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# THE RELEVANCE OF ULTRA LOW VOLUME SPRAYING FOR THE APPLICATION OF FUNGICIDES TO PROTECT WINTER LETTUCE UNDER GLASS AGAINST GREY MOULD

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Summary The advantages of ultra low volume spraying are particularly relevant to the protection of winter lettuce under glass against fungal pathogens. Apart from the obvious advantages of saving time and labour at application, control of grey mould was achieved at dosage levels much lower than those currently recommended for conventional methods.

The ultra low dosage factor has a very significant bearing on the current concern over dithiocarbamate residues on lettuces at the time of harvesting. Conventional application methods frequently lead to excessive residue levels.

Trials showed that a thiram/dicloran mixture applied by ULV at regular intervals gave better protection against grey mould on lettuce than thiram applied by conventional high volume methods, and gave residues well below those permitted by current EEC legislation.

## INTRODUCTION

The dithiocarbamate fungicides thiram, mancozeb and zineb are widely used on outside and glasshouse lettuce as protectants against grey mould (Botrytis cinerea) and downy mildew (Bremia lactucae).

Lettuce is a high-value, long term crop when grown in winter under unheated glass. In a cold season the growing period may be as long as three months, and grey mould and downy mildew are a constant threat. Thiram is applied widely as a protectant against grey mould, either by conventional HV spray methods or as a dust. With these methods, clearly visible deposits on the leaves frequently occur, but of greater significance is the large amount of dithiocarbamate residue which can occur.

The general position of ULV spraying in British horticultural practice has been reviewed by Lewis and Sylvester (1974). Its main advantages are well known, but several points are particularly relevant to lettuce crops. Firstly, the waterless nature of the spray is an advantage in a long term fungus-prone crop where minimal watering is a necessary element of good husbandry. Secondly, ultra low dose (ULD) has a particular advantage where residue build-up may occur on a long-term crop. The commercial application of the ULV system, with particular reference to lettuce under glass, has recently been reviewed by Sylvester and Lewis (1976).

As a result of surveys by the Association of Public Analysts (1975 and 1976) on lettuce samples showing residues well above the permitted limit of 5 p.p.m., the Advisory Committee on Pesticides and other Toxic Chemicals recommended that for lettuce the minimum interval between last application of all dithiocarbamate fungicides applied by HV or dust should be raised from the current one week (two days in the case of Zineb under glass) to two weeks.

In 1976 an EEC Council Directive set a maximum permissible level of dithiocarbamate on lettuce at marketing of 3 p.p.m. This has posed growers with a difficult practical problem, since this low level is virtually impossible to maintain at current recommended dosage levels and frequencies using thiram, mancozeb or zineb as HV spray or dust applications.

With these facts in mind, a series of trials was conducted on winter lettuce under glass, comparing a thiram/dicloran-based ULV spray with the recommended HV thiram programme, in terms of efficiency against grey mould infection, and build-up of chemical residues on the crop over the treatment periods.

## MATERIALS AND METHODS

a) Biological efficiency trials

Three commercial scale grower trials were undertaken in the Lea Valley area in early 1975 comparing the following treatments:-

1 Untreated control
2 ULV thiram/dicloran mixture applied at weekly intervals with a Turbair Tot rotary atomiser ULV sprayer at a combined rate of 0.42 kg a.i./ha in a spray volume of 5.6 l/ha at each application.
3 HV thiram applied at fortnightly intervals with a knapsack sprayer at a rate of 5.3 kg a.i./ha in a spray volume of 1700 l/ha at each application.

The ULV thiram/dicloran mixture was formulated as a stabilised suspension in a refined oil carrier of low volatility. All treatments commenced 7-10 days after the lettuces were planted out and were continued throughout the growing period until about a week before harvesting (see Table 1). The plants were free from grey mould at commencement, the treatments being intended as prophylactic programmes.

In the ULV treatments the lettuces were sprayed in 12ft wide strips along the length of the glasshouse bays, via narrow central paths. Treatments were applied from each direction on each occasion to maximise cover. HV thiram was applied with a knapsack sprayer to run-off, which necessitated a spray volume of about 1700 l/ha once the plants had closed together - a rate normally practiced in commerce.

