage increase in the discharge rate of the order 4.02 per cent as compared to without using this constant pressure valve. In case of spray angle it was found that spray angle remained constant at 76^0 with input pressure increasing from 1 to 5 kg/cm^2. The droplet size (VMD) decreased from 454 to 441 m and NMD decreased from 234 to 216 mm when the pressure was increased 1 to 5 kg/cm^2. Uniformity coefficient of 1.9 to 2.0 also remained constant. These data indicate that the use of constant pressure valve along with the nozzle improved the performance of knapsack sprayers, the economy in spraying operation by keeping discharge rate of sprayer more or less constant at 4.02 per cent. They are able to bring an improvement in the droplet size which are responsible for proper deposition of the pesticide on the target and also avoiding wastages due to drifts and spills. Realizing the fact that the use of constant pressure valve was beneficial in view of quality, quantity and economic point of view, it was considered suitable for use in the knapsack sprayers. This valve is very easy to fit with the

Table 2 : Observation taken for Aspee Hi-Tech Sprayer (SRP-60) without constant pressure valve

Sr. No.	Pressure (kg/cm^2)	With out using constant pressure valve					
		Discharge rate (cc/min)	Spray angle (degree)	Volumetric efficiency (%)	Droplet size		
					VMD (µm)	NMD (µm)	Uniformity coefficient
1.	1	291	76	90.91	471	209	2.2
2.	2	363	77	86.76	369	160	2.3
3.	3	449	79	85.85	344	147	2.3
4.	4	520	82	84.55	299	130	2.3
5.	5	555	83	82.90	276	115	2.4

Table 3 : Observation taken for Aspee Hi-Tech Sprayer (SRP-60) with 1 kg/cm^2 constant pressure valve

Sr. No.	Pressure (kg/cm^2)	With out using constant pressure valve					
		Discharge rate (cc/min)	Spray angle (degree)	Volumetric efficiency (%)	Droplet size		
					VMD (µm)	NMD (µm)	Uniformity coefficient
1.	1	249	76	82.66	454	234	1.9
2.	2	251	76	83.32	452	232	1.9
3.	3	254	76	84.61	450	225	2.0
4.	4	257	76	82.72	445	218	2.0
5.	5	259	76	82.52	441	216	2.0

nozzle and simple in construction. Similary type of investigation has been also carried out by BIS (1982); Paulo (1999) and Tayade (2001).

Conclusion:

After conducting the experiment and taking down all the reading the use of 1 kg/cm^2 constant pressure valve in line with nozzle showed the marked improvement in reducing the discharge rate only 4.02 per cent. The volumetric efficiency also remained high about 84.61 per cent. Using this constant pressure valve, the quality of spray is represented by spray angle and droplet size was more or less constant as compared to without constant pressure valve by increasing same input pressure from 1 to 5 kg/cm^2.

The use of this flow control device along with the nozzle were effective in getting economic spraying by reducing the extra pressure which builds up in down stroke of lever causing over discharge of pesticide solution.

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