general practice for the control of perennial grasses. An Oxford Precision Sprayer was used to apply the herbicides in a volume of 30 gal of water/ac at 30 psi.

At each site, the treatments were applied in March, May and August in order to determine the effect of climatic conditions on the persistence of the chemicals measured by crop response.

Each main treatment was divided into three sub-plots which were cultivated at intervals of one, two and three weeks after spraying. Half of each sub-plot was rotavated with a Howard "Gem" and the other half ploughed with a single furrow plough pulled by a capstan winch on the front of a Land Rover. Owing to the very dry conditions during the early part of the year, it was not always possible to cultivate to a depth of more than 3-4 in, but during the late summer and autumn penetration was increased to a maximum of 8 inches.

In order to prepare a seed bed the ploughed plots were raked before drilling but there was a sufficiently fine tilth on the rotavated plots to make this unnecessary. Rika barley, dressed with liquid seed dressing, and thousand-headed kale were drilled immediately after cultivation and at weekly intervals thereafter in order to ascertain the length of time chemical residues persisted in phytotoxic quantities in the soil under varying climatic conditions and cultural treatments.

Crop damage was assessed by a scoring technique, observations being made by three independent assessors whose mean score was recorded. The scoring system was as follows:-

0 - no crop damage
1 - slight crop damage or retardation of growth
2 - severe damage
3 - crop killed or damaged beyond recovery

Amino triazole showed up as a chlorosis which turned the leaf white and later pink. Symptoms of dalapon damage were retardation in growth, necrotic leaf spots leading to die-back of the leaf apex and eventual death of the plant.

On each of the three sites a total of 216 separate observations were recorded by each assessor and thus, a reasonably high degree of accuracy was obtained.

RESULTS

Relative phytotoxicity of herbicides to test crops

In order to reduce the standard error the results of all three experiments have been combined in table I.

TABLE I. CROP DAMAGE AT MEAN OF 1-5 WEEKS AFTER TREATMENT - MEAN SCORE OF PLOUGHED AND ROTAVATED PLOTS

Treatment	Barley	Kale
Control	0	0
Amino triazole	0.48	0.07
Dalapon	2.59	0.62
Significant difference (P = 0.01)	0.45	0.51

Dalapon was thus considerably more phytotoxic to both barley and kale than amino triazole at application rates recommended for couch control during the period of these observations. These differences are highly significant. Kale is much more tolerant of residual amounts of both chemicals than barley, but it should be noted that, despite its selectivity to dicotyledons, dalapon has caused more damage to kale than amino triazole under conditions of the experiment.

Methods of Cultivation

One of the reasons for carrying out cultivations following treatment with dalapon and amino triazole is to accelerate the breakdown of chemical residues in the soil. A study was made of the best method of achieving this and table II shows the mean score for damage to barley drilled on rotary cultivated and ploughed land at a mean of 1-5 weeks after spraying.

TABLE II. DAMAGE TO BARLEY ON TREATED LAND SUBSEQUENTLY ROTARY CULTIVATED OR PLOUGHED

Treatment	Rotary cultivated	Ploughed
Control - no herbicide	0	0
Amino triazole	0.35	0.60
Dalapon	2.78	2.40
Significant difference (P = 0.01)	0.10	

On soil treated with amino triazole rotavation has resulted in significantly less damage to the following crops than ploughing; on the other hand, ploughing has produced less damage to crops where dalapon is concerned.

As stated previously, kale is less sensitive to residues of these herbicides than barley, and thus the differences between rotavated and ploughed land are not as great in the case of kale, (See Table III.)

TABLE III. DAMAGE TO KALE ON TREATED LAND SUBSEQUENTLY ROTARY CULTIVATED OR PLOUGHED

Treatment	Rotary cultivated	Ploughed
Control - no herbicide	0	0
Amino triazole	0.05	0.09
Dalapon	0.60	0.64
Significant difference (P = 0.01)	0.36	

The differences between rotary cultivation and ploughing are not significant owing to the relative tolerance of the indicator crop of kale to herbicidal residues.

Interval between spraying and planting

Barley and kale were drilled at weekly intervals after spray treatments applied in March, and crop damage was recorded in Table IV.

TABLE IV. BARLEY AND KALE - MEAN SCORE FOR DAMAGE PER PLOT

barley

Herbicide	No. of weeks between spraying and drilling				
	1	2	3	4	5
Amino triazole Dalapon	0.58 2.31	0.42 2.27	0.47 2.24	0.29 2.17	0 1.71

kale

Herbicide	No. of weeks between spraying and drilling				
	1	2	3	4	5
Amino triazole Dalapon	0.17 0.75	0.17 0.74	0.07 0.75	0.02 0.59	0 0.19

These results cannot be analysed statistically owing to a considerable number of missing plots in which the test crops did not germinate, nevertheless there is a consistent reduction in crop damage as the interval between spraying and sowing is increased.

