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Thiram residues on glasshouse lettuce[1,2]

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Summary

Growth of the plant proves to be the most important factor influencing thiram residue levels in lettuce. In relation to crop growth the time of application is important: the later the application, the higher the residue. The number of applications and the amounts of thiram applied also determine the final residue levels. The effect of irrigation is small. A certain amount of the residue can be washed off only if irrigation is applied in the early stages of crop development. The investigation has also shown that other processes may have an effect on the residue levels.

Introduction

Besides the influence of the growing techniques, effective pest and disease control is of great importance for the quality of glasshouse lettuce. The most damaging pests of the crop are cutworms (*Agrotis sp.*) and aphids, but both are relatively easily controlled. A single application of a short-living insecticide is often all that is required to control the pests. Usually there are no problems with these insecticides with regard to residues at the moment of harvest.

Of the fungal diseases, *Botrytis cinerea* and *Rhizoctonia solani* occur most frequently, whilst *Sclerotinia minor*, *Sclerotinia sclerotiorum* and *Bremia lactucae* crop up less frequently. Most of them are soil-borne and can be eradicated by soil desinfection or fungicides can be applied to protect the plants. The main problem in preventing an attack of these diseases by the use of fungicides is the fact that the chemicals must be applied in an early stage of crop development as later on the soil surface is covered completely by the crop. This means that the fungicides used must be persistent enough to offer protection to the crop during the whole period of growth. Added to this there is the problem that even a light disease infection may result in a substantial deterioration in quality and serious financial losses.

It is almost always possible to find residues of fungicides on glasshouse lettuce. An important aspect of the residue problem in lettuce is the unfavourable relationship between the surface area of the lettuce and its weight. As residue levels are always expressed in parts per million of the weight, it is obvious that the lettuce with its disproportionate surface/weight ratio is very much at a disadvantage.

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[2] Publikatie van het Proefstation voor de Groenten- en Fruitteelt onder Glas te Naaldwijk No 213.

The fungicide thiram is widely used in the glasshouse lettuce crops. It is applied as a 10 % dust for the control of *Botrytis cinerea.* Formerly this fungicide was applied regularly right up to the stage when the crop covered the whole of the soil surface. Later on, only a single treatment was given with a higher dosage rate shortly after planting.

The following factors may have a bearing on the residue levels:

1. the amount applied per treatment;
2. the time of application;
3. the number of treatments;
4. the growth of the plant;
5. irrigation.

Results and methods

A number of experiments were carried out to analyse the influence of these factors. The experiments were usually carried out in normal lettuce crops in which the thiram dust was applied with a small type dust applicator. For factors 1 and 2, the residue levels were determined at crop harvest only, with samples of 3 to 5 heads per treatment. For factors 3, 4 and 5 the residue levels were monitored throughout the growing period. Depending on the size of the lettuce, samples consisting of a certain number of heads were analysed at weekly intervals. The thiram residue levels were determined colorimetrically and in a later stage of the investigation with the CS_2 method. The analyses were carried out by the Central Institute for Nutrition and Food Research at Zeist.

Amount applied per treatment

The results achieved in the control of fungal diseases depend, amongst other things, on the amount of fungicide applied. The following treatments, applied under identical conditions, were designed to determine whether the residue levels found in the crop are proportionate to the amount of fungicide used:

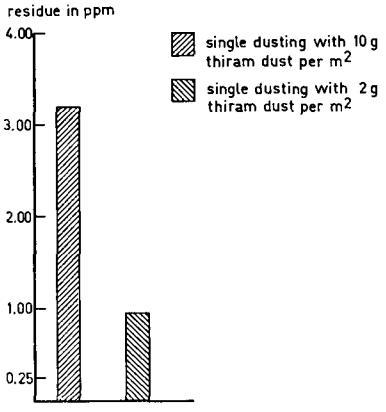

Fig. 1. Effect of the amount of fungicide applied on the final residues found in lettuce.

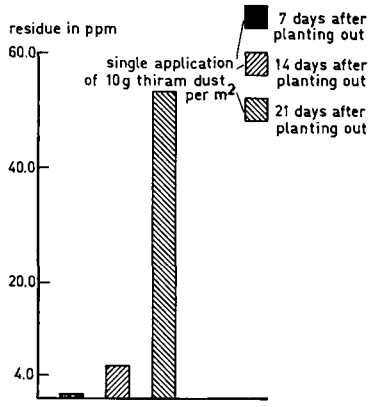

Fig. 2. Effect of the time of application of the fungicide on the final residues found in lettuce.

