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# Comparative Evaluation of Electrostatic Sprayer with Powered Mist Blower

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**Abstract:** Theknapsack mist blower is one of the most popular and versatile pesticide application equipment in India due to its simplicity, ease of operation and inexpensiveness. However these sprayers have to overcome certain constraints like low deposition efficiency, poor distribution and low penetration into dense plant canopy. The introduction of electrostatic sprayer could overcome these lacunas with its application efficiency by about 80% with 50% less spray chemical ingredients. Both the sprayers were evaluated for comparative assessment of performance both under laboratory and filed conditions. The evaluation was done for deposition efficiency and biological efficacy. The results shown that in all the combination of parameters, thespray deposition efficiency of electrostatic sprayer was very high with uniform distribution irrespective of leaf taxonomy, anatomy and morphology. The wrap around effect of spray cloud on the plant surface due to electrostatic force between the charged particles and plant target was also observed. The usage of chemicals was about 30 to 35 per cent in case of electrostatic sprayer that of air assisted sprayer.

**Keywords:**Deposition efficiency, Electrostatic spraying, Mist blower, Air assisted sprayer.

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## INTRODUCTION

In India, the powered knapsack mist blower is one of the most popular and versatile pesticide application equipment because of its simplicity, ease of operation and inexpensiveness. But still these sprayers have to overcome the problems of reduction in deposition efficiency, distribution and penetration into the plant canopies (Bindra and Singh, 1971). The introduction of electrically charged sprays for agricultural application can provide greater control of droplet transport with impending reduction of wastage. The use of electrostatic spraying can be increase the application efficiency by about 80% with 50% less spray chemical ingredients (Derksen et al. 1991).

In the country, only a few attempts have been made so far in developing and testing indigenous electrostatic spray charging systems. Hence the study on the performance of a commercial electrostatic sprayer was carried for the depositional characteristics on two different crops Pepper and Ginger. For the study the Kerala State Council for Science Technology and Environment, Government of Kerala extended financial support and the work was carried out at KrishiVigyan Kendra, Wayanad, Kerala Agricultural University.

## REVIEW OF LITERATURE

Hussain and Moser (1986) investigated the electrostatic charging methods for use with hand- and shoulder-carried plant protection sprayers. They concluded that electrostatic charging could be successful for better deposition with conductive spray liquid of droplets ranging from 10 to 50 µ m. Smith (1986) reported about the electrodynamics technology, which use electrical forces to generate very small, highly charged droplets and propels them towards the crop. He examined the advantages of the system as developed for small holder tropical agriculture compared to other manual method for pesticide application.

Allen *et al.* (1991) developed a system to improve the efficiency of mist-blower sprayers and reduce environmental contamination by electrostatically charging the output from these machines. The developed system consists of annul electrodes and standard hydraulic nozzles. Durairaj*et al*. (1994) compared the charged and uncharged spray deposition on an aluminum cylinder target using indigenously developed electrostatic charging system for a spinning disc sprayer. They concluded that total deposition was greater for charged spray, implying that the charged spray would give better under canopy coverage than conventional spray.

In order to improve spraying results, an inductive electrostatic sprayer was designed by Jia*et al.* (2013). The performance of the sprayer was then tested. The test result shows that the charge-to-mass ratio can reach 0.951 mc/Kg when electrostatic voltage is 20 KV and working pressure is 0.25 to 0.4 MPa. Patel *et al.* (2015) developed and analyzed an air assisted electrostatic spray charging nozzle for agricultural pesticide application in liquid form. They observed that 2 to 3 times increase in leaf top deposition in electrostatic spray over non-electrostatic spraying, also found that under leaf deposition area has been enhanced by 4 to 5 times.

## MATERIALS AND METHODS

A commercial model of electrostatic sprayer was imported from United States of America (USA) and was evaluated for performance against knapsack powered mist blower at the laboratory set up of Kerala Agricultural University.

