A GREEN SECTION
RESEARCH PROJECT
*Funded by the
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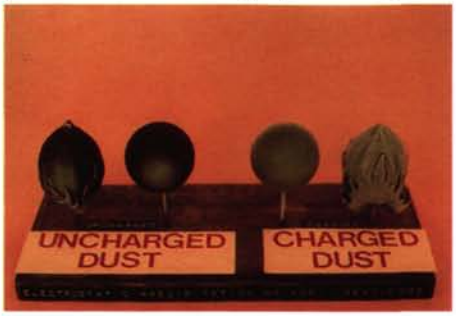
Figure 1. Research prototype machine for evaluating electrostatic pesticide spraying.

An example of the electrostatic precipitation spray technique. Note total cover as compared to conventional spray on the left.



Electrostatic Spraying of Turfgrass

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INTRODUCTION

GOLF, UNLIKE OTHER sports, has, as an intrinsic feature, a close relationship with nature. And yet, excessive and incorrect applications of the pesticide chemicals which provide economical control of insect, disease and weed pests can cause acute setbacks in the surrounding environment. The conventional methods of turfgrass management using pesticide sprays are not always effective; sometimes as much as 80 percent of the spray drifts away to adjacent plots and contaminates the wildlife and water supplies.

To improve this situation, electric forces have been incorporated into spray application. In electrostatic spraying, the finely atomized spray droplets are given a negative charge. The charged spray cloud then induces a positive charge onto the nearby plant material, which is at ground potential. Because of the attraction between opposite charges, the negatively charged spray cloud is drawn to the positively charged plant. This results in a more uniform spray deposit and less airborne drift of the spray particles.

Electrostatic spraying offers as much as 50 percent reduction in the amount of pesticide used and a deposition efficiency as high as seven times that obtained with conventional methods of spraying in row crops (Figure 2). The resulting economic advantages and better control of pests achieved by using electrostatic spraying also offer potential benefits in the field of turfgrass management.

It was hypothesized that the addition of an electrostatic precipitator above the charged spray cloud would introduce additional forces on the charged droplets, forcing them to be deposited even faster onto flat grass targets. Since the drift of airborne droplets is directly proportional to the time the droplets remain in the atmosphere, an electrostatic precipitator might aid in reducing drift. Thus, the objective of this study was to investigate the degree of improvement in spray deposition onto turfgrass-type targets achieved with charged sprays applied under various type electrostatic precipitators (Figures 1 and 3).

