“LOW VOLUME” PHYTOIATRIC APPLICATIONS WITH ELECTROSTATIC DISTRIBUTION SYSTEMS.

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Foreword and scopes

Use of "electrostatic” and “electrodynamic” equipment in the “low volume” pesticide distribution systems employed for plant protection is arousing considerable interest owing to the improvements it can achieve in the formation of an even coating of the product it deposits over the plants in question.

While the polarity induced in the finely micronized drops reduces wastage due to drift, it also prevents the drops from aggregating during the dynamic phase of the conveying action and from overlapping each other when they strike the surfaces of the plants. This produces significant effects on the degree of protection achieved and reductes the amount of product that goes to waste (Marchant and Green, 1982; Spilman, 1984).

Interesting results were observed when these systems were used for treatments on herbaceous crops such as wheat, barley, cotton, etc. (Lav. 1982; Arnold et al., 1984) even though in certain cases, penetration of the pesticide mixture into the vegetation was limited by the thick foliage (Cayley et al., 1985).

On the other hand, there are few indications concerning applications on tree crops, especially as the progressive establishment of the “low volume” method (Cesari et al., 1984) would appear to represent an interesting option (Inculet et al., 1981).

To add to the information concerning the real possibilities offered by electrostatic systems, certain trials were conducted during the 1984-85 two-year period. The intention was to assess the efficacy of a “low volume” pneumatic-electrostatic mist blower used for treatment against apple scab by applying progressively lower doses of fungicide while quantifying the amount of product that actually deposited on the treated surfaces.

Materials and methods

The tests were conducted in the province of Ravenna in an 8-year old apple orchard covering some 600 m2 (cv. “Starkrimson”) cultivated with the fan-tree method (2.10 x 4.10 m) and with foliage (L.A.I.) measuring an average 8 m in length. The trees were 350 cm in height and the foliage 100 cm thick.

The tested equipment was a pneumatic system (**MARTIGNANI-KWH-B612**) operating at a "low volume" (100 l/ha in 1984; 120 l/ha in 1985), which had been fitted with an electrostatic device able to generate a 15000 Volt potential difference with 150 μ voltage.

The phytoiatric efficiency was assessed on the basis of the degree of protection against Venturia inaequalis provided by the two systems, pneumatic and pneumatic-electrostatic, which were operated one at a time. The machines advanced at a speed of 6 kph during the treatment.

The fungicide products used were bitertanol + mancozeb in 1984 and triforine + dithianon in 1985, applied in progressively decreasing doses (-25% in 1984; -20% and -40% in 1985) compared to the “standard” dose used at a “normal volume” of 1500 l/ha (tab. N° 1 and N° 2).

At both times, the treatments against apple scab were carried out to combat infections which had occurred during the period between blooming and growth of the fruit (tab. N° 1 and N° 2).

Assessments made after all the infections had been dealt with involved the fruit and leaves at three different foliage heights (h1 50-150 cm; h2 150-250 cm; h3 250-350 cm).

During 1984, assessments were also made in order to achieve a comparative evaluation of the amount of plant protection product (bitertanol) deposited on the apple tree leaves after one single application of a “standard” dose. Samples were then subjected to gas-chromatographic analysis after extraction of the active principle.

Analysis of the results

Working in conditions that were very favourable for the development of v. inaequalis infections and using a mixture of fungicides possessing a high degree of biological activity, especially in relation to the curative function, a good degree of leaf and fruit protection was observed for both the distribution systems used, as shown by the results obtained during the course of 1984 (tab. N° 1).

However, the tendency of the pneumatic-electrostatic system to provide a better protection for the leaves than the fruit was observed in these conditions.

25% dose reductions did not appear to sensibly influence the degree of leaf protection provided by the two systems. On the other hand however, and unlike the results observed for the “standard” dose applications, it should be emphasized how the pneumatic-electrostatic system tended to achieve a higher degree of action on the fruit.

In relation to the protection provided by the two systems at the various different foliage heights and to the different doses used, progressively increasing values of apple scab infection were evident in both the leaves and fruit as the height of the foliage progressed from 50 cm to 350 cm.

The assessments made in 1985, when the tests were conducted in the presence of a more serious infection than the previous year owing to the considerable quantity of v. inaequalis inoculum and using a mixture of fungicides possessing a high curative and preventive action (trifoline + dithianon), highlighted more marked differences in the action of the two distribution systems than those observed in 1984, also in relation to dosage reduction and the type of plant organ being protected.

More specifically, when the tests were conducted with a “standard” dose, we noted that the pneumatic-electrostatic system always provided a superior degree of action, although to no significant extent, than the pneumatic system in relation to both the foliage and fruit.