**Description of Electrostatic Sprayer (ESS MBP 4.0 Mountain Man Sprayer)**

| | |
|---|---|
| Nozzles | : 1 |
| Standard hose length | : 30.5 m |
| Weight | : 54.4 Kg. |
| Dimensions | : 1.1 m × 0.6 m × 1.8 m |
| Flow rate | : 9.5 ltr./hr. |
| Droplet size | : 40 microns |
| Spray range | : 4.6 to 61 m. |

The ESS MBP Mountain Man Sprayer is a self-contained unit and does not require hook up to an external air source. Combining the best features of a backpack spraying system with the versatility and convenience of a mobile air supply, the MBP 2.5/4.0 allows workers to travel faster and further than before. The ergonomically balanced cart has handles fore and after. The back pack can be prefilled with the chemical mixture and carried along the remote locations. When the compressor cart is in the desired location, simply pull down the kick stand, hook up the back pack, start the gasoline powered compressor and start spraying.

**The high pressure air flow generating unit**

The MBP uses 6.5 hp Briggs & Stratton gasoline engine to power the air compressor. Lead free gasoline and 10W-30 detergent oil is being used.The compressor produces pressurized air which is used to atomize and propel the liquid spray. 30-weight compressor oil is being used in the compressor.The MBP-4.0 is equipped with 15 ltr. tank which is worn on operators back.

The quick connect to air connection is on the top of the air hose storage tank. The other end of the air line hose connects to air leader to the spray gun. The leader to the spray gun is below the liquid leader and is easily recognizable because is connector is larger than the liquid connector. The quick connect for the liquid line is on the bottom of the back pack tank and connects the liquid leader of the spray gun.

**The Spray Gun**

The spray gun is held by the operator during spraying. Activation of the trigger causes liquid to spray. The spray gun has the following user-serviceable parts: the air filter, the liquid filter assembly, the nozzle assembly, and the batteries.There is an inline air filter is located outside of the base of the spray gun in the air hose. It filters dirt out of the air lines.The trigger turns the gun ON and OFF. It can be continuously held for operationor it can be located in place.To engage or disengage the trigger, depress the trigger up towards the body of the spray gun to start spraying. The liquid filter assembly is located outside the base of the spray gun. It is composed of NPT body, a strainer, a flow disk, an adapter and a cap. The strainer is the active filtering element in the volume of liquid that flows through the line. There is an extra flow disk and an extra strainer in the MBP parts kit to replace the damaged parts.

**The Nozzle Assembly**

The nozzle assembly is located at the end of the spray gun wand. It is composed of nozzle body, internal O-ring, Teflon ring, cover, external O-ring and a hood. For cleaning he spray gun, always rinse the out with clean soapy water after every day’s spraying. Unscrew the cover from the nozzle base and remove the Teflon ring. The spray charging operates on two 9-volt rechargeable batteries which are located in the base of the spray gun. In average conditions, the batteries will last 10 to 15 hours of operation on a charge.

**Quantification of Spray Deposition on Target**

Spray deposition on the plant targets were quantified using tracer wash procedure (Sumner et al, 2000). Water sensitive paper method and leaf wash method were adopted for the study. The procedure is to spray a tracer fluorescent solution of known concentration on targets, after placing a removable, sampling surface of known area (water sensitive paper method) on the target or considering the whole leaf surface as target. The deposited tracers on the targets were recovered by wash procedure. The concentration of recovered tracer solution was recovered in terms of its optical density by using spectrophotometer. This was in turn used to compute the quantity of spray fluid deposited from the correlation obtained between known concentrations and optical densities.

**Leaf wash method**

In leaf wash method 10 leaves from each plant targets were collected randomly and different parts of the plant surface. Dye residues were washed from the top side and under sides of the leaves separately. Dye solutions thus collected were evaluated for transmittance with a Spectrophotometer and compared with the calibration from known washed deposits to determine dye deposition on each samples.

**Measurement of Absorbance**

1.5 g of fluorescent tracer (DAY GLO type GT-15-N Fluorescent Blaze Orange dye) was dissolved in 1000 ml of water, making concentration of tracer liquid 1500 ppm (Durairaj, 1994). This concentration of tracer residue on the target is analogous to pesticide active ingredient of an actual spray solution. This facilitated a direct comparison of relative deposition efficiencies of the electrostatic versus conventional spraying techniques. After spray, the spray fluid deposited on water sensitive paper or leaf surface were retrieved and the dye is extracted by washing with known quantity of double distilled water.

