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PERFORMANCE OF A HAND OPERATED ROTARY SPRAYER

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ABSTRACT

A hand operated rotary sprayer was fabricated by using locally available materials such as G.I. sheet, wood, rope and plastic tube. Performance studies were carried out at different throughputs and spraying heights at normal walking speed. The field capacity of the sprayer was 0.49 ha/hr or 16.6 l/ha at spraying height of 50 cm, nozzle speed of 2000 rpm, working speed of 2 km/hr, and spray discharge was 133.5 ml/min. The lateral distributions of the spray liquid from the rotary sparyer were measured. It was observed that about 65 % of the total spray output was deposited within the radius of 50 cm of the rotary nozzle. The spray deposition in different heights on paddy plants was measured. The maximum deposition was found at the top of the plant. During spraying operation pulse and respiration rate of operator were recorded. The spraying cost was about US$ 3.5/acre.

INTRODUCTION

Chemical application is necessary to protect field and horticultural crops from the pest and diseases. Chemical application is reliable and quick (Hussain, *et al.,* 1989). The major reasons for less use of pesticides or insecticides in Bangladesh are non availability of a suitable spraying machine (Hussain & Moser, 1986). At present, some sprayers are available in the market and are being used in the field. The price of these sprayers is very high and the farmers can not buy them.. Besides, farmers do not know the techniques of repairing and maintenance and over all technical know how.

So, a hand operated low cost rotary sprayer having easy access in repairing and maintenance should be available at the farmers level to protect the crops. Only then the farmers will be interested to have their own sprayer. Considering the above points in mind, a hand operated rotary sprayer was fabricated in the Department of Farm Power & Machinery with the following objectives :

(i) to test and evaluate the sprayers at laboratory and field condition,

(ii) to carry out the ergonomic studies.

DESCRIPTION OF THE SPRAYER

The different parts of a manually operated rotary sprayer are shown in Fig.1. The spray liquid from the tank (A) flows on a rotating disc (F) through a plastic tube (G) and liquid was atomized by the centrifugal force of the disc (F). The tank (A) of the sprayer was made of m.s. sheet and its capacity was about 10 liters. The control key (D) controlled the rate of discharge. The shaft of the rotor (E) was made of mild steel rod having 25.4 mm in diameter and 100 mm in length. One end of the shaft was fixed with a main frame(B) on a ball bearing and

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the other end was threaded to use the disc. The disc was rotated with the help of a big wooden wheel and a rope. A wooden wheel (C) of diameter 250 mm and thickness of 30 mm was fixed on the wooden frame with a ball bearing. The different views of the rotary nozzle (F) is shown in Fig.2. The control key (D) can be changed in three positions such as 1, 2, 3 to vary the discharge.

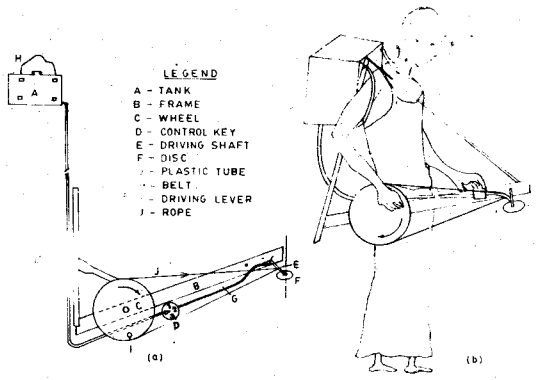

Fig.1 (a) Different parts of manualy operated rotary sprayer (b) operating condition

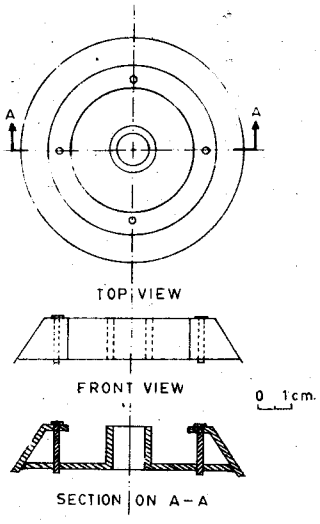

Fig.2 Different views of rotary nozzle.