Shortly prior to harvesting, sample blocks of lettuce from each treatment were carefully examined for grey mould infection, and samples of lettuces suitable for marketing were weighed. Results are given in Table 1.

b) Residue Trials

Seven commercial scale grower trials were undertaken in the Lea Valley area in the winter of 1975/76, to compare chemical residues following spray programmes with ULV thiram/dicloran and HV thiram. Dosage rates and frequencies of application were identical to those used in the biological efficiency trials. Two trials were carried out on unheated early winter crops with a growing period of 17 weeks, the remainder on winter/spring crops with a growing period of 10-13 weeks (see Table 2). Shortly before harvesting samples of lettuce were taken for analysis 4 and 7 days after the last application, for dithiocarbamate and where applicable, dicloran residues. Results are given in Table 2.

## RESULTS

a) Biological efficiency

Data in Table 1 show that the ULV thiram/dicloran spray programme afforded better protection against grey mould than the HV thiram in two out of the three trials (ULV = 94% and 80%, HV = 86% and 68% free from disease respectively), whilst

in the third trial the HV programme gave marginally better protection,(ULV = 84% free from disease, HV = 88%). The ULV treated plots yielded lettuce that were much drier and cleaner underneath, so that at cutting very little trimming-off of soft slimy basal leaves was necessary, even where grey mould was not present. This was considered to be at least partly due to the absence of water with each ULV treatment. The fact that a visible chemical deposit was absent was considered a major advantage by all the growers - most of the HV treated lettuces had chalky blotches on the older leaves.

b) Residues

The two trials undertaken in the winter (L/37 and L/38) showed, as expected, the heaviest build-up of dithiocarbamate, due to slow growth of the plants and the low temperatures minimising breakdown rate of the chemical. However, the residues from the ULV treatments were still exceedingly low compared with the HV (ULV mean value at 7 days after last treatment = 4.6 p.p.m. HV = 355 p.p.m.)

With the winter/spring trials L/41 and L/47 the dithiocarbamate levels with the ULV programmes were even lower than during the winter trials (mean at 7 days after last treatment = 1.5 p.p.m.), well below the EEC maximum of 3 p.p.m. A corresponding reduction with the HV treatments was observed (mean at 7 days after last treatment = 105 p.p.m). but levels were still unacceptably high compared with the ULV.

The dicloran residue levels in all the ULV treatments (mean = 1.3 p.p.m.) came well within the 10 p.p.m. maximum stipulated by the Codex Alimentarius Commission.

## DISCUSSION

The efficacy and residue trials demonstrated that a thiram/dicloran suspension in oil, applied ULV was highly effective in preventing grey mould on glasshouse lettuce. This protection was afforded at very low active ingredient levels - in most instances well within the levels stipulated by the EEC Council Directive in respect of thiram, and well within the dicloran levels stipulated by the Codex Alimentarius. These data were submitted to the Pesticides Safety Precautions Scheme, as a result of which a 4 day harvest interval was granted when the formulation was subsequently commercialised as Turbair Botryticide. This product is the only dithiocarbamate treatment for glasshouse lettuce in the UK with a harvest interval of less than 2 weeks.

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Table 1 - Control of Botrytis in glasshouse lettuce following ULV and conventional HV spraying programmes

| Trial reference | Treatment | Number of treatments | Growing period | Plants destroyed by Botrytis, % | Plants requiring trimming, % | Plants free from Botrytis,% | Mean trimmed weight per lettuce,g. |
|---|---|---|---|---|---|---|---|
| L/W 98 | Untreated control | - | early Feb to mid April | 28.7 | 39.1 | 32.2 | 196 |
| | ULV thiram + dicloran | 8 | | 1.2 | 4.8 | 94.0 | 281 |
| | HV thiram | 4 | | 3.0 | 11.0 | 86.0 | 273 |
| L/W 99 | Untreated control | - | late Jan to mid April | 10.2 | 73.1 | 16.7 | 261 |
| | ULV thiram + dicloran | 8 | | 2.1 | 13.5 | 84.4 | 287 |
| | HV thiram | 5 | | 2.0 | 10.0 | 88.0 | 289 |
| L/W 08 | Untreated control | - | early March to mid April | 26.0 | 47.0 | 27.0 | 202 |
| | ULV thiram + dicloran | 7 | | 1.0 | 19.0 | 80.0 | 244 |
| | HV thiram | 4 | | 10.0 | 22.0 | 68.0 | 230 |