DISCUSSION

During early and mid-summer there was very little rainfall and the soil became so dry, particularly on the medium and heavy land, that efficient and thorough cultivations at regular weekly intervals became difficult. Consequently germination was often poor owing to lack of soil moisture and the difficulties of obtaining a good tilth on the seed beds. The minor crop injury recorded to barley 3 weeks after the application of amino triazole is most probably due to the dry conditions not only affecting germination, but also increasing the persistence of the chemical in the soil. Similar damage was not observed after subsequent applications in more favourable conditions for breakdown during May and August. Indicator crops sown 5 weeks after the amino triazole treatment were unaffected, whereas dalapon severely damaged barley and slightly retarded the growth of kale sown after the same interval.

Under the conditions of the experiment, dalapon residues were significantly more phytotoxic to barley and kale than amino triazole. The damage to kale, however, was minor and can be attributed to high residual concentrations of the chemicals in the soil affecting the early drillings. Despite its selectivity to dicotyledons, however, dalapon residues caused significantly more damage to kale than amino triazole.

A comparison of ploughing and rotary cultivation for accelerating the breakdown of chemical residues in the soil showed that, in the case of the amino triazole rotory cultivation was the more effective method of cultivation. The most probable explanation for this is that the herbicide was leached to plough depth and by inversion of the furrow brought to the surface again where a sufficiently high concentration was left to be toxic to the indicator crops. Rotary cultivation, on the other hand, thoroughly incorporated and diffused the chemical residues throughout the cultivated layer, so that significantly less crop damage was recorded. In the case of dalapon, ploughing resulted in less damage than rotary cultivation and the explanation does not appear to be so straightforward. Whilst its greater solubility would tend to give a more even and rapid distribution in the soil which would favour breakdown in undisturbed soil, as in a furrow slice, where mechanical mixing as in rotary cultivation is applied, it might be expected that breakdown would be even more rapid, but this is not so. Ploughing is significantly better and no satisfactory explanation can be found at present.

It should be noted, however, that although less crop damage results after rotary cultivation of amino triazole treatments, other experiments have shown that ploughing gives more efficient control of couch grass.

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Discussion of preceding eight papers

M. J. Zwijns. Is there any evidence of differences in field results, with both amino triazole and dalapon, between 1959 and 1960 due to great difference in rain fall in these two years?

Dr. G. R. Sagar. The results of spraying dalapon during 1960 will not be available until next year because the dormancy caused by dalapon does not permit valid assessments until 12 months after spraying. No comparison is therefore possible until 1961.

Dr. C. C. McCready. I should like to ask Dr. Sagar one question about his experiment in which he found that the export of dalapon from a treated shoot of Agropyron was promoted by both an opaque cover and a transparent cover. Could the common factor here be the prolongation of absorption by the increased humidity under the covers?

Dr. G. R. Sagar. Under the opaque cover I would expect the stomata to be closed and under the transparent cover to be open. Therefore, if penetration is a major factor operating through the stomata, I would expect a bigger difference than I in fact obtained between these two treatments.

Mr. R. W. Sidwell. Has Dr. Sagar proved that no translocation takes place to older rhizomes? If so, how is dormancy maintained in axillary buds?

Dr. G. R. Sagar. I do not believe I have proved anything. Various workers have shown that mineral status may affect bud dormancy and I prefer to think that dormancy is maintained in Agropyron by the mineral nutrient status of the dormant buds being too low to allow dormancy to be broken, rather than by diffusion of specially produced chemicals to rhizomes, one chemical to keep the rhizome growing horizontally and another to keep the buds dormant.

Dr. R. K. Pfeiffer. Could Mr. Evans tell us something about the experience of the N.A.A.S. with TCA, which can now almost be regarded as the classic method of chemical couch control?

Mr. S. A. Evans. The results of some N.A.A.S. experiments with TCA are contained in previous Conference Proceedings. TCA has not been experimented with in recent years and no direct comparison with dalapon has been made.

Dr. G. R. Sagar. A chemical applied to the aerial parts of a plant depends for its movement to below-ground organs on a variety of environmental and internal factors, none of which we understand properly. There is no doubt in my mind that we can be far more certain that a chemical which enters the roots will be distributed extensively throughout a plant system via the xylem. There are two problems. First, farmers are not inclined towards soil incorporation, since it is more expensive and relies on soil conditions being suitable for using machinery to effect the incorporation. Second, plant physiologists cannot agree as to how any natural metabolite moves in the phloem and yet here we are introducing a foreign substance into that tissue and attempting to explain its pattern of movement. This is in fact the main problem.

