Danish Research Service for Plant and Soil Science **Report no. 1814**
Research Centre for Horticulture[1)]
Institute of Glasshouse Crops
DK-5792 Årslev

Research Centre for Plant Protection[2)]
Laboratory for Pesticide Analysis
Flakkebjerg
DK-4200 Slagelse

Residues of ancymidol cultivating *Aeschynanthus* in recirculating nutrient solution

Rester af ancymidol ved dyrkning af Aeschynanthus *i rindende vand*

Erik Adriansen[1)] **and Peder Odgaard**[2)]

Summary
In an experiment with chemical growth regulation of the pot plants *Aeschynanthus hildebrandii* and *A. speciosus* the recirculating nutrient solutions were supplied with different amounts of ancymidol. The solutions were replaced twice without repeated ancymidol addition. Samples of the solutions and of the pot soil were taken throughout the experimental period (about 5 months) for ancymidol analysis.

The ancymidol disappeared gradually from the solutions, mainly due to adsorption to the pot soil. At the first replacement of the nutrient solutions, 3–5 weeks after application, up to 20% of the initial ancymidol still remained in the solutions. In the applied soil/solution system the adsorption coefficient for ancymidol was determined to be about 100. Therefore, a small part of the adsorbed ancymidol may be released into the new solution after replacement.

The total residues of ancymidol decreased during the experimental period. At the end of the experiment 2–10% of the supplied ancymidol was found in the pot soil, while nothing could be detected in the recirculating nutrient solutions.

Key words: *Aeschynanthus,* ancymidol residues, recirculating nutrient solution, soil adsorption.

Resumé
I et forsøg med vækstregulering af potteplanterne *Aeschynanthus hildebrandii* og *A. speciosus* er ancymidol i forskellige doseringer tilsat de recirkulerende næringsstofopløsninger. Disse er udskiftet 2 gange uden ny tilsætning af ancymidol. Prøver af næringsstofopløsninger og pottejord er analyseret for ancymidol på forskellige tidspunkter fra tilsætningen til forsøgets afslutning efter 19–23 uger.

Ancymidol forsvinder efterhånden fra opløsningen, hvilket overvejende skyldes adsorption til pottejorden. Ved første udskiftning, 3–5 uger efter tilførsel, er der endnu op til 20% af den tilsatte mængde ancymidol til stede i opløsningen. I det anvendte jord/vand-system var adsorptionskoefficienten for ancymidol omkring 100. Derfor frigøres sandsynligvis lidt af det adsorberede ancymidol i den nye næringsstofopløsning.

Den fundne totale mængde ancymidol falder med tiden. Ved forsøgets afslutning er der ikke påvist ancymidol i den recirkulerende næringsstofopløsning, og i pottejorden er der kun genfundet 2–10% af den tilsatte mængde.

Nøgleord: *Aeschynanthus*, ancymidol restkoncentrationer, recirkulerende næringsstofopløsning, jordadsorption.

Introduction

Ancymidol (Reducymol) is a growth retardant used in pot plant production. Applied as a soil drench ancymidol has a stronger effect than a foliar spray (6, 13). Unfortunately soil drench is a more time consuming method of application. However, in a water culture system it is easy to add ancymidol in the reservoir of the recirculating nutrient solution. It is shown that ancymidol added in this way retards the growth of 3 tested pot plant species, *Beloperone guttata* T.S. Brandegee, *Clerodendrum thomsoniae* Balf. f. and *Crossandra infundibuliformis* Nees 'Mona Wallhed' (1). The effect of an ancymidol supply in the solution is identical to that of ancymidol applied as soil drench (2, 3).

Replacement of the recirculating nutrient solution reduces the problems in keeping the optimum pH, composition and concentration of fertilizers in the solution. The replaced solution of fertilizers may be used on areas outside the greenhouses. In cases when ancymidol has been added it is necessary to know the residues for safe distribution.