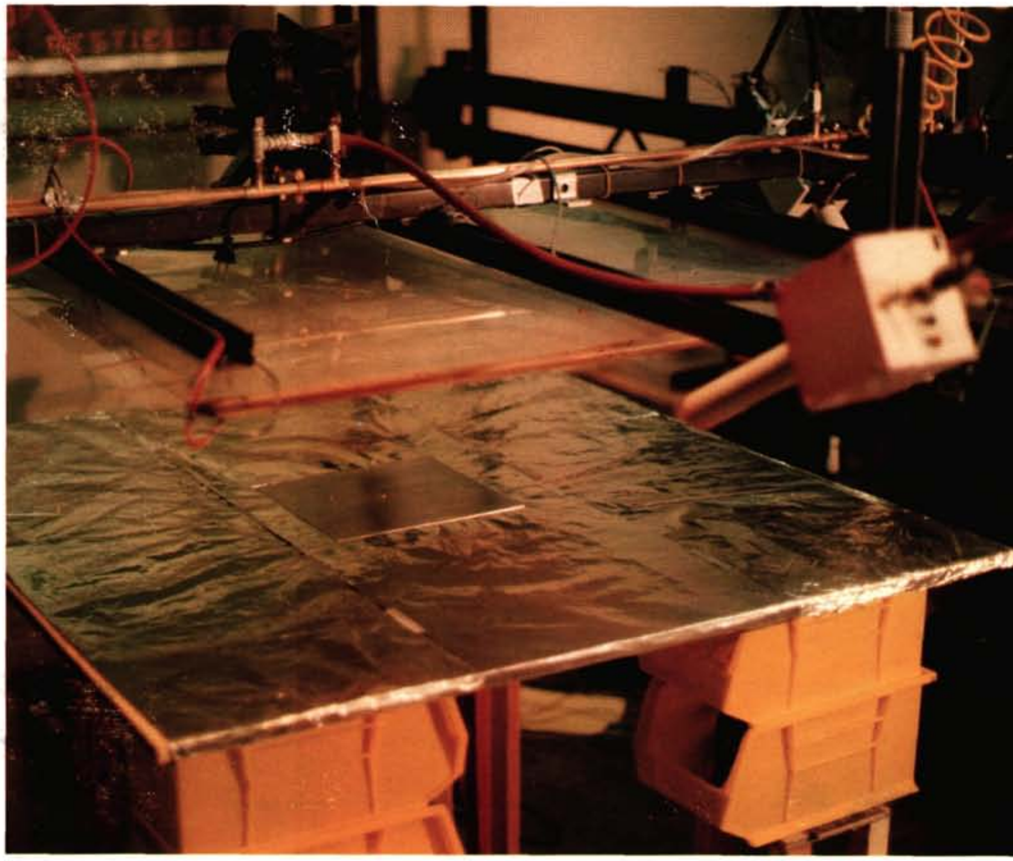
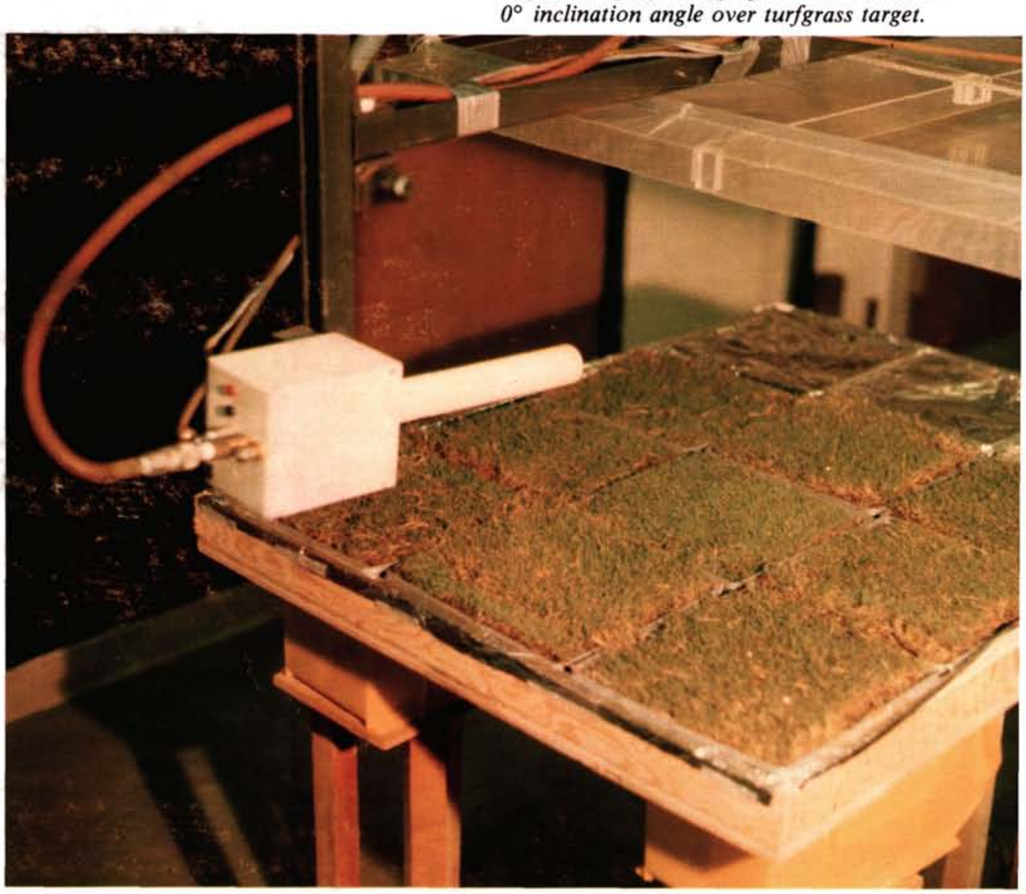


Figure 2. Experimental setup of spray-charging nozzle at 45° inclination angle above flat deposition surface.