METHODOLOGY

A wheel made of wood was used to provide rotational speed to the shaft of the disc with the help of a rope. The rpm of the wheel was recorded by counting the number of the turn per minute during operation. The disc speed was calculated by using the following equation.

$$N_N = \frac{N_W D_W}{D_N}$$

where, N_N = RPM of the driven shaft.
N_W = RPM of the driving wheel.
D_N = Diameter of the driven shaft.
D_W = Diameter of the driving wheel.

Lateral distribution of spray deposit over the filter papers having 5 x 5 cm in size was measured. The filter papers were placed side by side upto a length of 200 cm on a table for receiving the spray deposit.

The field capacity of the sprayer was recorded for different spraying heights, discharges and working speed. The spraying time was recorded by a digital stop watch.

Some filter papers were placed from top to bottom of the plant.After spraying, the filter papers were collected and washed them by distilled water containing 0.3% methanol. A self balancing turner fluorometer was used to quantify the target deposition.The relative humidity, dry bulb temperature were measured by a digital hygrothermometer.

Some ergonomic studies were carried out for the hand operated rotary sprayer. The effect of spraying time on forward speed, heart bit, rpm of nozzle and respiration rate were studied. The weight of the operator was measured by weighing machine. The age of the operator was also recorded during field work. The forward speed of the operator, nozzle speed, heart bit and respiration rate

were recorded at an interval of 30 minutes. The pulse rate was recorded by crude method normally by hand touch procedure. The respiration rate was found out by counting the movement of hair placed in front of the nose. The linear distance was measured by a meter tape.

RESULTS AND DISCUSSION

The throughput of the nozzle at different settings of the control key was determined in the laboratory condition. The key could be set on 1, 2 or 3 position in the control panel of the sprayer. The discharge rates for the three positions 1, 2, 3 were 41.7, 110.5 and 133.5 ml/min respectively. Field capacity in liter per hectare and hectare per hour were found out for different discharge rates. Two heights of the nozzle position such as 25 cm and 50 cm above the ground were used in the experiments. The experimental result is shown in Table 1. The distribution of spray drops of the rotary sprayer is presented in Fig.3. It was observed that the width of spraying was about 200 cm. At the centre of spraying disc, the spray deposit was about 2.75% of the output. The spray deposit increased linearly upto the distant of 50 cm on all sides of the disc and then decreased very sharply to 0.1% of the output upto distant of 1m to all sides.

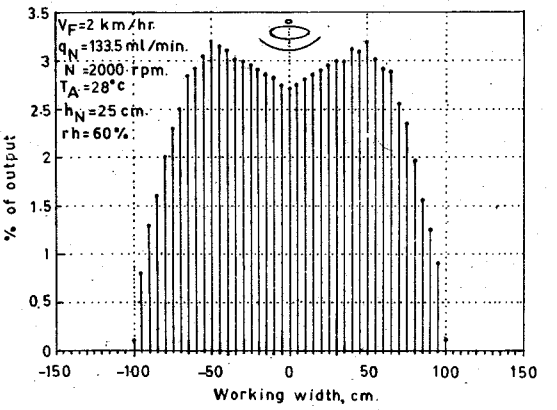

Fig. 3: Lateral distribution of spray from the sprayer, V_F = Forward speed, q_N = discharge, N = RPM, T_A = Air temp, h_N = Nozzle height, rh = relative humidity.

A field experiment was conducted on a paddy field.. The height of spraying was 25cm and the control key position was at 3 during spraying. The filter papers were positioned on the plant of different heights. The spray deposition obtained at different heights is shown in Fig.4. At the top of the plant the deposition were higher than the bottom of the plant.