The electrostatic system’s greater degree of action was particularly evident with decreasing doses of product when it came to protecting the fruit, where applications with this system using doses reduced by 20% did not diminish the degree of action in any significant way, unlike the pneumatic system. In actual fact, the applications made with the pneumatic-electrostatic distribution system with doses reduced by 20% achieved similar results to those obtained with the pneumatic system and “standard” doses of product.

A further reduction to the dose (40%) led to a significant decrease in the degree of protection for both the systems as compared to applications with “standard” doses of product. In such operating conditions, the pneumatic system also presented significantly reduced levels of action in relation to applications made with the pneumatic-electrostatic system and 20% dosage reductions.

TAB. N° 1 - Distribution systems, product doses and results of the protection treatment against apple scab - year 1984 -

Distribution system	Dose of product (g/ha of P.C.)	Leaves (19/6)		Fruit (19/6)	
		Degree of damage at the different foliage heights (% of leaves affected)	Average % degree of action (% degree of damage)	Degree of damage at the different foliage heights (% of fruit affected)	Average % degree of action (% degree of damage)
Pneumatic-electrostatic	2250* + 1125** (standard)	h1 2.71a h2 3.85a h3 7.00a	80.11a	h1 2.00a h2 6.50a h3 11.17a	62.56a
Pneumatic	2250* + 1125** (standard)	h1 4.57a h2 6.14a h3 7.25a	73.67a	h1 1.00a h2 6.00a h3 8.75a	75.19a
Pneumatic-electrostatic	1687.5 + 843.75* (25% reduction)	h1 4.57a h2 4.85a h3 6.57a	76.56a	h1 2.00a h2 4.25a h3 8.25	74.42a
Pneumatic	1687.5 + 843.25* (25% reduction)	h1 5.14a h2 6.85a h3 6.28a	73.23a	h1 2.50a h2 7.75a h3 31.75a	66.42a
Control	-	h1 28.00b h2 20.00b h3 20.25b	(22.75)	h1 18.50b h2 25.00b h3 22.00b	(21.83)

* Dose of mancozeb, equal to 150 g/h1 of commercial product with 80% of A.P.
** Dose of bitertanol, equal to 75 g/h1 of commercial product with 25% of A.P.
Infection dates: 29/4; 5/5; 9/5; 15/5; 19/5.
Treatment dates: 2/5; 11/5; 18/5; 24/5; 6/5.

TAB. N° 2 - Distribution systems, product doses and results of the protection treatment against apple scab - year 1985 -

Distribution system	Dose of product (g/ha of P.C.)	Leaves (27/6)			Fruit (26/6)		
		Degree of damage at the different foliage heights (%)	Average % degree of action (% degree of damage)	Increases in the degree of protection (%)	Degree of damage at the different foliage heights (%)	Average % degree of action (% degree of damage)	Increases in the degree of protection (%)
Pneumatic-electrostatic	2250* + 750** (standard)	h1 7.66 h2 8.33 h3 7.23	86.77	10.44	h1 0.66 h2 1.66 h3 5.66	82.38a	17.84
Pneumatic	2250* + 750** (standard)	h1 10.50 h2 15.83 h3 13.83	77.21ab		h1 2.93 h2 3.99 h3 7.68	62.68ab	
Pneumatic-electrostatic	1800 + 600 (20% reduction)	h1 12.50 h2 12.50 h3 14.66	77.98ab	4.37	h1 3.66 h2 2.99 h3 8.33	66.95ab	28.58
Pneumatic	1800 + 600 (20% reduction)	h1 13.50 h2 15.50 h3 16.83	74.57ab		h1 3.32 h2 6.53 h3 13.99	47.81c	
Pneumatic-electrostatic	1350 + 450 (40% reduction)	h1 13.83 h2 21.83 h3 18.33	70.04bc	12.40	h1 2.99 h2 7.33 h3 12.23	50.00c	42.66
Pneumatic	1350 + 450 (40% reduction)	h1 23.16 h2 23.16 h3 23.33	61.34bc		h1 6.33 h2 9.33 h3 16.66	28.67c	
Control	-	h1 66.66 h2 63.83 h3 49.66	(60.06)		h1 9.33 h2 14.21 h3 21.77	(15.10)	

* Dose of triforine, equal to 150 g/h1 of commercial product with 18% of A.P.
** Dose of dithianon, equal to 50 g/h1 of commercial product with 75% of A.P.
Infection dates: 24/4; 4/5; 12/5; 29/5; 1/6.
Treatment dates: 29/4; 8/5; 16/5; 23/5; 31/5.

