ELECTROSTATIC SPRAYER OF AGRICULTURAL CHEMICALS

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ABSTRACT

Agricultural chemicals spraying is one of the most efficient methods for pesticides control. General farming groups use Speed Sprayer but its deposition amount on practical crops is only 20% of total amount in SS case. Agricultural chemicals which fail to arrive the crops not only cause environmental contamination but loss of agriculture chemicals by lower deposition efficiency. For the purpose of improvement of these problems, this experiment proposes SS attachment type electrostatic induction spraying apparatus with DC power which improves deposition efficiency of agriculture chemicals on the crops.

INTRODUCTION

Most of fruits are sprayed chemicals many times during the growing season to protect trees and their fruit from pest and disease damage. Some droplets of spray never reach fruit or foliage and fall to the ground or are carried out of the orchard by wind as drift. Those droplets of spray missing the trees are not only wasted expense for growers, but also are potential source of environmental pollution. In the development of electrostatic crop spraying technology, the majority of world wide research studies have either concentrated upon the physical aspects of spray charging and dissemination or upon biological evaluation of pest control efficacy being achieved by prototype machines in laboratory or field test programs. In this study, an electrostatic sprayer having a nozzle was developed and evaluated its spraying performance. High voltages of 7.5 and 10kV were supplied for the electrostatic electrode. Electrode was designed as ring type(Ø50mm) and the protype was attached on a speed sprayer. A machine vision with a microscope(Micro world system mw-200) was used to get the coverage rate, the density and the diameter distribution of the droplets for the performance evaluation of the spraying system.

Key Words : Agricultural machine, Speed sprayer, Electrostatic, Agricultural chemicals

Experimental Apparatus and Methods

High Voltage Source

The output of the High Voltage Source can be adjustable between 0 and 30kV, whose input voltage and current is DC12V and 10mA. Figure 1 shows apperance of the High Voltage Source we used. Table 1 shows the specifications of the high voltage source.

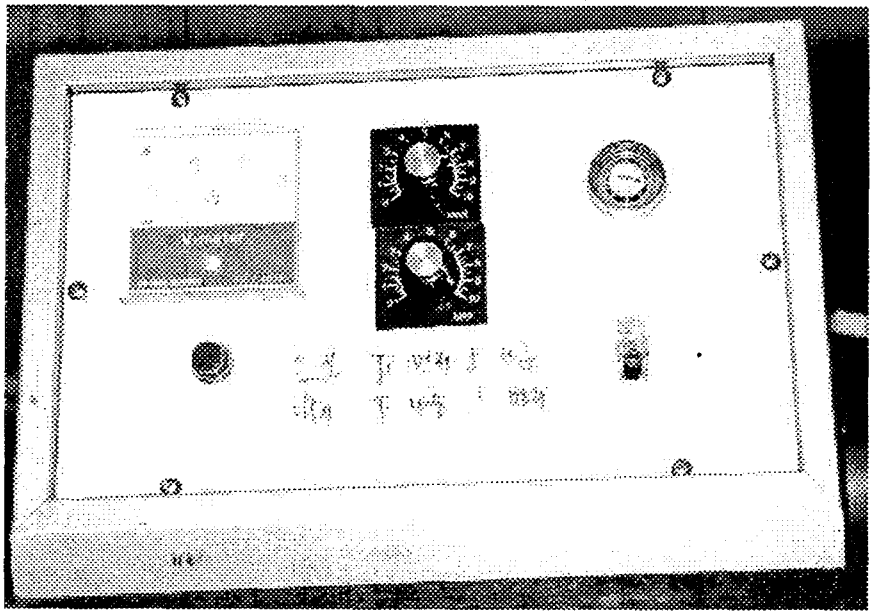


Fig.1 High voltage source

Table 1. Specifications of the high voltage source

Size (L×W×H)	Input Voltage (V)	Output Voltage (kV)	Output Current (mA)
350×190×250mm	DC 12	0~30	10

(2) Electrode

High voltage source and its Electrode were fitted to a speed sprayer. Electrode was designed to reduce the leakage of electricity. Figure 2 and table 2 show specifications of the electrode