The recovered tracer concentrationwas analyzed for optical density (absorbance) with Spectrophotometer. Spectrophotometer was pre calibrated with double distilled water representing zero absorbance reading. Then further calibration was carried out in the visible region of the electromagnetic spectrum of wave length ($\lambda$) 555 nm, which is same as that of fluorescent tracer material and commercial agricultural chemicals. Solutions of known standard concentrations (ppm) of the tracer were prepared and measured for their optical density on the spectrophotometer. The concentration of the tracer of the sample could be directly measures by the spectrophotometer in terms of ppm.

**Biological Efficacy of the Electrostatic Spray**

Biological efficacy of the electrostatic spray was evaluated and compared with commercial air assisted sprayer and conventional hydraulic sprayer. The trial was conducted in the mango orchard of the RARS farm when it was attached with hairy caterpillar and the banana plot was attached with *spodopteralitura*. Both cases chemicals were sprayed with all the three sprayers.

## Result and Discussion

The trials were conducted for both cases of Electrostatic sprayer and common commercial air assisted sprayer zig-zag motion, either horizontally or vertically depending upon the plant target surface, of the nozzle with 50% overlap gives the better spray deposition on the plant target irrespective of canopy density.Sampling was done randomly from the plant surface.The plant targets were selected were Ginger (Long narrow leaf with dense canopy) and pepper (Round smooth leaf with dense canopy).

**Deposition Efficiency :Case I, Pepper(*Piper nigrum*)**

The zig-zag vertical movement of nozzle with 50% overlapping was adopted. The stem of the plant surface and underneath of leaf also deposited with uniform distribution of spray particles in the case of electrostatic sprayer. While evaluating the single leaf for upper and lower leaf surface the deposition efficiency of electrostatic sprayer was as shown above (Fig. 1, Fig. 2 and Fig. 3).

In the case of dense canopy with smooth leaf also he electrostatic sprayer shows almost double the deposition efficiency than the conventional air assisted sprayer. Splashing of spray was high in the case of air assisted sprayer while that was almost zero with electrostatic sprayer. The spray dripping was also observed in the case of air assisted sprayerwhich is nil in the case of electrostatic sprayer. Spray accumulation on the leaf margins due to air impact was also observed in the case of air assisted sprayer which is minimum in the case of electrostatic sprayer. This marginal accumulation of chemicals leads to the burning of leaf if the concentration of chemical is high.

The wrapping around of spray particle was also observed in electrostatic sprayer. The samples collected from the rear side of the plant were also deposited with 15 to 20 per cent of spray deposit in case of pepper and coffee like tree plants. This clearly indicates the wrap around of the charged spray on target. The wrap around of charged spray particles could be visually observed when sprayed on black pepper (Fig. 4). The same effect was 2 to 5 per cent in case of commercial air assisted sprayer. Also this deposition was not due to wrap around effect, but the penetration of particles through the plant canopy due to the air flow force.