When the dose was reduced by 40%, a significant decrease in the degree of foliage protection for both the systems was only observed in comparison with the pneumatic-electrostatic system and “standard” doses.

Further analysis of the results concerning the trend of the % increases in the degree of action provided by the electrostatic system as compared to the pneumatic one in relation to dosage variation (Fig. N° 1) showed that while, speaking of the fruit, that increase grew as the doses decreased, there were no appreciable variations on the foliage, thus confirming that the electrostatic system is highly efficient for fruit protection.

With regard to the protection achieved at the different foliage heights, the results of the previous year were confirmed again, thus the degree of action provided by both the systems decreases as the plants become taller.

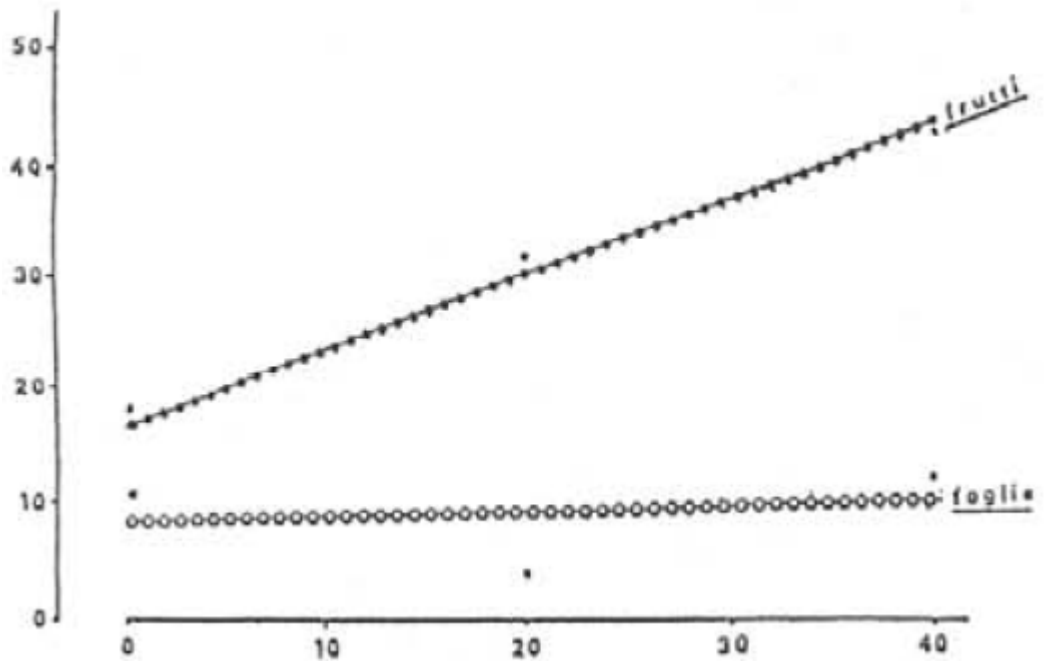
The analysis showed that there was a greater amount of active principle deposited on the leaves (Fig. N° 2) in the plots treated by the pneumatic-electrostatic system and this confirmed the results of the biological action. We also noted that when the product was applied with the electrostatic system, the presence of wind (0.3 m/sec.) did not influence the formation of the deposit in either of the rows directly subjected to the treatment, on which the weighted values were more or less identical.

The results of the applications made with the pneumatic system were extremely different, as a greater quantity of product was applied to the downwind row, thus highlighting the problem of reducing drift.

The results obtained from the two-year experimentation allow the following considerations to be made:

- Applied to the “low volume” pneumatic system, the electrostatic device sensibly improved the phytoiatric efficiency of the treatment against apple scab.

FIG. N° 1 - Variation of the ratios pertaining to the % increases of the degree of foliage and fruit protection provided by the electrostatic system as compared to the pneumatic one in relation to the reduction in the dose of product applied per unit of area.