Figure 3. Spray-charging nozzle oriented at 0° inclination angle over turfgrass target.



EXPERIMENTAL ANALYSIS

An electrostatic spraying nozzle specifically suited for charging pesticide droplets has been developed within the agricultural engineering department at the University of Georgia (Figures 4 and 5). The nozzle uses the principle of electrostatic induction to charge the liquid droplets and is powered by a transistorized supply energized with a 12 volt d.c. battery of the type found in tractors. This charging nozzle system has been designed onto the self-propelled vehicle shown in Figure 1 in order to evaluate the performance of electrostatic pesticide spraying onto various living-plant targets, including turfgrass. The nozzle itself was evaluated for its use in turfgrass spraying in conjunction with the added electrostatic precipitators.

Two types of electrostatic precipitators were studied. First, a high-voltage metal plate was maintained above the charged cloud to act as an electrostatic precipitator. The potential on the high-voltage plate was varied from 0 kilovolts to -30 kilovolts in steps of 10 kilovolts. The second type was a dielectric-barrier

Figure 4. Electrostatic spraying of turfgrass under dielectric-barrier precipitator.

electrostatic precipitator made of a polyethylene sheet stretched over a square plexiglas frame. Initially the polyethylene sheet would accumulate negative charges on its surface through the impingement of charged spray from below. Later, these accumulated charges would repel further spray droplets downward toward the turfgrass.

Quantitative analysis of spray deposition with charged and with uncharged sprays was done on a flat aluminum target simulating turfgrass. A fluorometric technique was used to quantify the amount of spray deposition onto the aluminum target resulting from the different treatments.

The spray experiments, conducted in the laboratory with a sprayer simulator, tested the charging nozzle at 0-degree, 15-degree, 30-degree and 45-degree inclination angles. The nozzle trailed 0.15 m (6 inches) behind the electrostatic precipitator in its travel. The target surface was placed 0.3 m (12 inches) below the nozzle, which as aligned coplanar with the precipitator for 15-degree, 30-degree and 45-degree inclination angles (Figure 2). For the tests with 0-degree nozzle inclination angle the nozzle was maintained 0.15 m (6 inches) below the precipitator (Figures 3 and 4).

The spray cloud current, which is a measure of the degree of spray charging, was varied from 0 μA (uncharged) to -8 μA in steps of 2 μA.

