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SPRAYING WITH ELECTROSTATIC CHARGING FOR EFFICIENT PESTICIDE APPLICATION

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ABSTRACT

Some parameters of electrostatic charging of spray drops which influence the amount of spray deposit and drift are discussed. Methods of spray drop charging and spray current measurement have been outlined. Spray deposit increased with charged sprays and simultaneously the drift was reduced. As a result environmental pollution from spray application was very less.

INTRODUCTION

Drift causes environmental pollution which ultimately hampers the normal life of human, animal, fishes and to some specific crops (Adam, 1977; Lee, 1976). In traditional method of spraying at least 80% sprays go to unwanted places which is called chemical loss or drift (Mathews, 1982; Hussain and Alam, 1991). The drift may be in air or soil. Air drift pollutes a long distances from spraying target and soil drift which is carried by rain water, pollutes water bodies causing problems in fish culture. Therefore, safe spraying is needed which is possible by selecting proper time and use, optimum wind velocity in the field, appropriate nozzle type and pressure, flow rate, height of spraying, optimum drop size and electrostatic spraying.

Spray deposit on a target can be achieved upto 90% of spray drops by electrostatic spraying and drifting amount can be reduced very significantly (Hussain, 1984; Law, 1978; Hussain and Kleisinger, 1992; Hussain, 1986; Moser and Hussain, 1992). Electrostatic spraying is possible by three methods such as Contact Charging, Corona Charging and Induction Charging. Contact and Corona Charging require very high voltages and Induction Charging requires charging voltages ranging from 1 to 10 kV. Contact Charging requires very high technology in insulation. Current in the Corona and Induction Charging is very small ranging from 10 to 200 μA level. Performances of Corona and Induction Charging on spray deposit and drift are described.

MATERIALS AND METHOD

This work presented here is the outcome of laboratory and field work carried out in Germany. Knapsack sprayer having an air shear nozzle was used in the experiment.

A knapsack sprayer with an air shear nozzle (Fig.1) was used in the experiment. Corona and Induction Charging unit were installed with the sprayer to charge the spray drops. Charging voltages 5 to 30 kV for corona and 1 to 10 kV for Induction charging were used. High voltage was supplied from a high voltage generator having a proper voltage regulation system. Voltages higher than 20 kV were obtained from a pencil type commercially available generator. The low voltage (12V, DC) was supplied from car's

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battery. The schematic diagram of the charging system is shown in Fig.2. The spray current was measured by using a method as shown in Fig. 3. Electrode voltages were monitored with a high voltage probe. The current in the range of micro-ampere level was measured by a digital multimeter. The liquid pressure above atmosphere was monitored with an electronic pressure transducer. The flow rate through the nozzle was measured by using a graduated cylinder and time was recorded with a digital stop watch. The charge to mass ratio was calculated from the spray current and flow rate of nozzles. Fluorescein tracer element (BSF = Brilliant Sulpho Flavine) was used to prepare the spray solutions. The sprayed targets were washed with the de-ionized water and the amount of fluorescein material was quantified using a programmable fluorometer. Photocrometric filter paper was used to receive the spray deposit and plastic tubes having 2 mm outside diameter was plastic tubes having 2 mm outside diameter was used to receive the drifted spray particles. An axial flow blower was used to supply air to the spraying unit during the experimentation