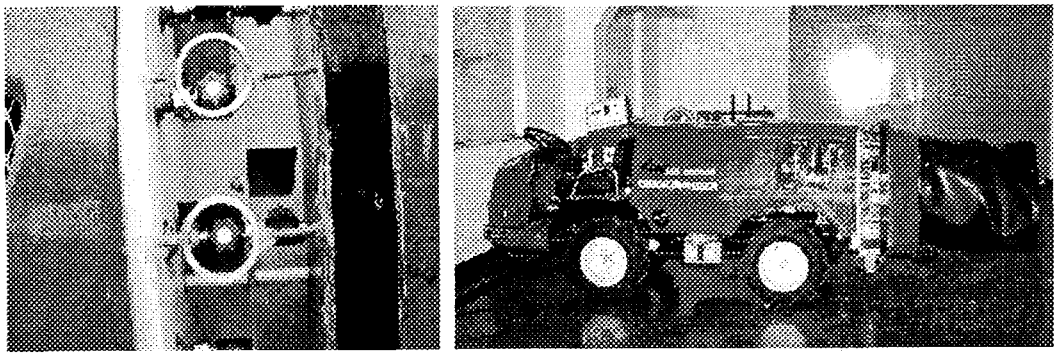


Fig. 2 Appearance of the prototype

Table 2. Specifications of the electrode

	Size(mm)	Number of ring	Distance of ring(mm)
Ring Type	Φ 50× 7× 5	19	120~130

Method of test

(1) Indoor test

The influence of the diameter of ring of the electrode to the angle of the target was measured using the water sensitive papers. By change the charged voltage from 0 and 15kV with the step of 2.5kV. we measured covering area ratio of underside of target. Figure 3 shows test apparatus. For analysing of covering area ratio used Microworld system(mw-200, Figure 4).

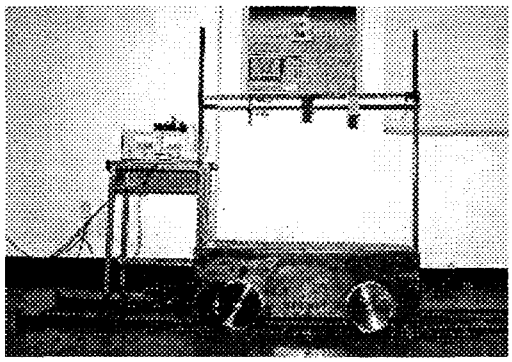


Fig. 3 Test apparatus

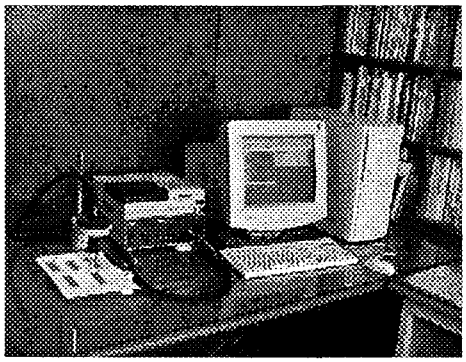


Fig. 4 Microworld(MW-200) system

(3) Field Test

Field test was performed apple tree varying the rotational speed of the fan and charged voltage(5, 7.5, 10kV). Figure 5 shows positions of targets on an apple tree to test the performance of the developed electrostatic spray system. Total 23 targets were positioned(5 positions of upper part, 9 positions of middle part and under part), respectively on the apple tree.