Table 2 : Residues (p.p.m) of thiram and dicloran in glasshouse lettuce following ULV and conventional HV spraying programmes

| Trial reference | Growing period | Growing period | ULV thiram/dicloran, applied weekly | | | | HV thiram wettable, applied fortnightly |
|---|---|---|---|---|---|---|---|
| | | | thiram | | dicloran | | thiram |
| | | | 4 days after last appln. | 7 days after last appln. | 4 days after last appln. | 7 days after last appln. | |
| winter L/37 | 17 | Sept to Jan | 5.6 | 3.7 | 0.7 | 0.7 | 320 |
| winter L/38 | 17 | Nov to March | 5.0 | 5.6 | 2.3 | 2.7 | 390 |
| winter/ spring L/41 | 13 | Jan to April | 1.3 | 1.6 | 2.6 | 0.5 | 150 |
| winter/ spring L/61 | 13 | Jan to April | 1.8 | 1.4 | 2.0 | 1.7 | - |
| winter/ spring L/47 | 10 | Feb to May | 1.6 | 1.4 | 1.2 | 1.5 | 66 |
| winter/ spring L/53 | 10 | Feb to May | 4.0 | 0.4 | 2.8 | 0.5 | - |
| winter/ spring L/54 | 10 | Feb to May | 1.4 | 1.9 | 1.3 | 1.3 | - |

# A PRELIMINARY EVALUATION OF AN ULTRA LOW DOSAGE OF PIRIMICARB AGAINST *SITOBION AVENAE* ON WINTER WHEAT

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Summary Pirimicarb† at 8.8 g a.i./ha reduced *Sitobion avenae* on winter wheat when applied at the beginning of flowering at 1.6% concentration in 0.5 l/ha with 90 µm vmd droplets, drifted over a 9 m wide swath. The relevance of applying ultra low dosages of aphicides in an integrated pest control programme is discussed.

## INTRODUCTION

A yield loss of between 500 to 600 kg/ha of wheat can be expected if populations of over 100 *Sitobion avenae* per stem occur between flowering and ripening (ADAS, 1973). Farmers are advised to spray if there are, on average, between 5 to 10 aphids per stem at the onset of flowering. The present study examined whether an ultra low dosage of insecticides would control cereal aphids at this growth stage. The effect of spraying at the end of flowering was also investigated, as early spraying may not always be feasible.

## MATERIALS AND METHODS

Twenty four plots, each 50 m x 36 m were arranged in a factorial design to compare a) early, late or no spray; b) one or two applications; c) two dosage levels and d) two droplet sizes.

Each plot was divided into four 9 m strips by tramlines produced by spraying 16 cm swaths with paraquat. A 5% ULV formulation of pirimicarb was applied undiluted or mixed with an oil plus emulsifier+ using an 'Ulva 8'§ and 'Mini Ulva'§ (Table 1). The wind speed never exceeded 1.5 m/s during the spraying.

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†supplied by ICI Plant Protection

+Ulvapron supplied by BP

§supplied by Micron sprayers

Table 1

Ultra low dosage sprays on wheat

| Dosage g a.i./ha | Droplet size vmd | Volume of spray l/ha | % a.i. | Sprayer |
|---|---|---|---|---|
| 8.8 | 50 | 0.18 | 5 | Mini Ulva |
| 0.9 | 52 | 0.28 | 0.3 | Mini Ulva |
| 8.8 | 90 | 0.54 | 1.6 | Ulva 8 |
| 0.9 | 90 | 0.54 | 0.16 | Ulva 8 |

The spray distribution across a plot was checked by spraying a suspension of 10% Saturn Yellow fluorescent tracer in a 50:50 mixture of 'Ulvapron' and water.

The early spray was applied on the 29th June. Plots receiving a second early spray were treated on July 13th. The single and double application of the late spray were on the 13th and 27th July respectively.

Aphid Sampling: Aphids were counted at weekly intervals on 10 stems selected at random from within eight sub-plots of each plot. In July, when aphid populations were larger, the number of sub-plots were reduced to four.

Yield: The oven dry weight per stem was determined on four 0.5 m sub-plots on the 22nd August.

## RESULTS

The single early spray at the higher dose significantly reduced the number of aphids (*Sitobion avenae* only) irrespective of droplet size (Table 2). Subsequent applications had no effect, as the population throughout the trial had decreased rapidly to insignificant levels.