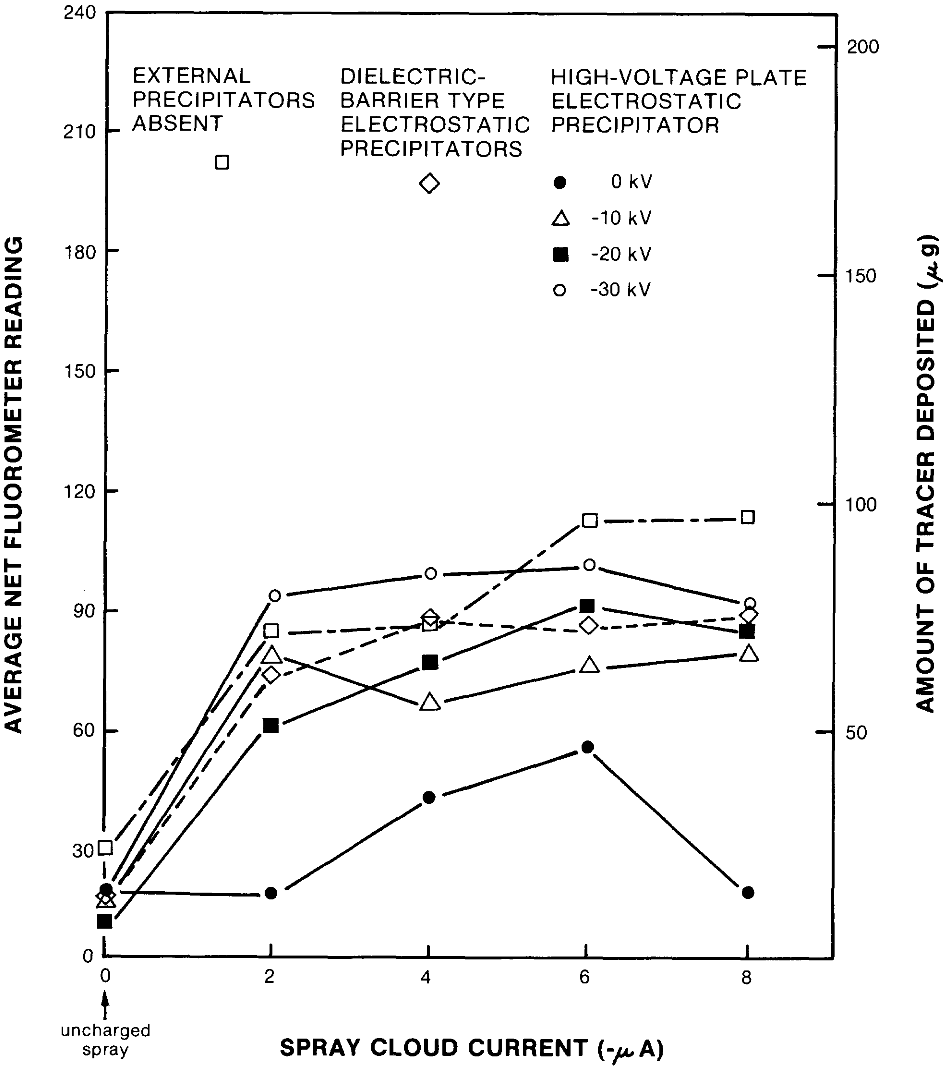
RESULTS AND DISCUSSIONS

The deposition was found to increase significantly on increasing the nozzle inclination angle. The different forces aiding the deposition of the charged spray droplets were: (a) the gravitational force, (b) the vertical component of the inertial force due to velocity of the spray, and (c) the electrical force due to the spray's space charge and the presence of the electrostatic precipitators. Since a 0-degree nozzle inclination angle would correspond to a minimum of inertial force component, it would give a better comparison of the other variables of primary interest in this experiment. Figure 5, therefore, shows the deposition with 0-degree nozzle inclination angle for charged and for uncharged conditions of the spray under the influence of the two types of electrostatic precipitators. Deposition achieved solely by the charged spray cloud without any added precipitators is also shown.

It is seen that the deposition increases on charging the spray up to typically 4 to 6 μA. Application of increasingly higher voltages to the precipitator plate can also be seen to enhance the movement of charged spray droplets downward for deposition. However, the presence of a grounded electrostatic-precipitator plate actually reduces target deposition. This is because the resultant electric field acting on the charged droplets then drives a portion of the spray upward to the grounded plate instead of downward to the target. It is also shown that maximum electrostatic deposition occurred purely as a result of the charged spray cloud's own self-generated space-charge electric field driving the charged droplets downward to the grounded surface. Nevertheless, in actual turfgrass applications the presence of crosswinds would likely favor use of some appropriate type of an electrostatic precipitator merely to enclose and protect the charged spray.

The dielectric-barrier type electrostatic precipitator appears to satisfy this need. At the higher levels of spray charging, it is seen to be practically as efficient as the high-voltage plate type electrostatic precipitator (even at -30 kV) for depositing charged spray onto planar targets like turfgrass. Moreover, the ease in its construction and the absence of those hazards associated with the high-voltage plate electrostatic precipitator make the dielectric-barrier type electrostatic precipitator the desirable approach in the design of electrostatic turfgrass sprayers.

Figure 5. Deposition of spray onto planar targets under charged and uncharged conditions for 0° nozzle inclination angle and for various electrostatic precipitator conditions.



CONCLUSIONS

It has been verified that electrostatic spraying can be successfully used to improve droplet deposition onto turfgrass-type planar targets. The deposition achieved onto the flat targets utilizing charged spray at -6 μA in conjunction with the dielectric-barrier type electrostatic precipitator was improved 3.6 times as compared with uncharged spray.

The presence of an electrostatic precipitator in the form of a polyethylene sheet above the spray cloud also acts as a protection for the charged spray cloud from the effects of crosswinds.

The above concepts of electrostatic spraying can be successfully incorporated in the design of turfgrass sprayers for more efficient and economical golf course management.

ACKNOWLEDGMENT

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