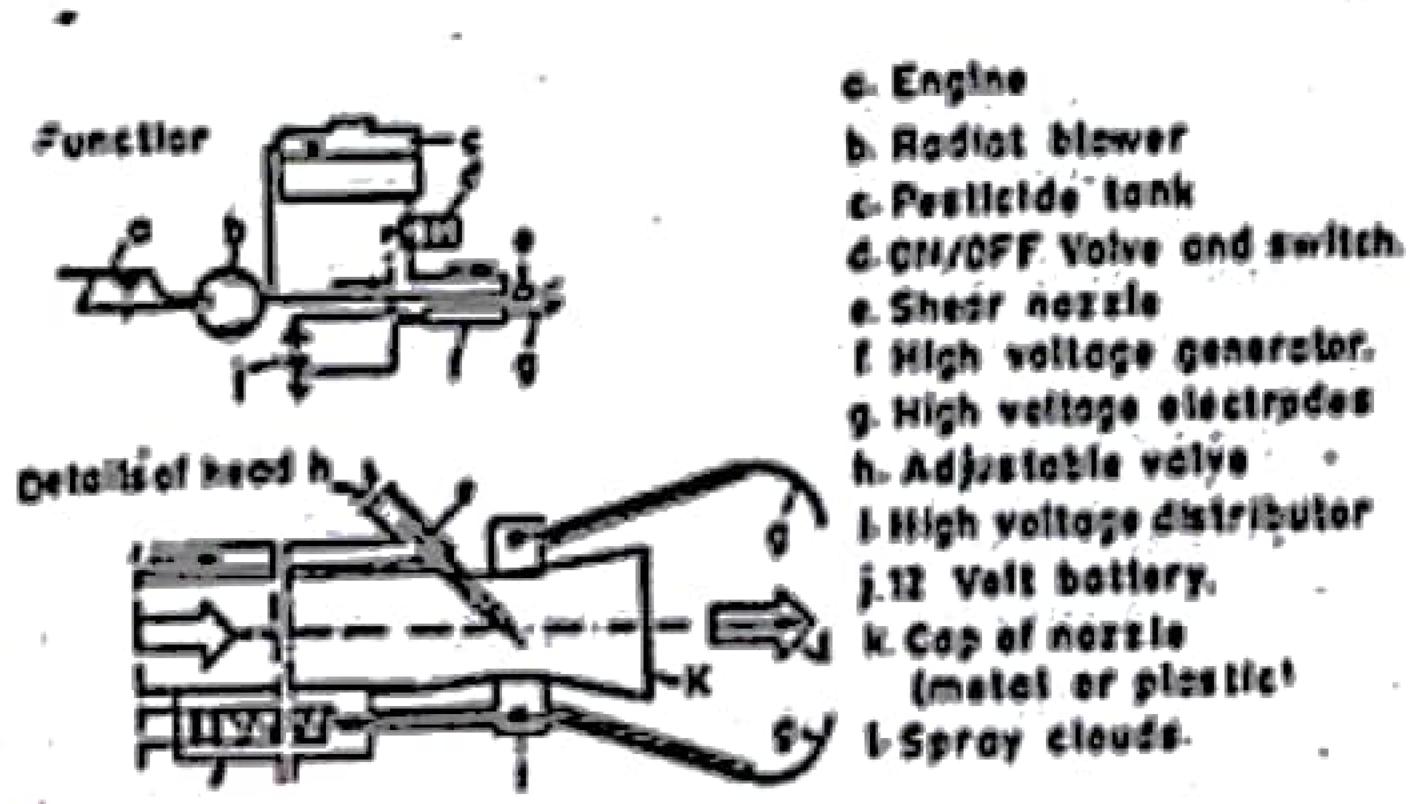

Fig. 1 The schematic diagram of the functions and details of a Knapsack sprayer.