Table 1. Field capacity of the sprayer at different spraying heights and discharge rtaes

Spraying height (cm)	Average forward speed (km/hr)	Average nozzle speed (RPM)	Average discharge rate (ml/min)	Field capacity (l/ha)	Field capacity (ha/hr)
25	2.0	1990.	41.7(1)	6.9	0.36
25	1.9	1990	10.5(2)	7.7	0.37
25	2.0	2000	133.5(3)	21.1	0.38
50	2.0	1990	41.7(1)	5.6	0.45
50	2.0	2000	110.5(2)	13.8	0.48
50	2.0	2000	133.5(3)	16.6	0.49

1, 2, 3 represent control key position

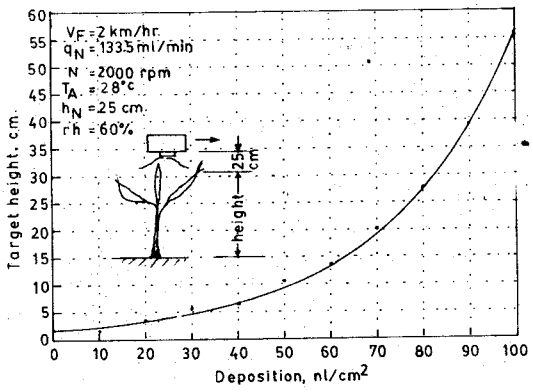

Fig.4 Spray deposition in paddy plant in different heights.

The ergonomic studies were done in the morning from 8.00 A.M. to 12.00 noon and in the afternoon from 2.00 P.M. to 6.00 P.M. The age and the weight of the operator were 22 years and 50 kg respectively. The statistical analysis of different ergonomic studies have shown in Table 2. The effect of operating times on pulse rate and respiration rate is presented in Fig.5. Both the pulse rate and respiration rate were increased with increasing the operating time.

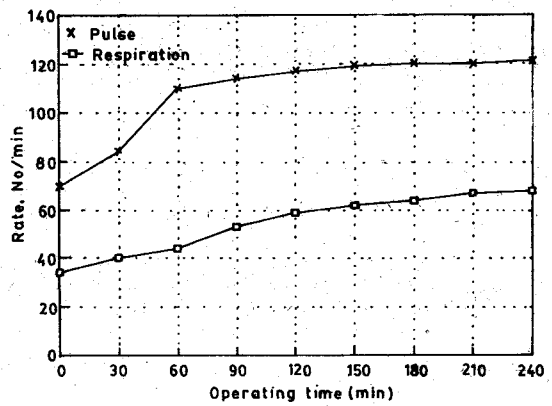

Fig. 5 Effect of operating time on operator's Pulse & respiration rate

Table 2. Pulse and respiration tate of sprayer operator

Time (min)	Forward speed (Km/hr)	Nozzle speed (rpm)	Pulse rate ((No./min)	Respiration rate (No./min)
00	2.30	2012.00	70.00	34.00
30	2.25	2010.00	84.00	40.00
60	2.20	2008.00	110.00	44.00
90	2.10	2005.00	114.00	53.00
120	2.00	2000.00	117.00	59.00
150	1.90	1998.00	119.00	62.00
180	1.85	1995.00	120.00	64.00
210	1.80	1993.00	120.00	67.00
240	1.70	1990.00	121.00	68.00
Avg.	2.01	2001.22	108.33	54.56
Sd	0.20	7.44	17.38	11.78
Maxi.	2.30	2012.00	121.00	68.00
Minm.	1.70	1990.00	70.00	34.00
Cv.	0.04	55.28	302.00	138.69

Fig.6 describes the influence of operating time on the forward speed of the operator. It was observedthat the forward speed decreased with increasing the working period.

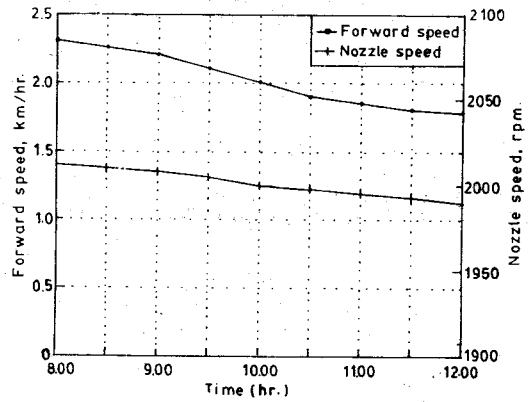

Fig. 6 Effect of operating time on forward speed & nozzle speed

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