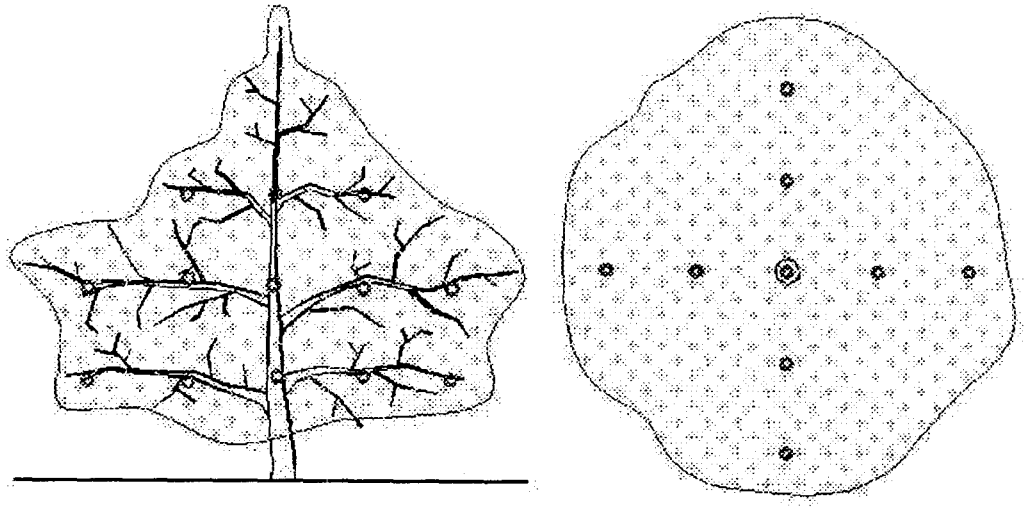
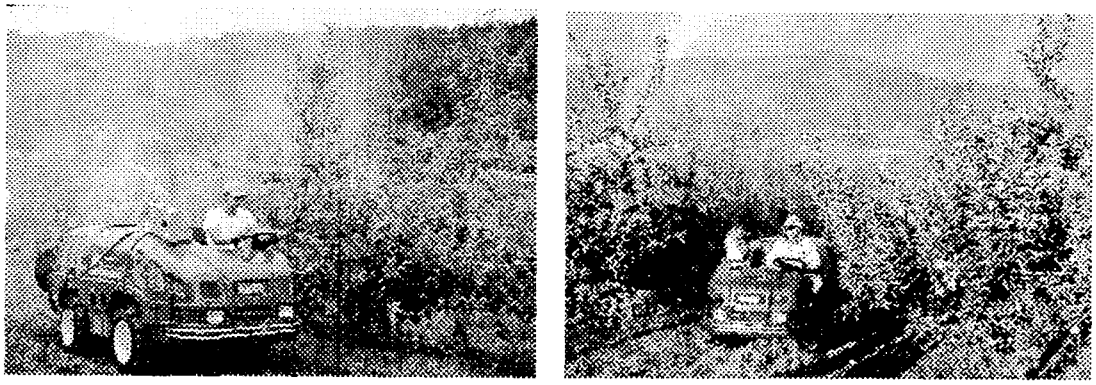
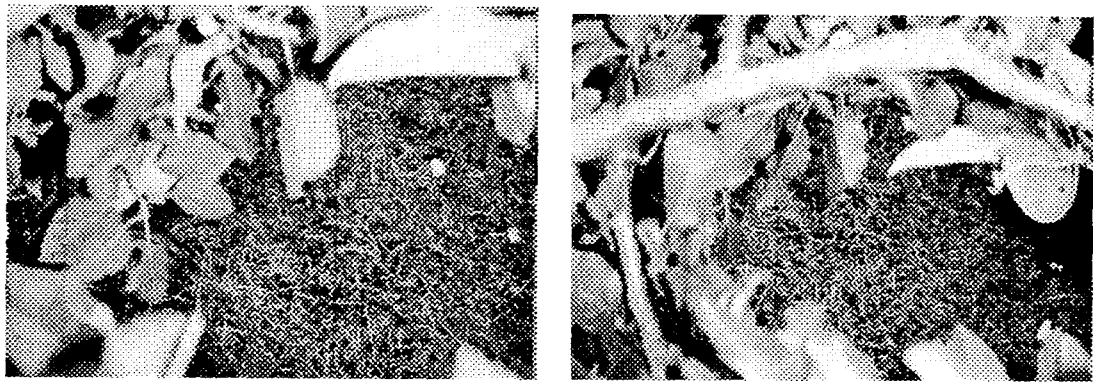


Fig. 5 Positions of targets on an apple tree to test the performance of the developed electrostatic spraying system



<a. View of test of prototype> <b. View of spraying agricultural chemicals>

Fig. 6 View of test of prototype



<a. Before spraying> <b. After spraying>

Fig. 7 View of water sensitive paper

RESULTS AND DISCUSSION

1. Covering Area Ratio

Table 3 shows the covering area ratio. The highest coverage area ratio 12.9% was obtained when the angle of target was 45° with the diameter of ring 50mm, distance of nozzle and ring 30mm and charged voltage 7.5kV.