A. a single application of 10 g thiram dust per m²;
B. a single application of 2 g thiram dust per m².

Fig. 1 gives the results of the residue determinations carried out for the two treatments 18 days after application of the fungicide. The graph shows that on the whole the amounts of fungicide applied are reflected in the residue levels. This might indicate that thiram is relatively stable on the plant.

Time of application

The time of application may be an important factor in the control of the disease as well as in the residue levels. In order to determine the latter aspect the following treatments were applied:

A. a single application of 10 g thiram dust per m² at 7 days after planting;
B. a single application of 10 g thiram dust per m² at 14 days after planting;
C. a single application of 10 g thiram dust per m² at 21 days after planting.

The results are shown in Fig. 2. The time of application obviously has a great effect on the residue levels. The treatment at 21 days after planting out – in this case equivalent to a treatment at 6 days before harvest – resulted in a very high residue level.

Number of treatments

The residue levels found after a series of fungicide applications are the result of the amounts applied and of the times of the treatments. To obtain more information about these aspects the following treatments were applied:

A. a single application of 10 g thiram dust per m² at 7 days after planting;
B. a single application of 10 g thiram dust per m² at 14 days after planting;
C. a single application of 10 g thiram dust per m² at 21 days after planting;
D. three applications of 3.3 g thiram dust per m² at 7, 14 and 21 days after planting.

Fig. 3 shows the results. In this experiment the residue levels were determined at

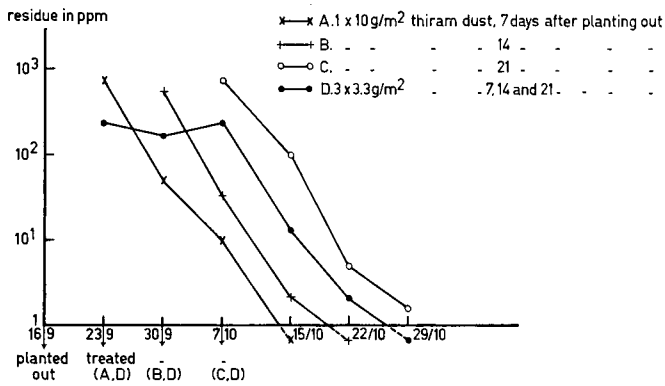

Fig. 3. Effect of a number of successive threatments on the residue levels in lettuce compared with a single treatment.

weekly intervals. As was to be expected, the highest levels were found with 10 g per m² at 21 days after planting.

However, where in total 10 g per m² was applied in three stages, high residue levels were also found, higher than those resulting from the single application of 10 g per m² at 14 days after planting.

With successive treatments it is almost inevitable that one or more of the treatments are applied at a late stage in the growing period, resulting in high residue levels, higher than are obtained usually with a single application at a greater dosage rate carried out at an early stage of the crop.

Growth of the plant

If one supposes that factors like breakdown of the compound and cultural operations have no bearing on the eventual residue levels, it could be postulated that the residue levels decrease in proportion to the growth of the plant. It would then become possible to calculate the residue level at any given time by determining the plant weight and relating it to the residue level immediately after application. This could be done with the equation

$$R_x = (G_1/G_x) \times R_1$$

in which G_1 represents the original weight of the plant and R_1 the original residue level. G_x represents the weight of the plant determined at stage x. R_x will be defined as 'growth residue'. Fig. 4 shows the growth curve of a lettuce plant, the 'growth residue' calculated from an experiment in which 10 g of thiram dust per m² was applied 7 days after planting, and the actual residue found in this experiment. As the experiment was started late in autumn, growth was relatively slow and the crop took more than two months to mature. Under more favourable conditions the growing period would have been reduced to 5 weeks. However, the 'dilution' of the fungicide by crop growth is not affected by the rate of growth.