A better distribution of spray was achieved with the 90 µm droplets than the 50 µm which were deposited only on the ear and flag leaf (Table 3).

Yield: No significant difference was found between treatments (Table 2). The maximum mean log (Control plot totals) was 2.5, which corresponds to a level of 8 aphids/stem (Fig. 1), which is too low a level to seriously affect the yield.

## DISCUSSION

In this field trial, two droplet sizes were compared at constant dosage rate irrespective of volume, but further studies will also need to consider comparison of droplet sizes at the same volume, even if the speed of travel is varied or multiple passes are necessary to compensate for different flow rates to the nozzle. The actual volume and droplet size needed may depend on the species of aphid to be controlled. Those on the lower leaves (*Metopolophium dirhodum*; Dean, 1974) may require a larger droplet and volume rate. **(Continued below Fig. 1).**

Table 2

Control of *Sitobion avenae* with ultra low dose sprays of pirimicarb

| Droplet Size | Aphid numbers 8 days after the first spray | | | | | | Yield - oven dry wt, (g) - of the early sprayed plots | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50 µm | | 90 µm | | Total for dose | | 50 µm | | 90 µm | | Total wt | |
| Dose Level | Sum Plots | Sum Logs | Sum Plots | Sum Logs | Plots | Logs | Wt/ Plot | Wt/ Stem | Wt/ Plot | Wt/ Stem | Plots | Stems |
| High | 34 | 2.45 | 24 | 1.64 | 58 | 4.09 | 767 | 2.97 | 1001 | 3.48 | 1768 | 6.45 |
| Low | 166 | 3.82 | 108 | 3.45 | 274 | 7.27 | 922 | 2.77 | 787 | 2.43 | 1709 | 5.2 |
| Control | 394 | 4.56 | 225 | 4.09 | 619 | 8.65 | 898 | 2.70 | 1197 | 3.15 | 2090 | 5.85 |
| Control | 221 | 4.07 | 229 | 4.28 | 520 | 8.35 | 660 | 2.45 | 901 | 3.21 | 1562 | 5.66 |
| | Control v's Treatment* | | | | | | Not Significant | | | | | |
| | High v's Low* | | | | | | | | | | | |

Key:

Sum Plots = Total from two plots, forty stems sampled from each plot.

Sum Logs = Each of the sub-plot total logged and summed from the two plots.

Wt/plot = Total from two plots, four 0.5 $m^2$ sub-plots taken from each plot.

Wt/stem = Total wt from the two plots corrected for the difference in the number of stems between samples.

Table 3

The number of fluorescent particles/stem section of wheat

(average of 40 stems sampled)

| Droplet Size | Ear | Flag Leaf | Lower Leaves |
|---|---|---|---|
| 90 | 226 | 189 | 59 |
| 50 | 50 | 20 | 0 |

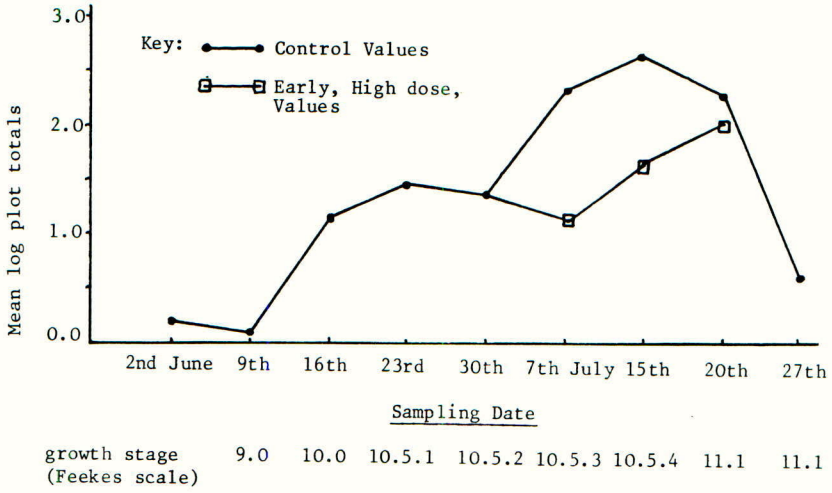


Fig. 1. The mean logs of aphid numbers on untreated and early high dose sprayed plots.
(The mean values for the plots receiving an early, high dose, spray are also plotted)