Table 3. Spray coverage rate of underside of target(%)

Size of charging device		Charged voltage(kV)				
		0	2.5	5	7.5	10
Ring dia. (Ψ mm)	50(30)	2.5	7.2	12.2	12.9	9.1
	60(40)	2.5	7.6	10.5	11.8	6.7

*( ) : Distance of Nozzle and Ring

Leakage of electricity

The leakage electricity result from the sprayed particles adhered to the surface of Speed Sprayer. The amount of leakage electricity was 0.5kV approximately at 7.5kV.

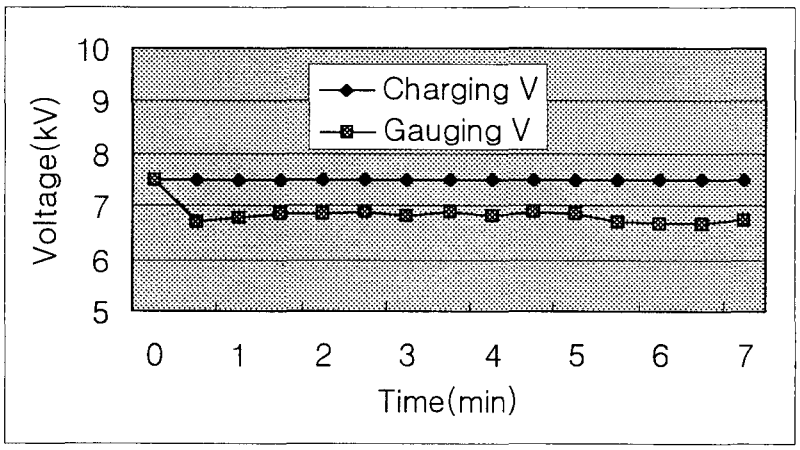


Fig. 6 Voltage leakage rate of the prototype

Consumption of fuel

The most common fan speed of conventional sprayers is 2,500rpm. But in this prototype it could be reduced to 1,500rpm, making it possible to reduce the fuel consumption to 43.1% of the amount of the conventional sprayers.

Table 4. Fuel consumption at different fan speed

Fan speed(rpm)	Wind velocity(m/sec)	Consumption of fuel(ℓ /min)
1,500	17.6	0.059
2,500	35.3	0.137

2. Field Test

The coverage performance in field test was most satisfactory at charged voltage 7.5 or 10kV, fan speed 1,500 or 2,500rpm. Figure 7, 8, and 9 and Table 5 shows the result of the field test.