Under acidic conditions (pH 4 or less) ancymidol degrades rapidly. When pH is maintained above 6, the compound is stable even at temperatures up to 50°C (8). Aqueous solutions of ancymidol at pH 7 and 11 have shown no degradation after 4 months at 25°C (5). In water culture the pH is usually kept between 5 and 6.5, and only on hot summer days the solution temperature rises to more than 25°C. Only slight degradation of ancymidol in the recirculating nutrient solution should therefore be expected immediately. However, the microbiological activity in the soil may cause degradation of the chemical (10), although no metabolites or degradation products are mentioned in the literature.

Ancymidol is moderately soluble in water, at 25°C approximately 650 mg can be solved per l (5). Its distribution in a soil/water system is governed by the solubility in water and its affinity to the soil medium. In a leaching experiment followed by chemical analyses, ancymidol had a much stronger adsorption to a pine bark medium than to mineral soils. Therefore a much higher ancymidol concentration was necessary in the strong adsorbing medium than in mineral soil to obtain equal growth regulating effects. Compared to pine bark, peat containing media seemed to cause weaker adsorption (12).

Einert (7) found that clay pots soaked in ancymidol solution before use adsorbed sufficient amounts to retard the growth of poinsettia. When higher concentrations were used for soaking, there was still retarding effect from the pots in a subsequent biological test, although new soil was used.

In the experiment with 3 pot plant species (1) the recirculating nutrient solution was replaced 3 weeks after ancymidol supply. Ancymidol was not added to the new solution. Nevertheless, at the end of the experiment 3–5 weeks later there was a retarding effect corresponding to a soil drench. It may be due to some ancymidol adsorbed to the pot soil, of which peat was forming the greater part.

For the present work, samples of recirculating solution and pot soil from a growth regulation experiment (4) have been taken periodically and analysed for ancymidol, to elucidate its soil/water distribution and persistence.

Materials and methods

Experiments with plants

Water and soil samples for ancymidol analyses were taken from an experiment with *Aeschynan-*

thus hildebrandii Hemsl. 'Ildebrand' and *Aeschynanthus speciosus* Hook. described by *Adriansen & Andersen* (4).

Each water culture unit included a tray (54 × 80 cm), a tank (25 l) and a centrifugal pump (4.0–4.5 l/min.). 30 pots were placed in each tray on a Fibertex-mat.

The solution in the tanks was replaced twice during the growing period and ancymidol was not added to the fresh solution.

The pot soil consisted of 3 parts (by volume) of peat without fertilizer and 1 part peat/clay mixture with lime and fertilizer.

Water and soil samples in *A. hildebrandii* were taken from units supplied with 0, 3.75 and 7.5 mg ancymidol. In *A. speciosus* the samples were taken from units supplied with 0, 7.5 and 15 mg. Duplicate samples were obtained by means of 2 units set up in each combination of species and ancymidol concentrations.

Water samples were taken from the tanks as shown in Table 1. At sampling number 1 the samples were taken just after ancymidol was added and the solution was stirred, but before the pumps were started. Samplings number 6 and 7 were carried out just before the 1st and 2nd replacement of the recirculating solution. Sampling number 8 was at flowering or at the end of the experiment.

Soil samples were taken at the same time as water samples number 2, 3, 4 and 8.

Table 1. Time from ancymidol addition to water sampling.

	A. hildebrandii		*A. speciosus*	
Sampling no.	Time from addition to sampling	Date	Time from addition to sampling	Date
1.	c. 15 mins	27/3	c. 15 mins	28/3
2.	1 hour	27/3	1 hour	28/3
3.	24 hours	28/3	24 hours	29/3
4.	1 week	3/4	6 days	3/4
5.	2 weeks	10/4	2 weeks	11/4
6.	5 weeks	1/5	3 weeks	18/4
7.	9 weeks	29/5	7 weeks	16/5
8.	19 weeks	8/8	23 weeks	4/9

Experiment without plants

The adsorption to soil was examined in the laboratory by addition of 3 different ancymidol quantities to mixtures of pot soil and nutrient solution. After shaking to homogeneity, the mixtures were left for 24 hours, then filtered, and the filtrates analysed for ancymidol.

Analyses

All samples were stored at a low temperature (2–5°C). The soil samples were not dried, but their water contents were determined contemporaneous with ancymidol analyses.