If the calculation is based on the increase in crop weight, the initial residue of

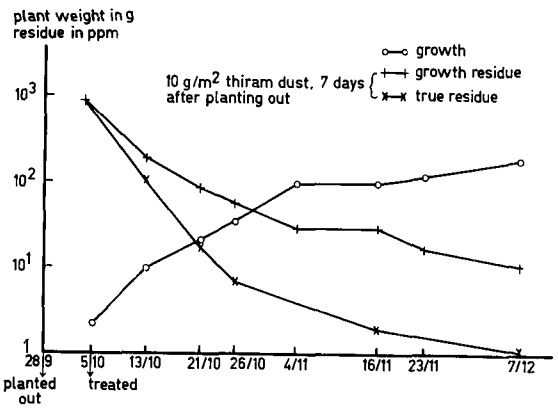

Fig. 4. Effect of the growth of the crop on the residue levels in lettuce.

1000 ppm immediately after application of the fungicide should have decreased to 10 ppm at the moment of harvest. In fact, it was only 1 ppm. This shows that crop growth is the most important factor in the disappearance of the fungicide. Other factors which play a part are relatively unimportant in this type of fungicide. Nevertheless, they have practical importance in meeting the legal residue tolerances. Amongst other factors, the effect of irrigation during the growing season was further investigated.

Irrigation

If the fungicide is applied actually to the plant, as is the case with dusting, crop irrigation would have a direct effect on the residues. However, irrigation is an operation which is applied in accordance with the crop's requirements and not as a means of regulating pesticide residues. It follows that the grower may apply little irrigation, that he may use irrigation at the start of the crop or more towards the end.

An attempt was made in a number of experiments to gain more information on the effect of irrigation under different conditions. For this purpose comparisons were made between two experimental plots which had been dusted with 10 g thiram per m². One plot was watered several times with the aid of spray lines and the other with trickle irrigation which excluded washing off of the residues.

The capacity of the spray lines was about 55 mm per hour and for each watering the lines were switched on for 10 to 15 minutes. Comparable quantities of water were applied with the trickle irrigation system. The irrigation frequencies used were:

A. seven applications of water, the first one two days after dusting;
B. five applications of water, the first one 45 days after dusting.

Fig. 5 shows the residue levels during the growing period. In order to distinguish between the two types of irrigation, reference is made to 'residue spray' and 'residue trickle'.

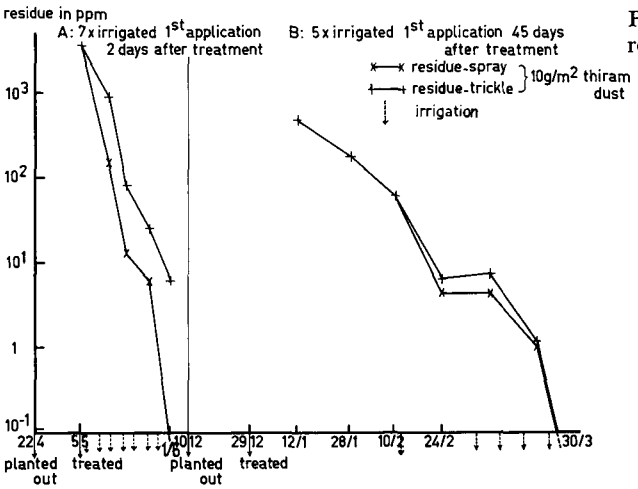

Fig. 5. Effect of irrigation on residue levels in lettuce.

In all the experiments a certain amount of the residue disappears as a result of irrigation.

In Experiment A a great deal of irrigation was applied right through the growing season. A difference in residue levels was found at the second sampling between the spray line treatment and the trickle irrigation treatment. This difference remained about the same throughout the growing season.

In Experiment B no water was applied in the early stages of the crop. Although some difference in residue levels was found after the first watering, the difference was much smaller compared with that found in Experiment A. It is probable that the fungicide is partly removed from the young plant only and that there is hardly any washing off of the fungicide from older plants or that the fungicide is merely washed to the heart of the lettuce.

How much effect irrigation has on the final residue levels depends on the reduction in residue levels caused by irrigation at the beginning of the season. In other words, it depends on how often irrigation is applied in the early stages of crop development.

Effects of other factors on residue levels

The investigation has shown that there must be other factors which have an effect on the residue levels. In experiments in which water was applied by trickle irrigation, excluding the possibility of washing off of the chemical, consistently lower residue levels were found than could have been expected as a result of crop growth. Very little is known about the cause of this, but it is supposed that chemical and physical processes may be involved. More information about these processes might well produce a more complete explanation of the thiram residue levels in lettuce.