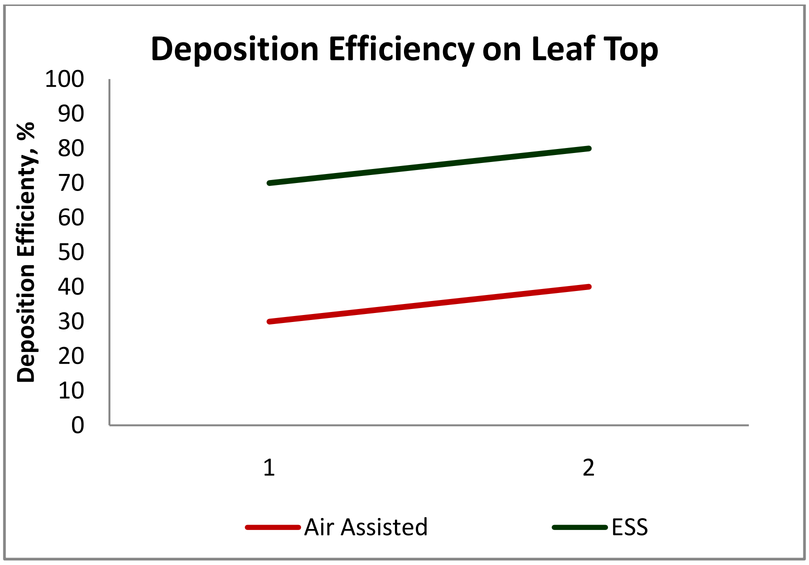


**Fig. 1.** Deposition Efficiency on Leaf Top of Pepper Plant

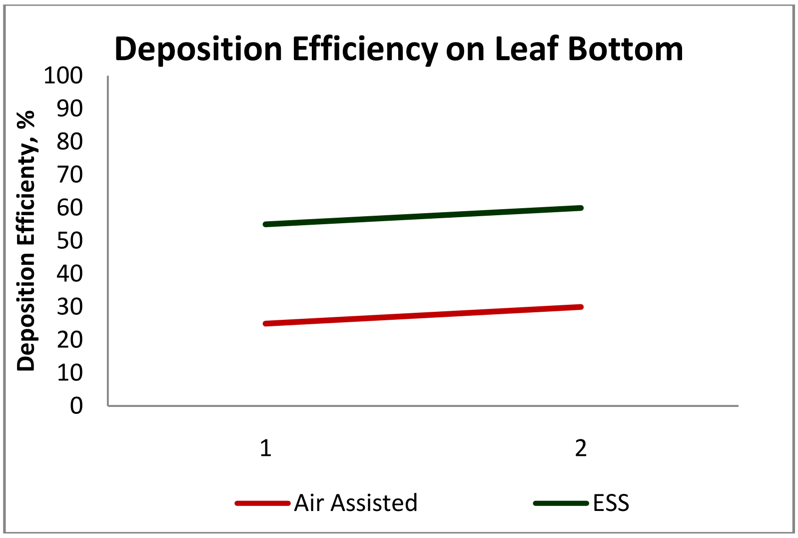


**Fig. 2.** Deposition Efficiency on Leaf Bottom of Pepper Plant

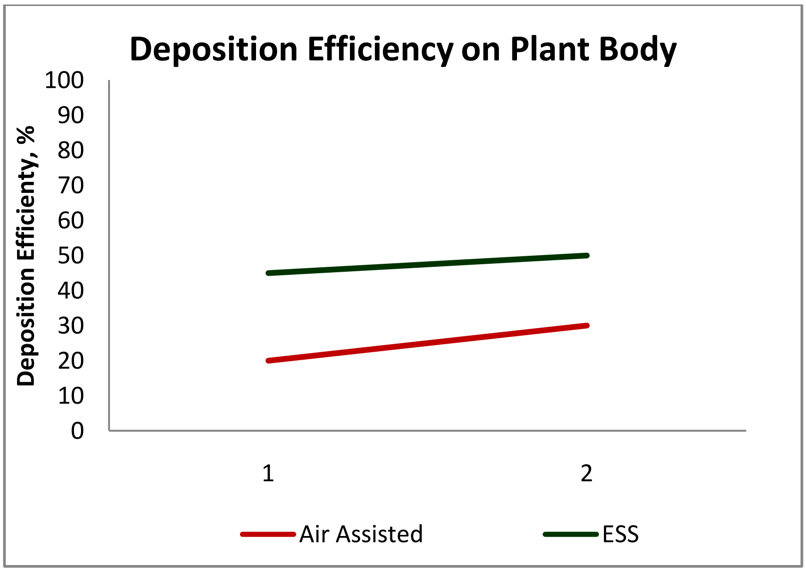


**Fig. 3.** Deposition Efficiency on Plant Body of Pepper Plant

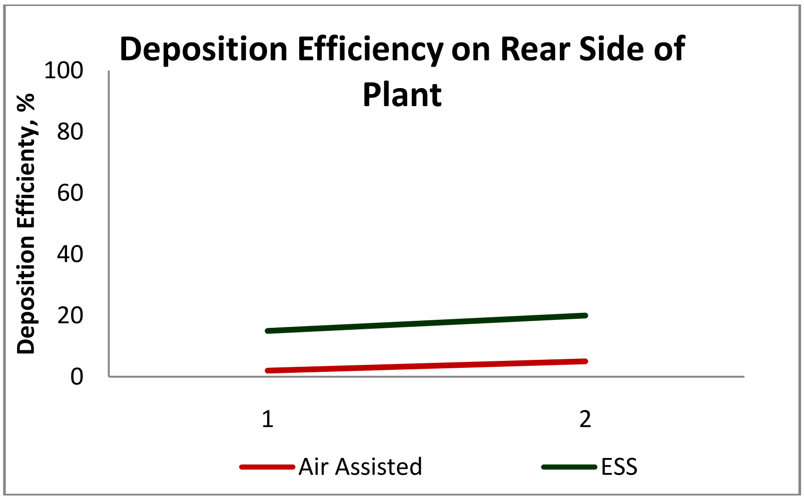


**Fig. 4.** Deposition Efficiency on Rear Side of Pepper Plant

**Deposition Efficiency : Case II Pumpkin(*Cucurbitapepo*L.)**

In the case of pumpkin the spray deposition was about double in the case of electrostatic sprayer than the conventional air assisted sprayer (Fig. 5, Fig. 6 and Fig. 7). In hairy surface like pumpkin, the deposition was more visually, but in analysis it was on par with the other plant surfaces. This indicates that there is no extra charge accumulation in hairy plants. The visual effect on deposition was higher since the area of deposition is more even it is visually not. Here the spray dye deposited each and every hairy parts of the leaf which is having more surface area in a smaller visual area.