**Discussion** (contd.)

At low dosages of pirimicarb, control of aphids may be achieved by a direct contact or fumigant action, as there would be very little systemic activity to affect the phloem feeding aphids (Galley and Foerster, 1976). The lack of control with the late sprays may have been due to a lower temperature, decreasing the fumigant effect or simply the effect of crop maturity. Thus under field conditions, the lowest effective dose is probably 25-50 g a.i./ha compared with the recommended 75-150 g a.i./ha (Martin and Worthing, 1975). As pirimicarb is selective, natural enemies survive, so there is a potential for the use of low doses which can provide an acceptable degree of control by checking the population growth of aphids at the critical period. Control over this short period is made easier and more economical by the use of ultra low volumes, especially with tractor-mounted C.D.A. equipment developed to provide the appropriate droplet size, and the use of tramlines to provide access to the crop when needed. The low dosages may not be so persistent, but a second application is feasible if natural enemy action does not maintain the aphid infestation below the economic threshold level. Further studies are needed in the use of low dosages of other aphicides in an integrated control programme.

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## Editor's Comment

Due to the absence abroad of the author and the fact that this paper has been abridged from a larger report, a number of apparent discrepancies appear between certain statements in "Results", the facts as presented in Table 2 and certain statements in "Discussion". At the Symposium Dr. G. A. Matthews will elucidate.

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# CDA - A HEALTH PERIL OR PANACEA

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Summary From the point of view of the safety of workers handling pesticides and consumers, controlled drop application may not be acceptable to regulatory authorities without further investigations and studies of operator exposure and of the residues left on food products by these new techniques. The outcome, favourable or otherwise, cannot be predicted from existing data.

## INTRODUCTION

It is now more than twenty years since what is today known as the Pesticides Safety Precautions Scheme first came into being. Its origins date back to three successive working parties, each under the chairmanship of Lord Zuckerman, the reports of which appeared in 1951, 1953 and 1954. These were devoted in turn, under the general heading of "Toxic Chemicals in Agriculture", to the hazards presented to users by chemical pesticides, to the possible risks to consumers from pesticide residues in food and to the likely adverse effects of these chemicals on wild life. Today the Scheme embraces all these three features, whereas I, for my part, will be discoursing this afternoon only on the first two.

As I am sure that all of you here are aware the Scheme is still, in essence, voluntary and it is gratifying to record that over the past two decades or so the utmost co-operation , in the main, has been forthcoming from all the signatory parties. Yet one element of statutory imposition has intruded to control the extent to which workers might be exposed to certain of the more toxic chemicals and legislatively this takes the form of the Health and Safety (Agriculture) (Poisonous Substances) Regulations. This section apart, the Scheme depends for its success in ensuring the safe use of pesticides overall on:-

1. The Ministry of Agriculture Secretariat, the Scientific Sub-Committee and, thirdly, the Advisory Committee being furnished by industry and from other sources with sufficient data and then, collectively, these bodies being possessed of sufficient interpretive and predictive wisdom so as to frame 'Formal Recommendations for Safe Use' that are at once as practical as they are comprehensive, so catering in advance for all eventualities.

2. The readiness and conscientiousness of industry to incorporate these 'Recommendations' in their labelling and, above all, the implicit adherance of users to these instructions.

Relevant to this Symposium, moreover, one element of principle pertaining to the Scheme must be borne in mind, namely, the 'Recommendations' are orientated to the active pesticide chemicals, their concentration in the formulation and in the dilution as applied and finally to their rate of application. There is no declared provision for specifying the type of machinery, equipment, or device to

be employed, except by implication. So, while the pesticide manufacturers and distributors may be active participants in the Scheme, the agricultural engineers, by contrast, have no such commitment. From time-to-time there have been murmurings, officially and elsewhere, about this possible omission in the regulatory measures, but the absence in practice of any complications on this account has conspired to a sense of complacency. The history of pesticide accidents to workers in Britain has shown an almost exemplary low incidence, while no-one has been demonstrably harmed and, less still, mutilated or killed by residues in the food of pesticides properly employed. Whereas eternal vigilance remained the key to the regulatory attitude, no dramatic new departures in the controls were either adopted or contemplated.