Dr. W. Ripper. With reference to Mr. Evans' paper, I would like to point out that of the 17 reported experiments, 9 did not comply with the maker's recommendations. Mr. Evans pointed out his variable results. I have been under the impression that the industry has asked farmers to follow the maker's recommendations and I am surprised that Mr. Evans has not done so. The N.A.A.S. should have more uniform experimentation. If maker's instructions had been carried out, the results would have been very different.

Is Dr. Sagar happy to draw conclusions about the application of very small quantities of labelled dalapon? In fact we saturate the plant with a tremendous quantity which may give different methods of translocation. All he says of our lack of knowledge of translocation is quite true. It is also true that systemic insecticides have been used very successfully within the last six years.

Dr. G. R. Sagar. As far as insecticides are concerned I will agree that we could usefully work in closer harmony with those concerned with these substances. I would however point to one danger. It would seem likely that many of our herbicides are closely related chemically to natural plant metabolites whereas many insecticides, particularly systemic types, are not. The point regarding application of small quantities of marked dalapon is very relevant. In my paper I pointed out the deficiencies in my technique and repeatedly warned that the observations are very preliminary. I agree that it is important that we bear in mind that the experimental dose is something like 1/300th of the dose in the field. This is a good point and must be considered together with the possibility of snags arising from the use of radioautographic techniques.

Mr. S. A. Evans. In reply to Dr. Ripper's reference to the N.A.A.S. experiments, the remaining experiments that presumably did comply with the manufacturer's instructions also did not give very good control of couch.

Mr. G. B. Lush. I would like to ask Dr. Leasure two questions. What was the significance of the relatively high greenhouse temperature under which the pot experiments reported were conducted? Has the improved control of couch resulting from the addition of these non-ionic wetters been confirmed in the field?

Dr. J. K. Leasure. The temperatures used in this test were settled on after about 3½ months of attempting to grow couch grass from two-node rhizome segments. The temperatures chosen gave the best growth of secondary rhizomes. With regard to field tests, these tests are being undertaken on a wider scale. Half a dozen tests were put out in the United States last year and it appears to us worth while following these up on a larger scale this year.

Mr. W. H. Salmon. I speak as a farmer and after listening to the manufacturers of various chemicals it would seem the control of couch grass is not difficult. Listening further to the speakers who have conducted experiments, I do not feel so happy and it does seem that conditions of growth, temperature etc. have to be just right to give even partial control. The cost is still high, more so than rotary cultivation. My impression is that farmers do not feel that spraying is really successful in eliminating couch grass.

30 or 40 years ago, a product called Gas Lime was much used by market gardeners. Spread on the ground in the autumn and worked in the soil it actually sterilised and killed all the vegetation and weeds. The great drawback was the toxic effect which prevented any cropping for six months. I do not think this by-product of the gas works is still available. Much of our arable land is dormant from October to February and soil conditions being suitable I would go to a lot of trouble during this period to eliminate couch grass. It should not be difficult for the agricultural chemists to produce a product of

similar properties and much less bulky, which could be applied during this dormant period and probably with less toxic persistency. It might even destroy wild oat seeds!

(Editors note: See "An assessment of the new herbicide 2,6-dichloro-benzonit benzonitrile" by G. E. Barnsley in Session 10)

Dr. W. van der Zweep. I am impressed by Dr. Leasure's data on the translocation of radio-active material to non-treated plant parts. We are trying to do this type of work at Wageningen. We realise the difference between these conditions and field conditions. Has Dr. Leasure any data on different treatment times? Do amounts of dalapon to which no wetting agents have been added finally have the same amount of radio-activity in the rhizome system as when wetting agents added? Perhaps the initial amount of radio-activity in the rhizome is higher but does it equalise later?

May I ask Dr. Sagar if there is any difference between treatment of lower leaves against treatment of higher leaves on the same shoot, and between shoots that have tillers and those that don't have tillers? Are there different means of translocation through the aerial system?

Dr. J. K. Leasure. With regard to the first question, I have really no data to support an answer. I have some observations which bear on this point. A test was run not merely with small amounts of tagged dalapon but also with a herbicidal dose of untagged dalapon plus the labelled dalapon. At the end of a period, plants having additional wetting agent already showed effects of the herbicidal action but plants receiving dalapon without the wetting agent did not show herbicidal effects at this time. In fact a few plants remaining, treated with dalapon alone, did not continue to deteriorate and never did show the same degree of effect as those treated with dalapon plus a wetting agent. Although analyses were made at only one time, I do not think it is a matter simply of initial increase as suggested by Dr van der Zweep.