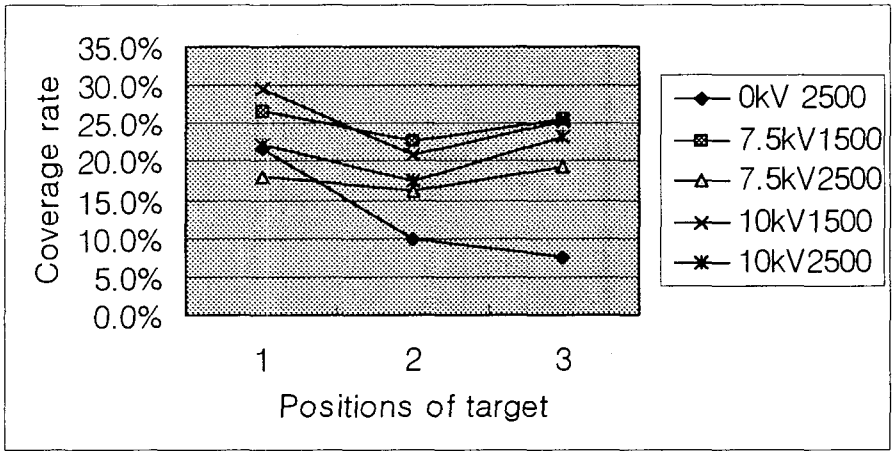


Fig. 7 Coverage pattern of upper part

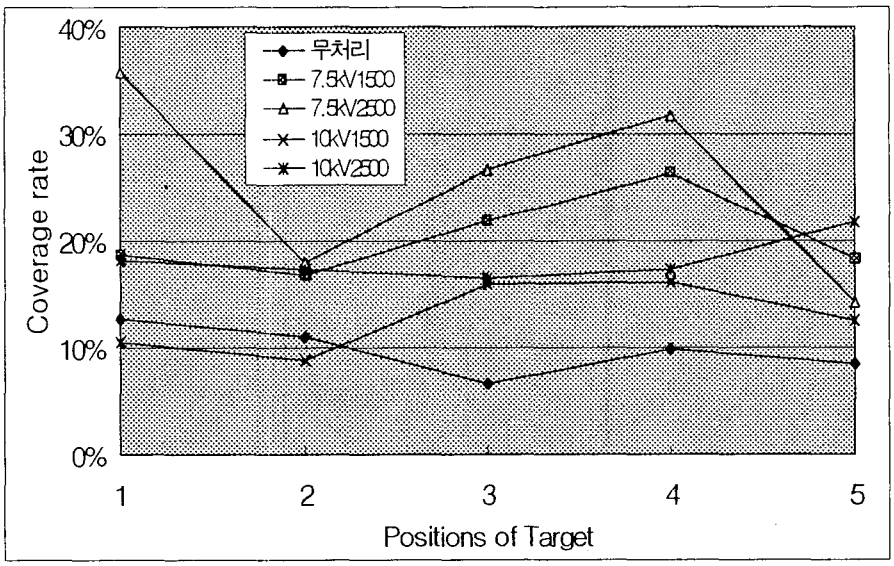


Fig. 8 Coverage pattern of middle part

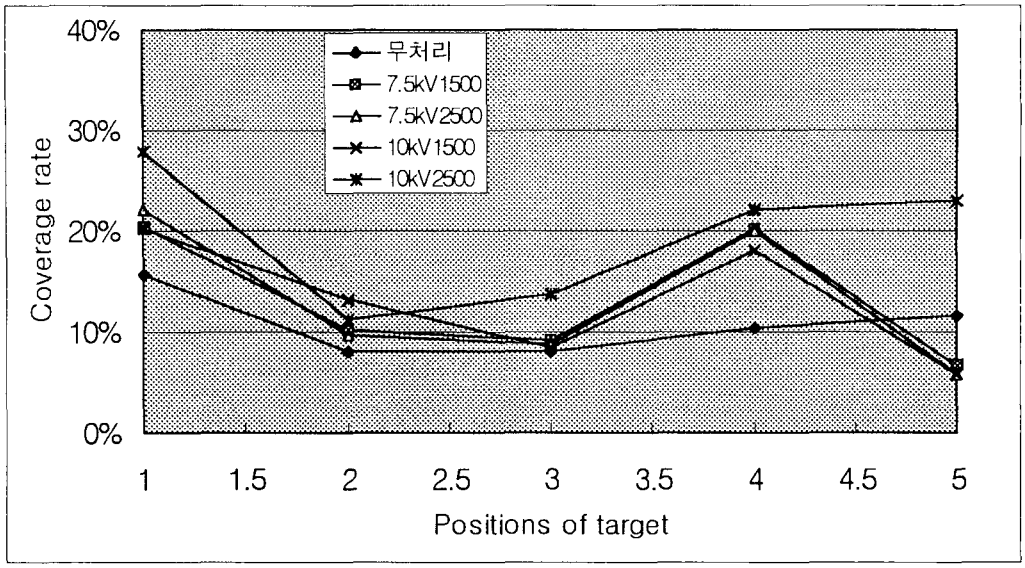


Fig. 9 Coverage pattern of lower part

Table 5. Coverage rate according to positions of target

Charged Voltage & Fan rpm	Upper part	Middle	Lower part	Average
0kV 2,500	11.2	8.0	12.7	9.6
7.5kV 1,500	24.2	23.8	17.9	22.0
7.5kV 2,500	18.0	23.3	15.9	19.1
10kV 1,500	22.6	14.2	16.7	17.8
10kV 2,500	19.9	15.1	16.7	17.2

CONCLUSIONS

1. In indoor test, the highest coverage ratio 12.9%(conventional 2.5%) at diameter of ring 50mm and charged voltage 7.5kV.
2. In field test on apple tree, we could get the highest coverage ratio 22.0% (conventional 10.6%) at charged voltage 7.5kV and fan speed 1,500rpm, in this study.

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