Ancymidol was determined by gas chromatography. The nutrient solutions were analysed mainly as described for ancymidol formulations by *Frank & Wilson* (9), and the soil analyses were based on a method described by *Frank & Day* (8).

The following modifications were introduced: Solution samples were extracted with dichloromethane instead of ethyl acetate. Soil samples were also extracted with dichloromethane directly, and the described acetone/ethanol extraction and charcoal clean-up was omitted. A florisil column clean-up of the dichloromethane extract was inserted. For both water and soil the residues were taken up in dichloromethane for gas chromatography. Phtalic benzylbutyl ester was used as internal standard. The g.c. column, glass, 2 m × 2 mm i.d., packed with 2.5% SE-30 on Diatomite MQ, 80–100 mesh, was operated at 205°C.

Duplicate analyses were carried out for each sample. Detection limits and recoveries of ancymidol are shown in Table 2.

Table 2. Detection limits and recoveries for ancymidol in recirculating nutrient solution and soil.

	Solution	Soil (approximately)
Detection limit	0.005 mg/l	0.1 mg/kg
Recovery		
at 0.2 mg/l or mg/kg	100%	50%
at 1.0 mg/l or mg/kg	100%	80%

Results and discussion

In Fig. 1, a–d the quantities of ancymidol recovered are stated in % of the initial added amounts, calculated as averages of duplicate samples and duplicate analyses. The standard deviation of each average is shown for the solution and for the root medium, except if the standard deviation is less than 4% of added ancymidol.

The total ancymidol content in the soil/water system decreased with time, undoubtedly due to degradation and plant uptake. Solution replacement caused some decrease as well.

Nutrient solution

The curves in Fig. 1 for ancymidol content in the recirculating nutrient solution show a distinct decrease already during the first day. After one week only 30–35% of added ancymidol was still present in the solutions. However, this is compensated for by the ancymidol content in the pot soil, indicating that adsorption was the main reason for disappearance of ancymidol from the solution in the first time.

Until the first replacement of solutions (for *A. speciosus* after 3 weeks and for *A. hildebrandii* after 5 weeks) the ancymidol content decreased to between 10 and 20% of added.

By each replacement of a solution the remaining part was diluted, with respect to ancymidol, approximately by a factor of 5. This part consisted of the solution in the system outside the tank. In Fig. 1 the dilutions are illustrated by discontinuation of the curves.

Detectable amounts of ancymidol were also found at the second replacement of solutions. The absolute concentrations just before first and second replacement were 0.02–0.12 mg/l and 0.005–0.03 mg/l, respectively.

In solution supplied with 0.6 mg ancymidol/l, the concentration at the first replacement (after 3 weeks) was 0.12 mg/l. Using the solution on lawns this and even higher concentrations may be harmless. But if it were to be used on ornamental plants or vegetables, the possibility of undesirable effects should not be disregarded. Delayed flowering was observed in *A. hildebrandii* treated with 0.075 mg ancymidol/l of solution (4).

At the end of the experiment ancymidol residues in the solutions were below the detection limit.

Soil

Soil adsorbed ancymidol is calculated from the concentration found in wet soil samples (with known water content) with the aid of the K_d adsorption coefficient, determined by the laboratory adsorption test. This coefficient is the amount of ancymidol adsorbed per g dry matter, related to the amount dissolved per g solution, when equilibrium is obtained.

A K_d value of approximately 100 was found for the combination of pot soil and solution used. It is possible that this value is not exactly valid for each unit or each pot. However, when the K_d is relatively high, some fluctuations do not greatly influence the calculation of adsorbed ancymidol.

Some root material included in the soil samples and especially the low ancymidol recovery in soil analyses were probably sources of greater variation than expressed by the standard deviation.

The greatest amount of adsorbed ancymidol was usually found in samples taken 1 week after the addition (Fig. 1). It is likely that the equilibrium between solution and soil had then been achieved, on the whole, and subsequently degradation (10), and plant uptake, might cause a decreasing curve.

