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Field evaluation of tractor operated boom sprayer of cotton crop

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■ **ABSTRACT :** India is second largest producer of cotton in the world though the yield is only 440 kg/ha as against the world average of 667 kg/ha, due to poor control of insect pest and dry land farming conditions. During pesticide application most of the pesticide is lost through drift. A major reason for such a pesticide loss is insufficient nozzle pressure, nozzle discharge, nozzle height etc. Hence, it is necessary to determine the optimum discharge rate and pressure so as to reduce the pesticide losses from the sprayer. Therefore, the hydraulic boom sprayer was tested in the field for cotton crop to study effect of nozzle discharge rates (*viz*., 0.45, 0.70, 0.90 and 1.35 l/min) and nozzle pressures (*viz*., 275.8, 413.7, 551.6 and 689.5 KPa) for spray uniformity. From the study it was found that nozzle discharge rate of 0.90 l/min and nozzle pressure of 689.5 KPa produced more uniform spray with droplet size of 125.55 to 287.50 µm, droplet density of 18 to 30 drops/ cm^2 and uniformity coefficient of 0.96 to 1.20.

■ **KEY WORDS :** Boom sprayer, Nozzle discharge rate, Nozzle pressure, Spray deposition

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Cotton crop is concentrated in semi arid regions of the country. More than sixty per cent production is contributed by three states alone namely Gujarat, Maharashtra and Andhra Pradesh. Cotton is one of the principal commercial crops in India with 9.5 million ha cultivated area which is largest in the world. India is second largest producer of cotton in the world though the yield is only 440 kg /ha as against the world average of 667 kg/ha due poor control of insect pest and dry land farming conditions. Cotton plays an important role in the national economy providing large employment in the farm marketing and processing sectors. Although, there has been a significant growth in production, productivity and quality of Indian cotton during the last 50 years, it is way below the average world productivity and far below the general quality requirements.

A major reason for such a pesticide loss is insufficient nozzle pressure, nozzle discharge, nozzle height etc. Hence, it is necessary to determine the optimum discharge rate and pressure so as to reduce the pesticide losses from sprayer. Therefore, the hydraulic boom sprayer was tested using droplet analyzer in the field for cotton crop to study effect of nozzle discharge rates (*viz*., 0.45, 0.70, 0.90 and 1.35 l/ min) and nozzle pressures (*viz*., 275.8, 413.7, 551.6 and 689.5 KPa) on spray uniformity.

■ METHODOLOGY

A 12 m tractor mounted boom sprayer (Table 1) was selected for study and its performance was evaluated in the field. The power for the operation of the boom sprayer was supplied by the power take-off (PTO) shaft of the tractor. For spray deposition on cotton crop independent variables were nozzle discharge rates 0.45, 0.70, 0.90 and 1.35 l/min and the pressures of nozzle were 275.8, 413.7, 551.6 and 689.5 KPa selected for study. The experiment was replicated three times under field condition on cotton crop.

Table A : Specifications of the boom sprayer

Technical descriptions	Boom sprayer
Tank capacity, lit	400
Working pressure, KPa	689.5
Maximum pressure, KPa	2758
PTO rpm	540
Minimum hp required	35
Gross weight of sprayer, kg	270
Size of sprayer (L × W × H), mm	1364x1000x1212
Application rate, lit/ha	580
Type and number of nozzles used	Plastic Hollow cone, 25

Experimental set-up :

The set up used in the field for evaluating the

performance of hydraulic boom sprayer is described as under. The performance of the boom sprayer was measured in terms of spray deposition *i.e.* droplet size, droplet density and uniformity coefficient.

Preparation of the sprayer:

A 12 m boom sprayer was mounted on a 35 Hp tractor with the help of three point linkage. A v-belt pulley of sprayer was connected to the tractor P. T. O. unit with universal joint. Royal blue indigo dye was mixed with water to prepare a colored spray solution. The chemical tank of the sprayer was filled with prepared colored spray solution.

Preparation of the field:

The plot size of 100x100 m was selected to evaluate the spray deposition of the boom sprayer on cotton crop. Two poles were erected at a distance of length 25 m and width of 12 m. Three glossy papers were stapled on each position *i.e.* Top, middle and bottom of the plant at a interval of 5 m, to observe the deposition of the droplets. After making all adjustments, set-up of the equipment was run for 30 minutes before actually starting the experiment.

Field performance of boom sprayer on cotton crop:

The experiment was performed on Tansa farm, ASPEE, Agricultural Research and Development Foundation, Mumbai during September 2011. The sprayer was operated through a selected 25 m length of field. In order to achieve uniform exposure of crop to the spraying the set up was started 3m before the canopy and was collected on the sample cards of glossy paper of size 62 mm x 44 mm. After the experiment, the sample cards were carefully removed and then taken for further analysis in the laboratory. The tractor operated boom sprayer in operation on the field is shown in Fig. A.

Fig. A : Tractor operated boom sprayer in operation

Instrument used to analyze the droplet spectrum:

Digital image analyzer was used to determine stain diameter and droplet size which analyze these samples after 24 hours of application to ensure that droplets had stopped spreading. 'Image pro plus' most powerful electronic imaging program was used for analysis of glossy paper. The advanced image processing features of the program are provided through the Microsoft Windows, consisted of microscope connected to computer software through Graphical interface card, which enable us to directly visualize the image on computer screen. These images were then processed in a computer which directly gave droplet size and droplet density.

Data analysis:

The data obtained in different experiments were stored in M.S. Excel and statistical analysis was conducted. The image-pro program was used to calculate the VMD and mean diameter of the droplet spectrum collected on the sample card at a specific location. The data were analyzed on computer using factorial CRD statistical software packages.