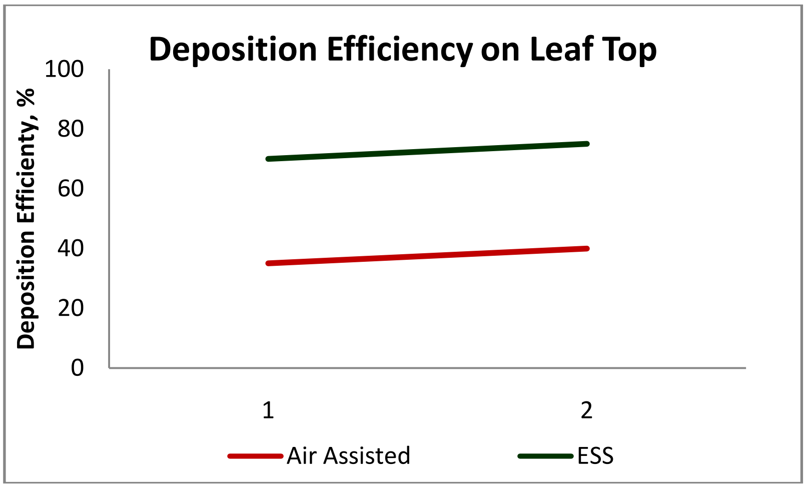


**Fig. 5.** Deposition Efficiency on Leaf Top of Pumpkin

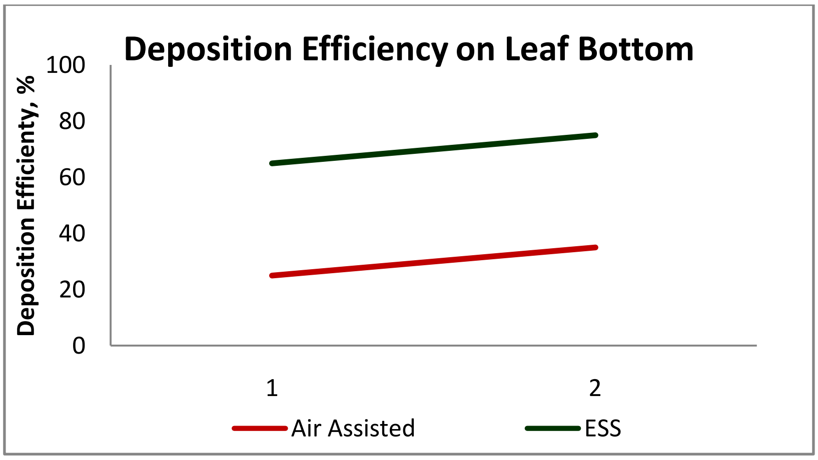


**Fig. 6.** Deposition Efficiency on Leaf Bottom of Pumpkin

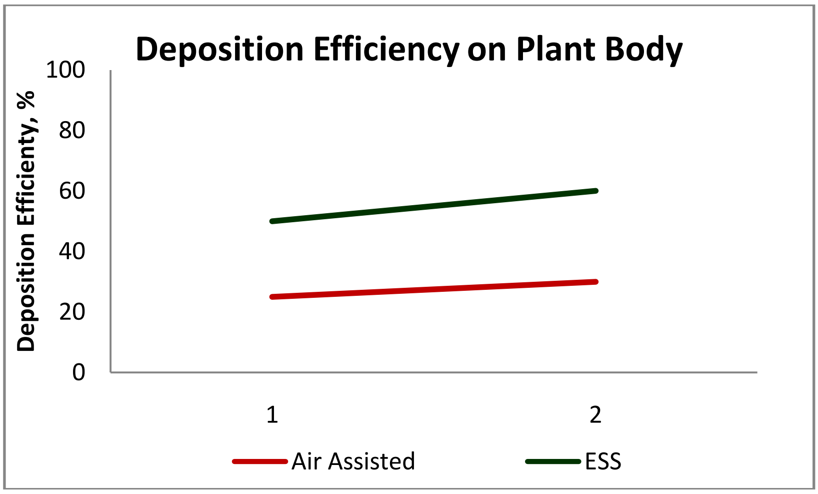


**Fig. 7.** Deposition Efficiency on Plant Body of Pumpkin

**Deposition Efficiency : Case III -*Colocasiaesculenta***

In case of colocasiea he leaf surface is almost water resistant in nature. That is the water cannot adhere over the entire plant surface except older leaves. The water droplets fall over the leaf will roll over and drip to the ground or soil. In this situation the electrostatic spray was deposited over the leaf and plant surface with about 50 to 65 per cent deposition efficiency (Plate 3) as in Fig. 8, Fig. 9 and Fig. 10. This was only because of the electrostatic force of attraction between the plant surface and charged droplets. The spray deposition by the commercial air assisted sprayer was maximum of 20%, that also on older leaves.