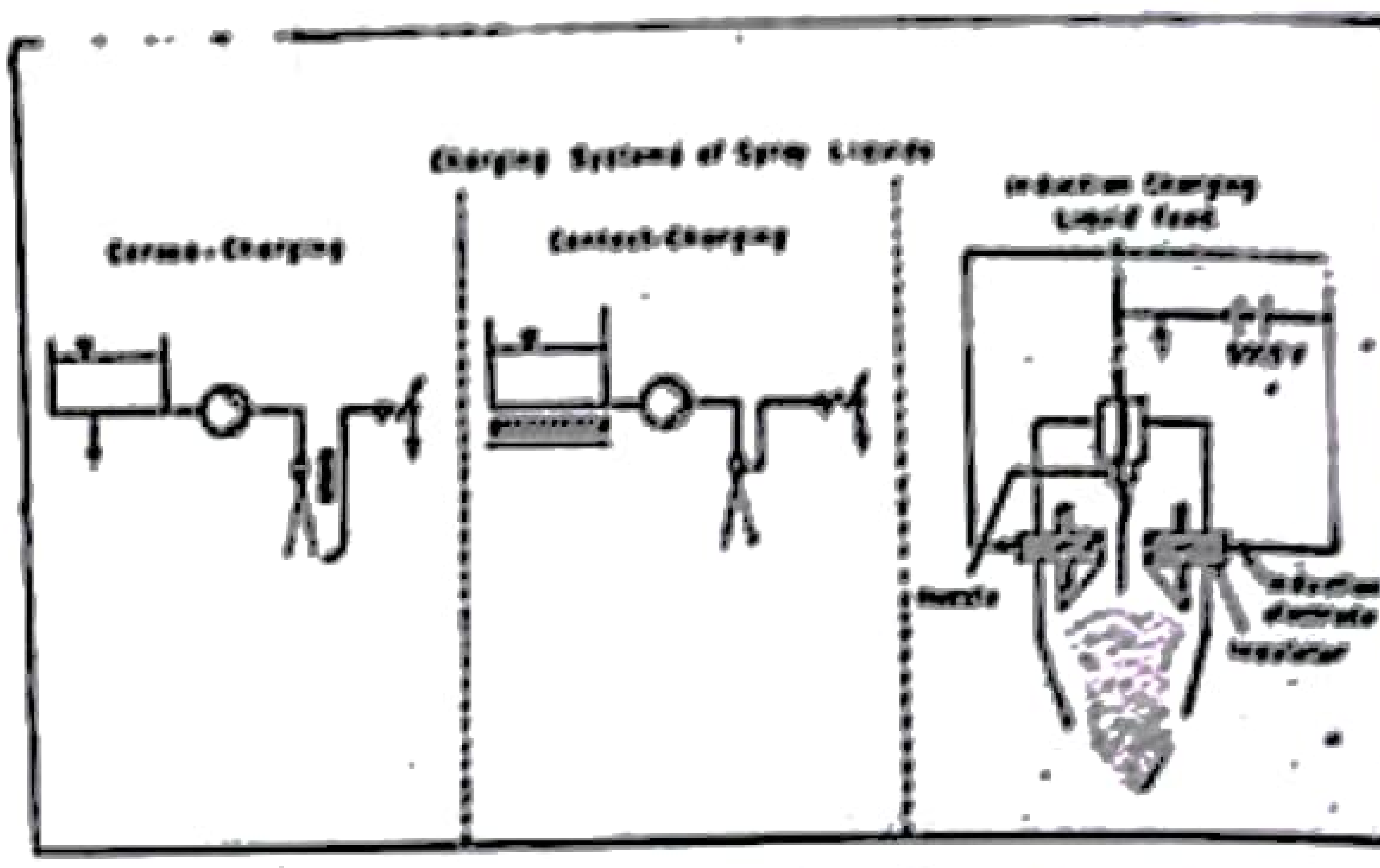

Fig 2 Methods of electrostatic charging systems.

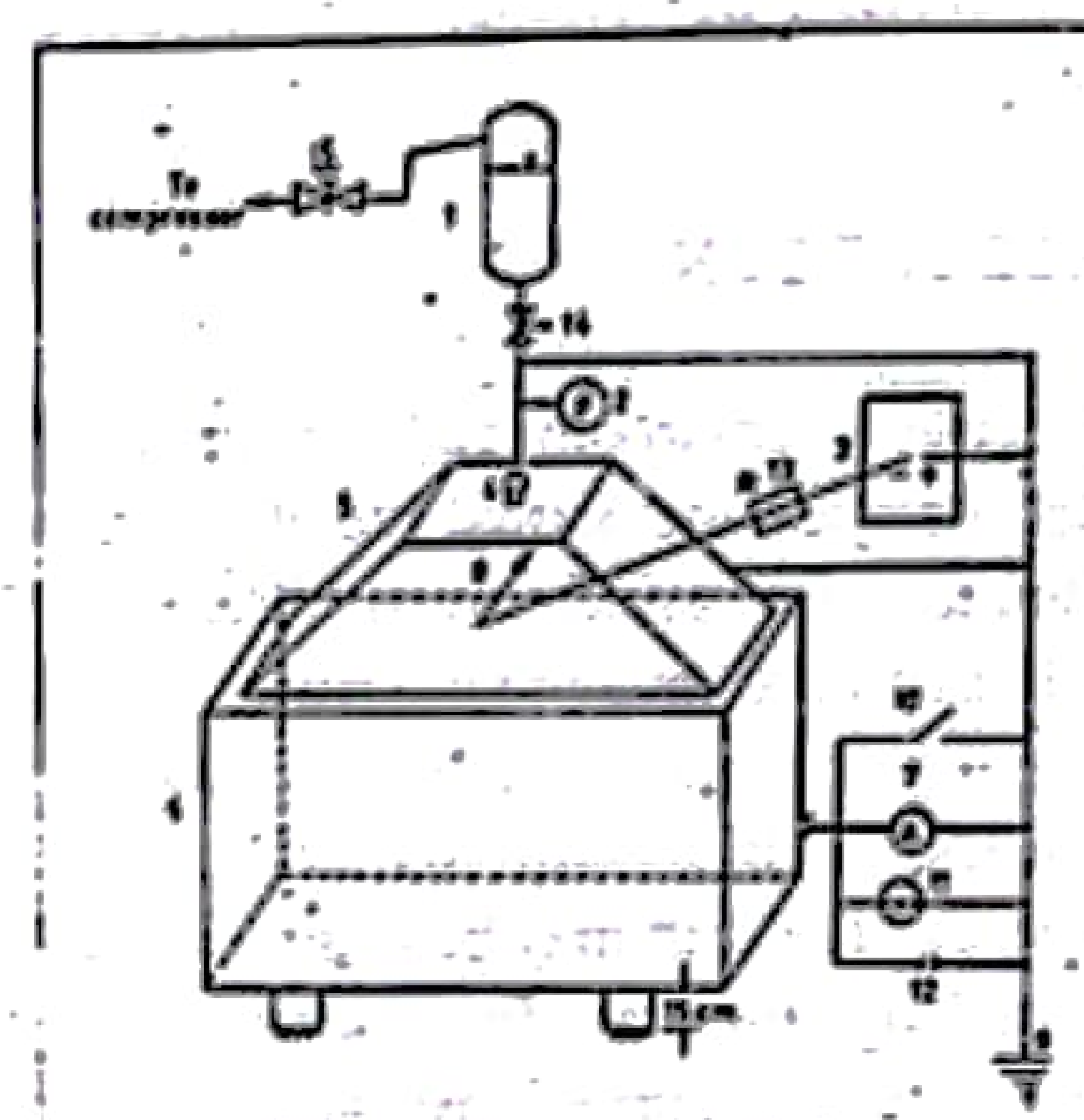

Fig 3 Schematic experimental set up

A test rig was used to hold the nozzle at desired height and provide the required driving velocity to the sprayer. A fan type digital anemometer was positioned to determined the cross wind speed at the position of the nozzle. Temperature and humidity was measured by using a combined thermo-hygrometer. Iso-kinetic drift monitoring equipment was used to measure the drifting spray drops. A portable meteorological station was constructed in the field to measure the meteorological data.