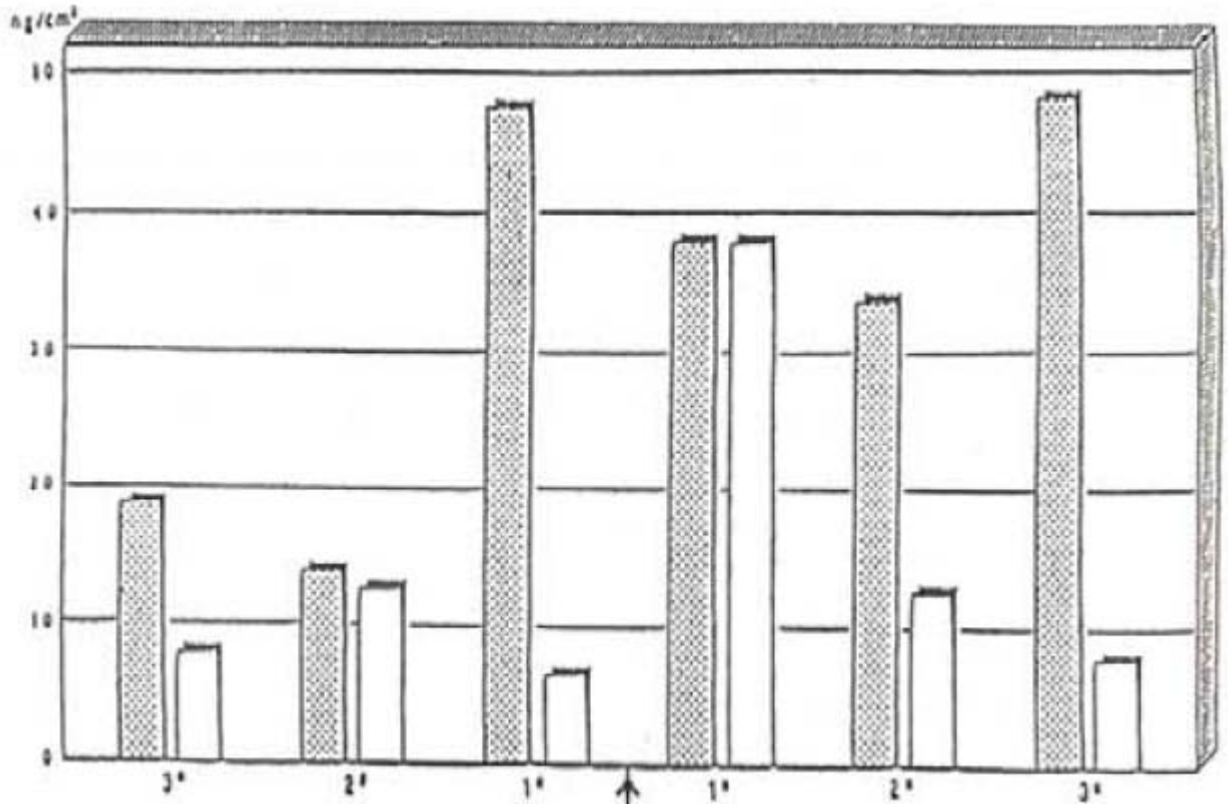


fruit

% increases in the degree of protection

foliage

FIG. N° 2 - Foliage coverage of bitertanol after an application with the examined distribution systems



- The more evident positive effects of the applications made with these systems were achieved in relation to fruit protection, also when reduced amounts of product were used. Compared to the pneumatic system used with the “standard” dose, the degree of protection did not diminish when 20% less product was used even when serious infections by the pathogen were treated.
- Since it created less drift, the pneumatic-electrostatic system also proved to be superior when it came to plant coverage, as less product was dispersed in the environment and wasted.
- However, the pneumatic-electrostatic system failed to achieve any substantial improvements in the protection of the higher parts of the foliage, where drift phenomena were more accentuated. This was evidently due to the attenuation to which the electrostatic charges were subjected owing to the longer distance the droplets were forced to travel in order to reach the tops of the trees.

In conclusion, the electrostatic system proved to be valid owing to the advantageous way it was able to distribute plant protection products over tree crops by means of equipment operating in the “low volume” mode.

More specifically, this system helps to get the most out of "low volume" applications since it improves the degree of coverage over the plants, particularly the fruit, reduces the amount of product that goes to waste through drifting or losses on the soil and thus requires less of the plant protection product itself.

However, use of the electrostatic system generally depends on the chemio-physical and biological characteristics of the pesticide employed, the type of pathogen and the seriousness of the infection it causes as well as the shape and size of the foliage treated.

SUMMARY

EFFICACY OF “LOW VOLUME” SPRAYS FOR APPLE SCAB CONTROL WITH THE ELECTROSTATIC-PNEUMATIC SPRAY SYSTEM.

The results obtained during a two-year trial period clearly demonstrated the superiority of an electrostatic-pneumatic spray system as compared to a simple pneumatic system for treating apple scab with fungicides, especially as regards fruit protection. Lower fungicide doses (up to 20% less) could be delivered by this system since less product was wasted due to drift while a higher amount was deposited on the surface of the fruit. However, the pneumatic-electrostatic system did not appear to substantially improve the degree to which the taller parts of the foliage were protected.

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