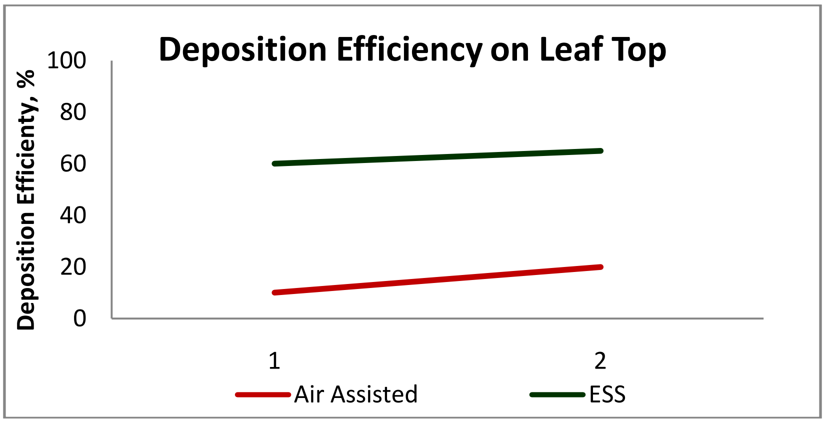


**Fig. 6.14.** Deposition Efficiency on Leaf Top of Colocasia

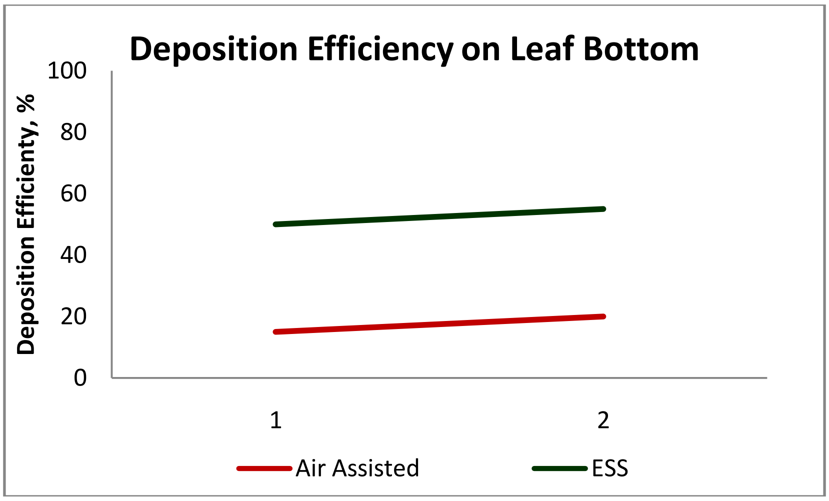


Fig. 6.15. **Deposition Efficiency on Leaf Bottom of Colocasia**

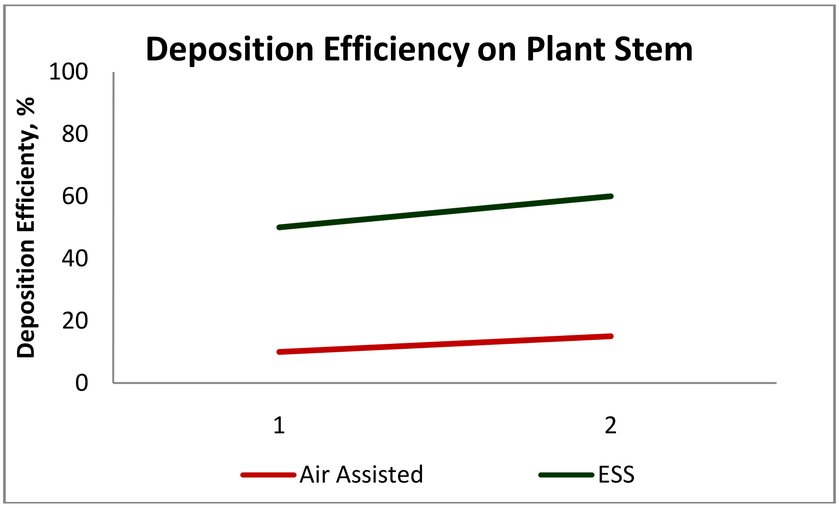


Fig. 6.16. **Deposition Efficiency on Plant Body of Colocasia**

**Biological Efficacy**

The electrostatic sprayer was operated with real agricultural chemicals against hairy caterpillar on mango tree and *Spodopteralitura* attack on banana. Contact type chemical was used against hairy caterpillar. 10 plants were sprayed with electrostatic sprayer, 10 with air assisted sprayer and 10 with hydraulic rocker sprayer. The peculiarity of these type caterpillars are, they will be get killed when the chemical gets in contact with its body not with its hairs. Only electrostatic sprayer could give 90 to 100 per cent control with the single spray. Even with 2 to 3 sprays, the other sprayers could not control this caterpillars.

The *Spodopteralitura* attack on banana affects the yield very seriously. All the three types of sprayers were evaluated in controlling this pest. Electrostatic sprayer gave 100 per cent control with a single spray. The air assisted sprayer also gave completed control in two spray. But the chemical usage was only 30 per cent of that with air assisted sprayer. These results shows that the spray deposition and its uniformity affects the pest control and effective application of agricultural chemicals. The reduction in application of these chemicals significantly reduce the environmental contamination also.

## CONCLUSIONS

In all the cases it was observed that the dye deposited by electrostatic sprayer was difficult to wash out from the plant surface than in normal method. The deposition was very high irrespective of leaf taxonomy, anatomy and morphology. The photosynthesis activity and the metabolic activity of plant is the main reason for accumulation of static electricity on the plant surface. The flying back to the plant surface due to electrostatic force between the charged particles and plant target was also observed and hence the increase in deposition efficiency. The usage of chemicals was about 30 to 40 per cent in the case of electrostatic sprayer that of air assisted sprayer. This was mainly because of uniform droplet formation, minimum dripping and splashing losses.

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