The stability ratio of atmosphere in the field was computed from the following relation[10].

$$S.R = (T_1 - T_2)/V_w^2$$

where

T_1 = Temperature at 12.0 m in °C

T_2 = Temperature at 2.5 m in °C

V_w = wind velocity at 7.5 m in m/s

High S.R values indicate very stable, near zero values indicate neutral condition and negative values indicate turbulent condition.

RESULTS & DISCUSSION

Laboratory test:

Spray drift test:

The spray drift was measured at different cross wind speeds. The experimental results are shown in Fig. 4. In all charging method, the weight of spray particles increased with an increase in the cross wind speed. At a cross wind speed of 3 m/s, the spray drift was less than 3 % of the total throughput of the nozzle. At a cross wind speed of 4 m/s, the spray drift increased very rapidly. At a cross wind speed of 5 m/s, the uncharged method had more than 7% spray drift, Contact charging 3%, corona charging 4.4% and the induction charging method 4.7%. The charging method had lessened the weight of spray drift by increasing the deposit. As a normal practice, the spraying operations should be conducted where the wind speed remains below 3 m/s in the field.

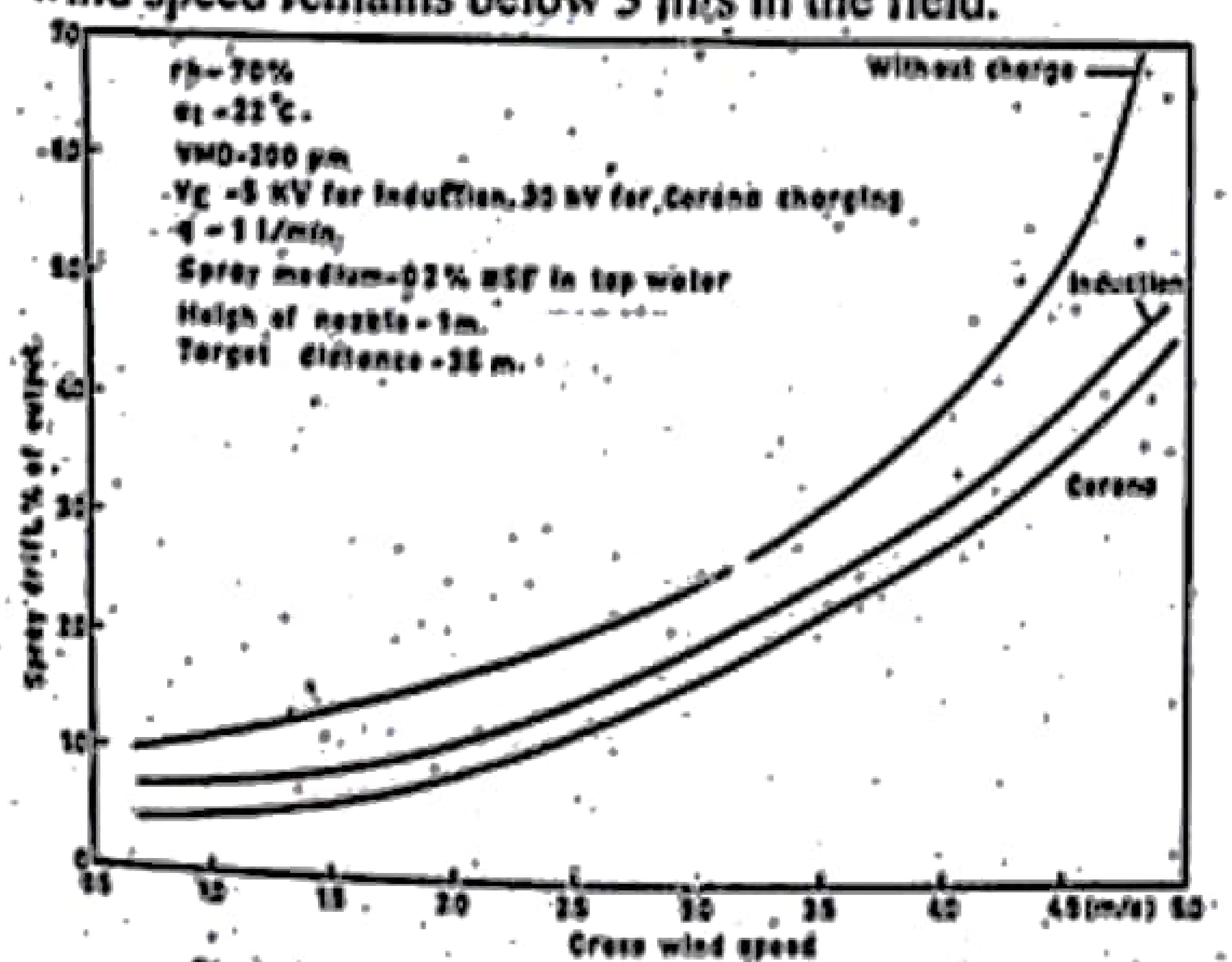

Fig. 4 Spray drift from charged and uncharged nozzle.

Effect of charge to mass ratio:

The effect of charge to mass ratio on the weight of spray deposit and drift was studied and the results are shown in Fig. 5. In this case, the charge to mass ratio for different charging voltages was determined and the corresponding weight of spray deposit and weight of spray drifts at constant air speed (3 m/s) were measured. It was observed that when the charge to mass ratio was increased by increasing the charging voltage, the corresponding wt. of spray deposit on the target increased and simultaneously, the weight of spray drift reduced very significantly. At low charge to mass ratio the weight of spray deposit obtained was not very different as spray deposit obtained by the uncharged method of spraying. But on the other hand, the drifted spray weight was nearly 4 times of spray deposit at low charging voltage.

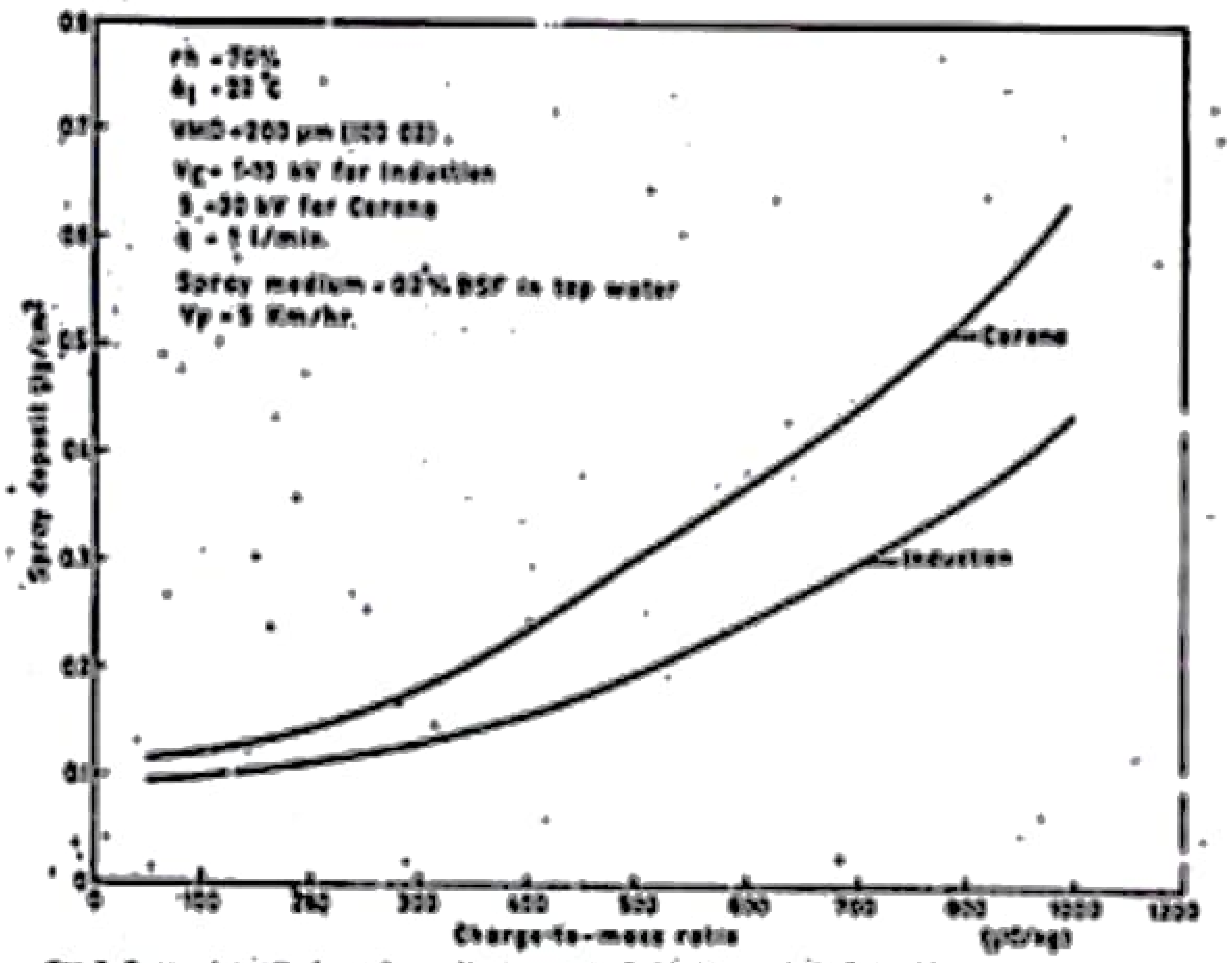

Fig. 5 Spray deposit depends on the amount of charge-to-mass ratio and charging methods.