## SUMMER 1976

Then, in 1976, the extraordinary climatic pattern that obtained across the country led suddenly to a situation that sounded an alarm. During those hot summer months our National Poisons Information Service became bombarded with enquiries from doctors about cases of organophosphorus poisoning occurring on the land. These, moreover, were real and validated events, though fortunately there were no fatalities on this account. Our follow-up of these cases revealed that owing to an unprecedented, late aphid assault on arable crops, toxic organophosphorus insecticides were being applied by the ultra-low-volume techniques by means of machines never intended to be deployed in this way and in a manner that would certainly not have been officially condoned. Not that we were alone in recognising this new emergency, for both ADAS and the Farm Safety Inspectorate were alerted to these happenings.

I realise, of course, that this misuse in insecticidal practice was not by any means to be identified with Controlled Drop Application - far from it. But this did bring to the attention of those acting in a regulatory capacity the propensity for unorthodox methods of application to raise new hazards that were previously unforeseen.

## C.D.A. AND HEALTH IMPLICATIONS

To me, especially, it has been fascinating to read the titles of the papers preceeding mine in this Symposium, even if I failed frequently to comprehend the contents. As long ago as 1936 I was an undergraduate student in agriculture and I can recall being enthralled then by a visiting lecturer from Long Ashton who regaled us with the abstruse physics and practical consequences of different spray droplet formulations and their dispersal, their spread on plant surfaces and the extent of their wash-off. That, however, must surely have been a far cry from the exact mechanisms that you are elaborating today. Still, if in ignorance my understanding is not entirely astray I gather that:-

1. C.D.A. involves more concentrated formulations at the point of application than those classically adopted.
2. There is, as a corollary, more contrived placement of the effective chemical on the weed, or on the infested crop.
3. While the total quantity of active chemical used per acre may be substantially less than by the methods we have followed hitherto, the amount actually deposited on the crop may, after all, be somewhat greater than usual.

On these assumptions new questions are immediately raised for me, medically responsible as I am, on the one hand, for the welfare of operators and, on the other hand, for the community for whom products thus treated are ultimately destined for food.

## THE WORKER

Those of you who may have read any of the official Recommendation Sheets or who have had anything to do with drafting product labels or endeavouring to follow the instructions thereon - and that, I suppose, includes most of you attending this meeting, - will at once recognise that, for an active pesticide chemical, toxicity is axiomatically proportional to concentration and, additionally, to the total quality to which anyone is likely to be exposed. It will not have escaped your awareness, moreover, that in the current instructions for use, issued at the instigation of the Ministry of Agriculture, Fisheries and Food, a distinction is commonly drawn between the strict precautions for personnel protection that are promulgated for handling the concentrated formulations as purchased, as against the far less stringent restrictions that frequently apply to the dilutions finally applied. A further consideration may also exist. If, in order to achieve a suitable physico-chemical form for optimum droplet size and persistence some modification in the formulation has to be introduced then this in its turn may alter, in one way or another, the capacity of the chemical to penetrate the human skin. In short, with the solutions designed expressly for C.D.A., there may have to be re-assessment toxicologically before they are released for use in this manner.

To leave the question there, however, may be as naive as it is priggish in the sense of committee righteousness. By the very nature of the techniques that are intrinsic to C.D.A., there may be less of a likelihood for the spray to rise, or drift, and so less of a risk of contaminating the operator. So this, too must be taken into account in arriving at the hazards in practice. In consequence and in terms of regulatory restraints, it could well be that we should bestir ourselves from the seclusion of Conference Room C at Whitehall Place and take direct notice of what happens in the field. Indeed, your demonstration of yesterday evening might well be repeated, albeit modified, for the enlightenment of my committee colleagues and myself, especially the toxicologists, who otherwise will have the most hazy notions of what this is all about.

May I add that we have no pre-conceived ideas that C.D.A. is necessarily more hazardous? Indeed, by adroitly placing the toxic chemical just where it is needed, and nowhere else, you may well be advancing to that state of affairs for which we are constantly striving in the cause of factory hygiene, namely, to fashion the process so that none of the material ever comes within direct reach of the worker. The evidence to this end, I should add, must nevertheless be convincing.