At the end of the experiment after 19 or 23 weeks about 1 mg ancymidol/kg dry soil was still present, except for the lower dose in *A. hildebrandii*. Therefore 2–10% of the added ancymidol then remained in the soil, even if the solutions had been replaced twice. Small amounts of the adsorbed ancymidol might have been released into the new solutions, according to the K_d value.

The found ancymidol persistence agrees with the literature cited in our introduction (1, 5, 7, 12). Later *Seeley* (11) demonstrated that sufficient ancymidol to retard *Chrysanthemum* growth persisted in a loam/peat/perlite medium, in which *Lilium longiflorum* had been grown for 11 weeks after a single drench.

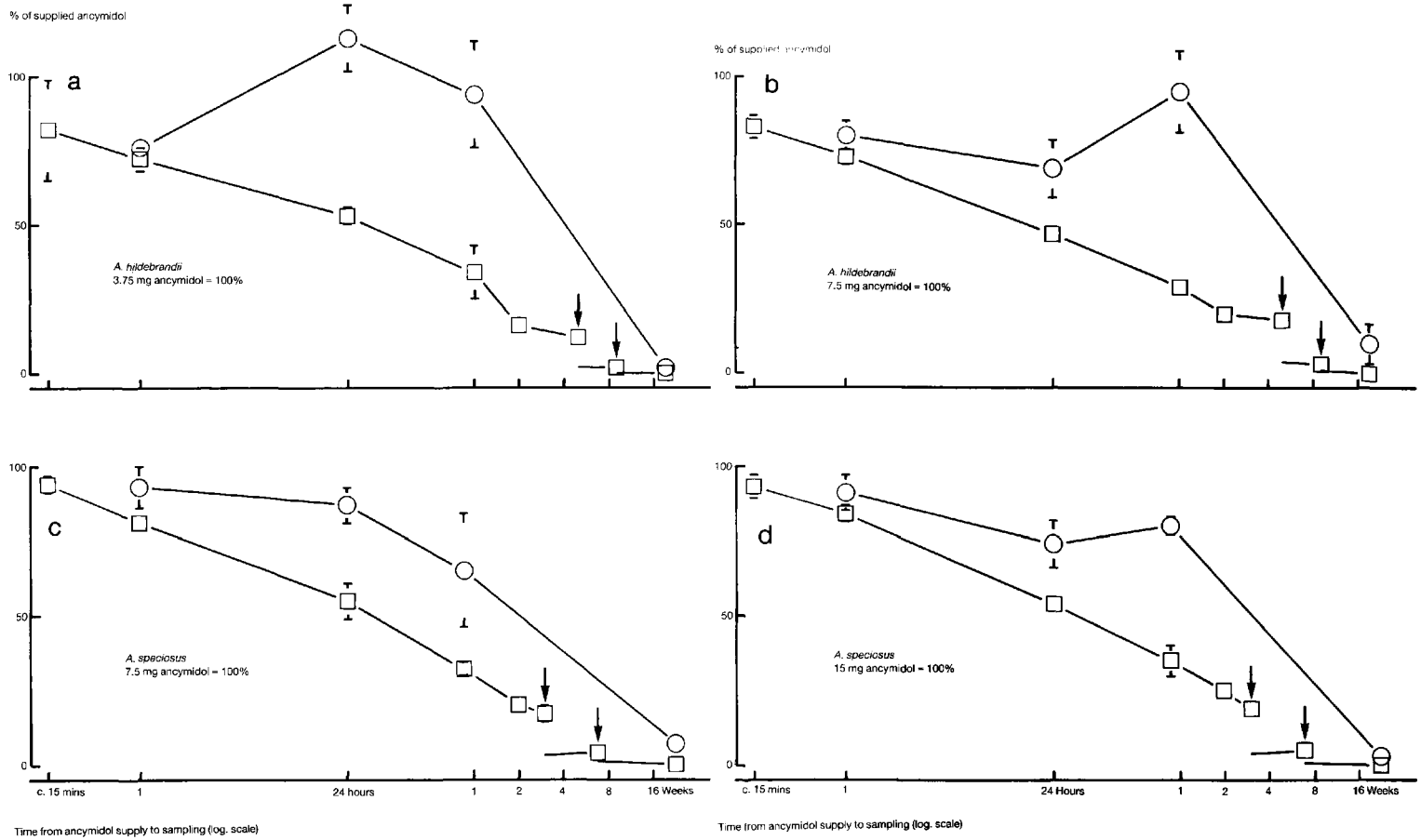

Fig. 1. Relative amounts of ancymidol found by analysis of the recirculating nutrient solution and the root medium. Mean of duplicate samples. 100% of the ordinate is the amount of ancymidol added to 25 l solution, feeding 30 pots.