Field experiment:

Spray deposit on soil:

Due to the insulation problems with contact charging method, spray liquids were charged by corona and induction charging method. A standard spray solution of 0.2% BSF diluted in tap water was used for the field test. This experiment was carried out to examine the influence of different operating conditions on the amount of deposition on soil, vertical stands and drift encountered at different distances from the sprayer.

The highest deposit was recorded by corona charging method within one meter of spraying nozzle. The deposit became less as distance was increased. The reason was that the charged spray drops looked for the nearest conducting surfaces for deposition. The electrostatic force on small drops governed their path of movement or flight onto only a few meters from the spraying nozzle. The uncharged small drops, owever, were carried many meters away from the nozzle as long as the travelling velocity was higher than the downward velocity (until the drops touched the target). Fig. 6. shows that the deposition obtained in the corona and induction charging is nearly 2-3 times higher than the uncharged method of spraying.

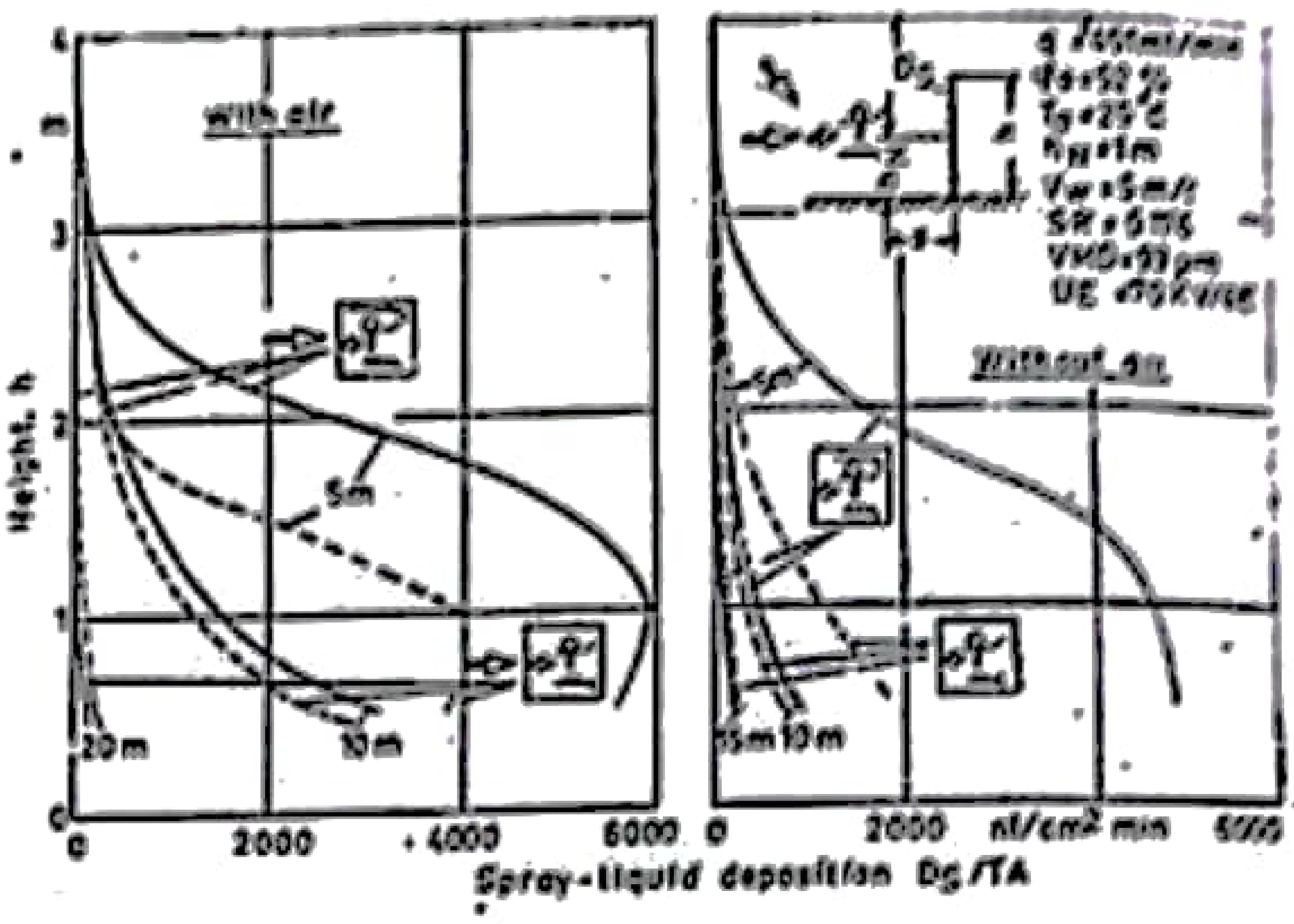

Fig.7 Spray deposit on vertical stands

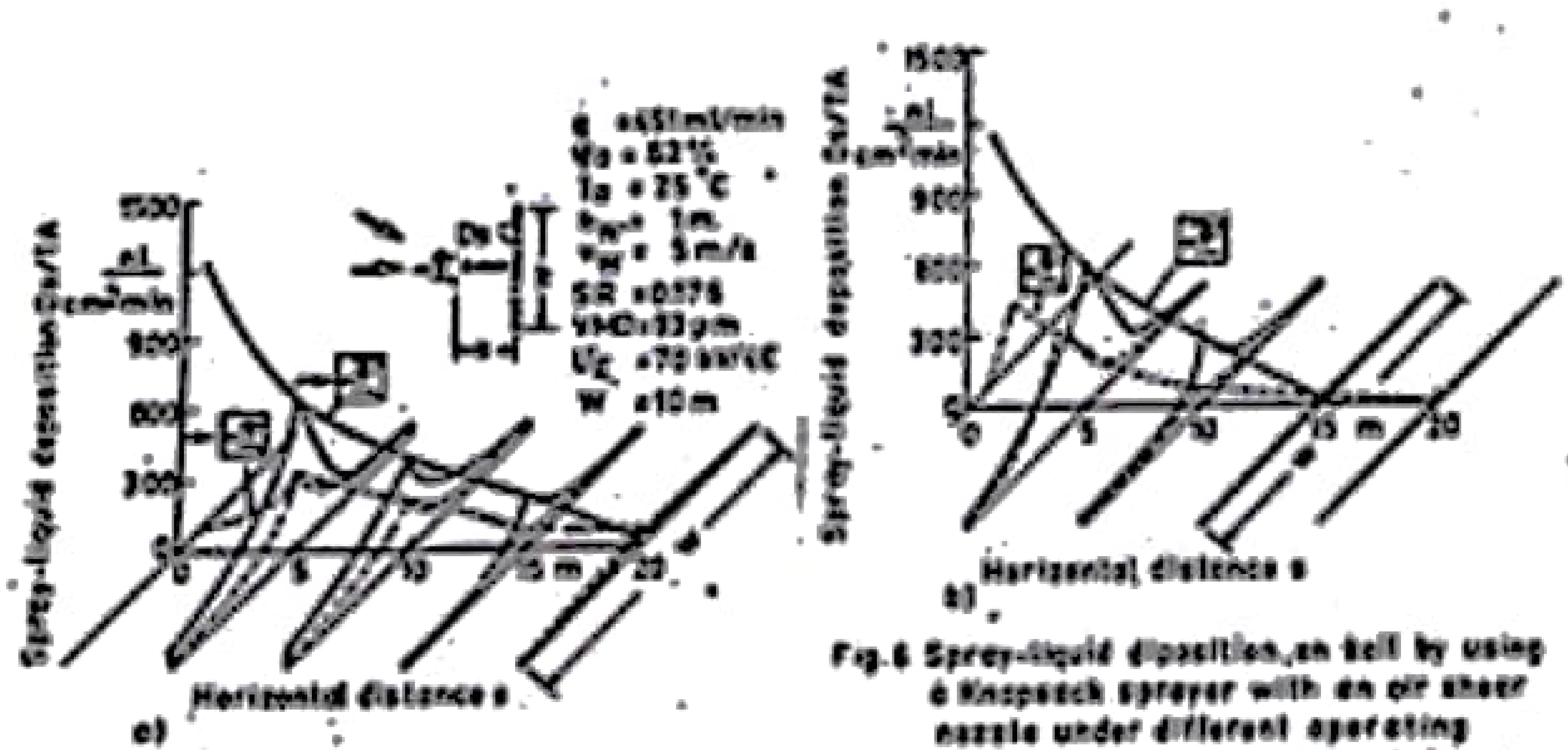

Fig.6 Spray-liquid diposition on soil by using a Knapsack sprayer with an air sheer nozzle under different operating conditions. a) with air b) without air

Spray deposit on stand:

Spray deposit on vertical stands (2x2x400 cm) which were placed at an interval of 5 m upto 20 m from the spray nozzle was recorded to find out the effect of electrostatic charging sprays as compared to the conventional spraying. The results are shown in Fig.7. In all operating conditions, the spray deposit decreased sharply toward upward direction and increasing the horizontal distances from the spraying nozzle.