At this stage, you will appreciate that having arrived at an arrangement for the safe use of C.D.A. that is acceptable, or more acceptable, as regards worker safety, will we then have to designate particular machines to ensure that the intended objectives are attained? After all, this very Symposium has been occupied with so many technical refinements and niceties. While such an extension of control might be quite new to the Pesticides Safety Precautions Scheme it is not entirely unfamiliar elsewhere in the realm of regulatory affairs. The B.S.I. awards its "kite-mark" to equipment that conforms to certain published standards, while in the territory of bio-engineering, official approval is granted with

discrimination to particular makes and models of machines vouchsafed for certain purposes in medicine or surgery, not least for haemodialysis, i.e. the artificial kidney.

Personally, at a guess, I would say that this revision in the P.S.P.S. approach is both imminent and inescapable.

## THE CONSUMER

A vast amount of energy, discussion, study, assertion and foreboding, some would say to an excessive degree, is expended on the possible risks to consumers, chronically rather than acutely, because of pesticides residues persisting in food. Yet these are possibilities that cannot be glibly dismissed. After all, they are the eventualities above all that exercise the fears of the public at large and, statutorily, this commendable urge to ensure a pure and wholesome diet dates back in this country at least to the Act (of 1860) for Preventing the Adulteration of Articles of Food and Drink.

For the serious arbiter on health, the acceptability of residues levels is generally related to the chronic, oral toxicity of the chemicals concerned in the most sensitive animals species among those subjected to toxicological experimentation. Besides the various national authorities, a number of international agencies pontificate on this problem, outstanding among them being the so-called Joint Meeting of the F.A.O. Working Party of Experts in Pesticide Residues and the W.H.O. Expert Committee on Pesticides Residues. Their successive, published "Evaluations" lend testimony to the assiduousness at arriving at "maximum acceptable daily intakes" for man, always expressed in terms of 'mg per kg body weight'. In other words this is a toxicological 'ceiling', above which the ongoing intake for man should not advance.

In what manner can this be assured in practice? Many countries throughout the world stipulate pesticide tolerances, statutorily backed. Other nations, among which the United Kingdom is the distinctive example, put their emphasis on pesticide usage, in so far as this will be accompanied by residues which, viewed against the dietary habits of the population, will not conspire to overall intakes that are excessive, healthwise. Whatever system is favoured it is obvious that a series of studies has to be carried out analytically to ascertain, under a range of field and climatic conditions, just what residues remain in the crops or other treated food products. Advisedly these tests are planned at different intervals after the last application and prior to harvesting. In this manner, residue "decay curves" may be constructed. At all events, the figures thus obtained will depend upon:-

1. The quantity of the active pesticide initially deposited upon the crop, etc.
2. The topical adherence at the site of application and the degree of systemic uptake and distribution.
3. The extent and rate of persistence, or "run-off".
4. The nature and rapidity of chemical degradation that the chemical undergoes following application.

For the "full commerical clearances" already granted under the Pesticides Safety Precautions Scheme, at least for food crops, etc., there have been adequate data under each of these four headings derived from the pesticide usage in the approved, orthodox manner. It would be presumptuous to believe, without some query, that the data from a quite different technique of application would be identical. By C.D.A., for instance, will there be more chemical finding its

way to that part of the plant to be harvested for food? Will the adherence and persistence be enhanced, will systemic uptake be encouraged, or will dispersal from the surface be more rapid? Will chemical degradation be promoted, or will it be inhibited? These doubts cannot be resolved by either guesswork or inspiration. I can see no alternative to the authorities demanding a revised corpus of residues data prior to acquiescing formally to these new techniques in so far as they may have consequences for the food consumer.

## WILDLIFE

C.D.A., I am afraid, opens up all sorts of possibilities in the eyes of the ecologist. With relief I can declare myself as no expert on wild-life, in any shape or form. You must be prepared, however, for challenges in this respect.

## CONCLUSION

By this stage you may be feeling that, even as an invited speaker, I am hardly a harbinger of good tidings. Perhaps as a guest I have appeared before you as an impersonationof that regulatory scepticism and reaction that you find so often characterises the official attitude to any progressive movement. Far from it. I canadmit that, masquerading as a custodian of human health as regards pesticides, I will take nothing on trust. So, before C.D.A. can be acclaimed as a saviour towards the worker and the consuming public I feel we must have these further investigations and a toxicological reassessment. But, I insist, I am not prejudiced. In the end, as far as human exposure is concerned, C.D.A. may be shown to have significant advantages and if you can couple these to technical advances and, above all, to greater economy in pesticide practice, then surely the world will be your oyster.