o——o Total in the solution and root medium.

□——□ In the solution.

↓ The solution replaced.

T
⊥ Standard deviation (not shown if less than 4%). The standard deviations on total curves refer to the root medium only.

Conclusion

When ancymidol is added to a recirculating nutrient solution, the greater part will be adsorbed to the pot soil. Because of this there is sufficient ancymidol to maintain the retarding effect on plants even after replacement of the solution, by means of desorption from the soil.

At replacement, after several weeks, the solution still contains ancymidol in a concentration which may complicate its disposal.

After several months, including 2 replacements, ancymidol is not detectable in the last solution, but some ancymidol still remains in the pot soil.

Further investigations, including plant analyses, are needed with different irrigation systems, plant species and pot substrates together with growth regulators to elucidate their conditions of effect and pathways of disapperance and degradation. With greater knowledge plant growth regulators can be utilized even more effectively and safely than today.

Literature

1. *Adriansen, E.* 1976. Retardering af vækst hos potteplanter dyrket i rindende vand. Statens Planteavlsforsøg. Meddelelse nr. 1272. Wuchshemmung von Topfpflanzen in Fliesrinnen. Gartenwelt 76, 275–276.
2. *Adriansen, E.* 1979. Growth retardation of potted plants cultivated in water culture, with ancymidol applied to the nutrient solution. Acta Hort. 91, 387–393.
3. *Adriansen, E.* 1980. Virkning af daglængde og tilførselsmetode for ancymidol på blomstring og vækst hos *Clerodendrum thomsoniae* Balf. f. Tidsskr. Planteavl 84, 399–413.
4. *Adriansen, E. & Andersen, H.* 1983. Virkning af gødskningsperioder, Reducymol og Atrinal hos 2 *Aeschynanthus*-arter. Tidsskr. Planteavl 87, 167–177.
5. *Anonymous* 1972. Technical report on A-Rest (ancymidol). Elanco Products Company, Indianapolis, USA, 1–4.
6. *Cathey, H. M. & Heggestad, H. E.* 1973. Effects of growth retardants and fumigations with ozone and sulfur dioxide on growth and flowering of *Euphorbia pulcherrima* Willd. J. Amer. Soc. Hort. Sci. 98, 3–7.
7. *Einert, A. E.* 1976. Slow-release ancymidol for poinsettia by impregnation of clay pots. HortScience 11, 374–375.
8. *Frank, R. & Day, E. W.* 1976. Analytical methods of pesticides and plant growth regulators (G. Zweig, ed.) 8, 475–482.
9. *Frank, R. & Wilson, J.* 1971. Technical paper. Eli Lilly and Company, Greenfield, Indiana, 1–4.
10. *Perkow, W.* (ed.) 1971. Wirksubstanzen der Pflanzenschutz- und Schädlingsbekämpfungsmittel. Ancymidol, 2 p. 2. Ergänzungslieferung 1976. Verlag Paul Parey.
11. *Seeley, J. G.* 1982. Retention of ancymidol in a soil medium and in clay pots. HortScience 17, 198–199.
12. *Tschabold, E. E., Meredith, W. C., Guse, L. R. & Krumkalns, E. V.* 1975. Ancymidol performance as altered by potting media composition. J. Amer. Soc. Hort. Sci. 100, 142–144.
13. *White, J. W. & Holcomb, E. J.* 1973. Height control methods for poinsettias. Penn. Fl. Gr. Bull. (267) 2,16.

Manuscript received 9 October 1985.