After analyzing the data, a set of independent variable giving optimum value of droplet density and size were selected.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Field performance of the boom aprayer:

Different experiments were conducted in the field to evaluate the performance of the sprayer. They are discussed as follows:

Effect of nozzle discharge rates and pressures on droplet size (VMD), droplet density (DD) and uniformity co-efficient (UC) of boom sprayer :

Effect on droplet size (VMD) :

The VMD of boom sprayer varied from 125.55 µm to 287.50 µm at nozzle discharge rates of 0.45, 0.70, 0.90 and 1.35 l/min and nozzle pressure of 275.8, 413.7, 551.6 and 689.5 KPa. The smallest droplet size was at the nozzle pressure of 689.5 KPa and nozzle discharge of 0.90 l/min and the largest size was at a nozzle pressure of 275.8 KPa and discharge rate of 0.45 l/min. The droplet sizes (VMD) were very close to the effective range of 150 µm to 250 µm (Mathews, 1979). The droplet size for top upper and top lower plant position were found as 181.55 µm and 174.47 µm, bottom upper and bottom lower were found as 172.80 and 169.71, whereas for bottom upper and bottom lower these were 165.68 µm and 155.44 µm. Fig. 1 shows the droplet size for three different locations. Optimum droplet size (*i.e.*

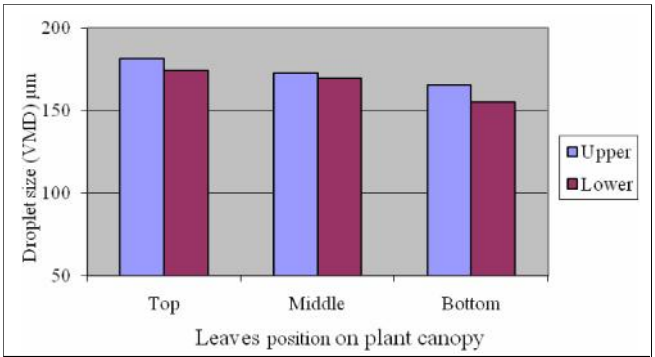

Fig. 1 : Droplet size at three position of the plant for nozzle discharge rate of 0.90 l/min and pressure 689.5 KPa for boom sprayer

between 150 to 250 µm) was obtained for nozzle discharge rate of 0.90 l/min and nozzle pressure of 689.5 KPa.

Effect on uniformity co-efficient (UC):

The uniformity coefficient of sprayer was found in the range 0.96 to 1.20. The uniformity coefficient for top upper and top lower plant position were 1.23 and 1.23, middle upper and middle lower were 1.20 and 1.13, whereas for bottom upper and bottom lower plant position these were 1.12 and 0.99. Fig. 2 shows the uniformity co-efficient of boom sprayer for 0.90 l/min nozzle discharge and 689.5 KPa operating pressure.

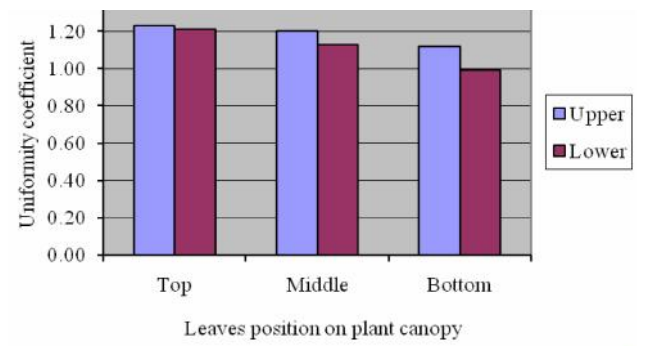

Fig. 2 : Uniformity coefficient at three position of the plant for nozzle discharge rate of 0.90 l/min and pressure 689.5 KPa for boom sprayer

Effect on droplet density (DD):

The droplet density of boom sprayer varied from 18-30 drops/cm^2. The droplet densities for top upper and top lower position were 29 and 23 drops/cm^2, middle upper and middle lower position were 20 and 19 drops/cm^2, whereas for bottom upper and bottom lower plant position these were 19 and 17 drops/cm^2. Fig 4 shows droplet density for various plant positions.

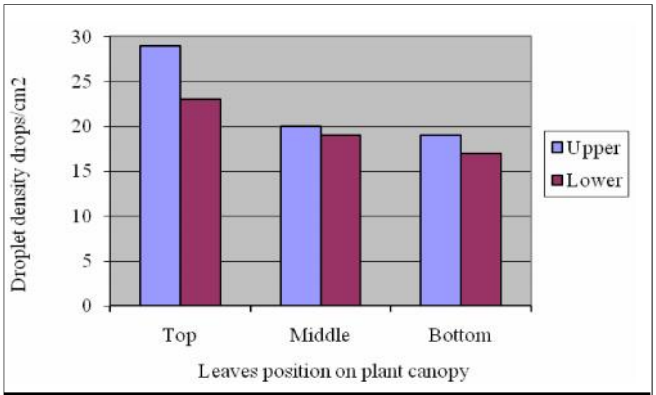

Fig. 3 : Droplet density (DD) at three position of the plant for nozzle discharge rate of 0.9 l/min and pressure 689.5 KPa for boom sprayer

Conclusion:

From the results following conclusions are drawn:

– Droplet size (VMD) of the boom sprayer varied from 125.55 to 287.50 µm.

– Droplet density (DD) of the boom sprayer varied from 18 to 30 drops/cm^2 .

– The uniformity co-efficient of the boom sprayer varied from 0.96 to 1.20.

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