Spray deposit and drift on wheat field:

The amount of spray deposition on wheat plant, spray drift on soil and air was recorded and the result is shown in Fig.8. The highest deposition on the plant was obtained when the electrostatic corona charged sprays was used. Both drift on soil and air increased when uncharged sprays were applied in the field. With charged sprays drift on soil and air was reduced significantly.

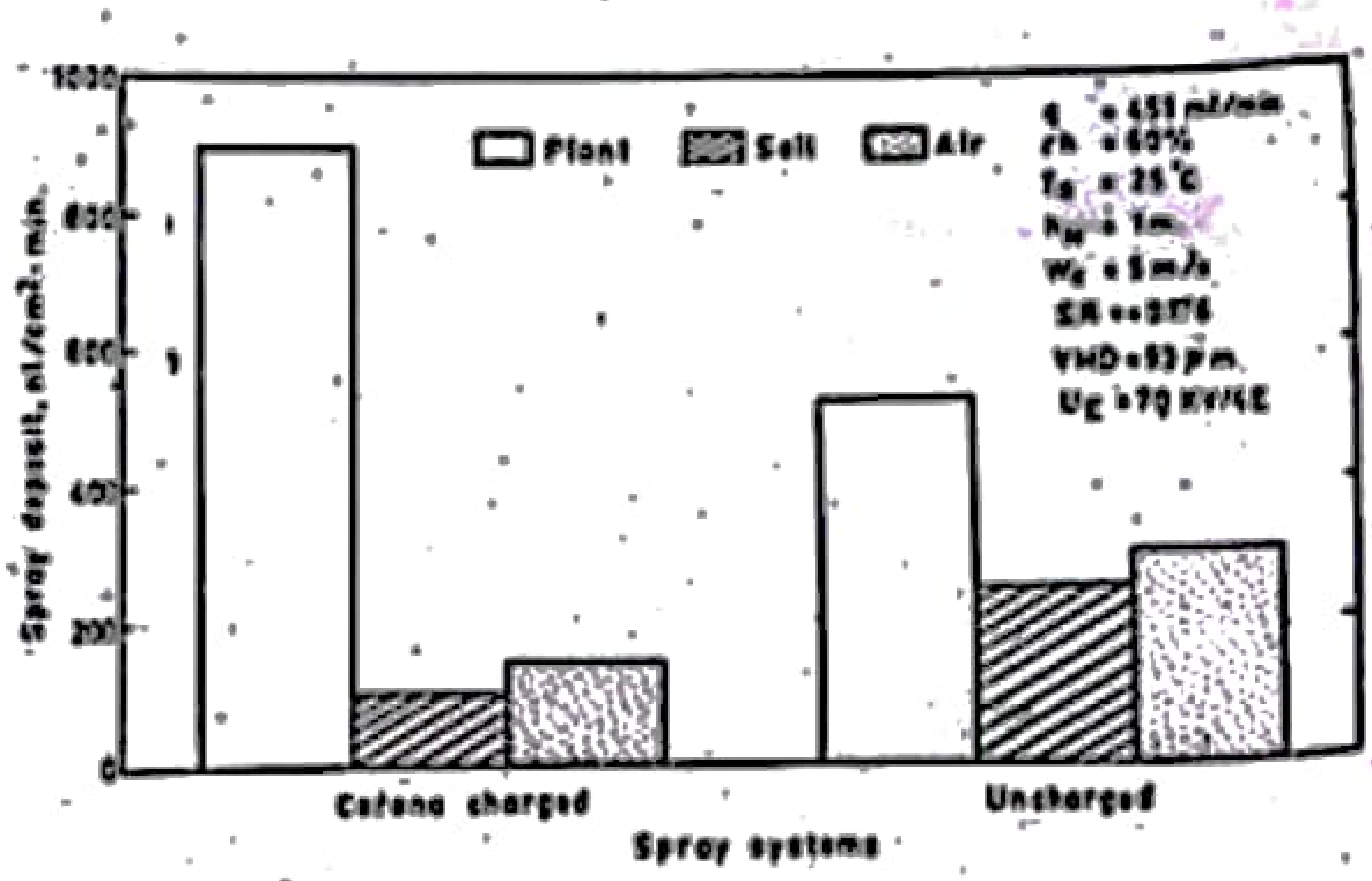

Fig.8 Spray deposit on plant and Drift on soil and air

CONCLUSION

1. An increase in charge to mass ratio gives an increase in spray deposit and decreases the drift.

2. Cross wind speed has an increase in drift with increasing wind speed. The weight of spray drift reduced with charged sprays in comparison to uncharged sprays.

3. In field practices it was found that the spray deposit on wheat plants with charged sprays was higher than the uncharged sprays and simultaneously drift increased more than two times.

4. The distribution of spray deposit around the target was significantly better within one meter with charged spray drops.

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