Dr. G. R. Sagar. I tried treating the youngest or oldest leaves and using only visual assessment for radioautographs, there was very little difference between these. This would appear to be contrary to the general hypothesis of mass flow and I may suggest that the major factor influencing the movement of one herbicide is not necessarily the same one for any other herbicide. I believe that Craft's view of herbicide movement may be too simplified. In my other experiments which I have not reported here, the comparative vigour of the two shoots determined the pattern of movement of dalapon. Movement of the labelled material was almost invariably from the "weaker" to the "stronger" shoot and not vice-versa.

CONTROL OF REEDS (PHRAGMITES COMMUNIS) IN ARABLE LAND WITH DALAPON

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Summary. Reeds (Phragmites communis) are troublesome weeds in some arable fen fields. Limited trial and field experience suggests that dalapon can be expected to give a very effective control. 15 lb/ac would appear to be a satisfactory dose in most circumstances. Application should be made when there is good growth of leaf. Control would seem most practicable in cereal stubbles but potatoes and sugar beet may be suitable alternatives.

INTRODUCTION

Reeds (Phragmites communis) occur commonly in dykes in the fens and often invade arable fields. Infestations are normally most serious along headlands but may extend over a large proportion of the field, interfering with hoeing and presumably reducing crop yields by competition.

METHODS AND MATERIALS

Two trials were carried out with dalapon.* The first of randomised block design (plot size 1/100th ac) was laid down on a cereal stubble on 30th September, 1958 when most reed re-growth was 9-12 in. high with occasional plants up to 30 in. high. The field was cropped with potatoes in 1959 and sugar beet in 1960. The second was sprayed by logarithmic sprayer on a cereal stubble on 1st September, 1959 when reed re-growth was 3-16 in. high. The field was cropped with potatoes in 1960. The results of farmer usage of dalapon on reeds is also considered.

RESULTS

Results are summarised in Table I and Fig. 1

TABLE I. ASSESSMENTS OF EFFECTS OF TREATMENTS ON REED NUMBERS, ONE AND TWO YEARS AFTER SPRAYING

TRIAL 1

Dosage of dalapon (lb /ac.) applied 30.9.58	Reed Counts 14.8.59		Reed Counts 27.9.60	
	Numbers AC	per cent control	Numbers AC	per cent control
0	10,000	0	129,450	0
10	100	99	15 ,750	88
20	300	97	7,550	94
30	150	98½	8,750	93
40	100	99	2,700	98

*Used as the commercial formulation "Dowpon"

The apparent build up of the reed population on the controls may be due to a poorer cultural control having been obtained under the sugar beet crop (1960) than under potatoes (1959). In any case, it is not easy to count dense reed infestations under a crop and the 1959 figure for the untreated plots was estimated only.

TRIAL 2

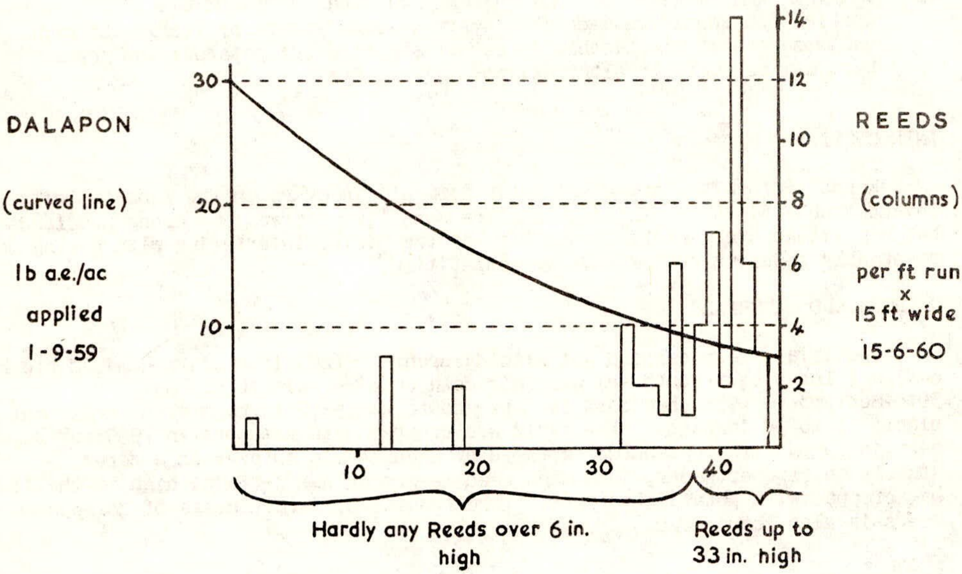

Fig. 1. Assessment of Effects of Treatments in year after spraying (Log. Plot).

Failure to control every reed at the higher doses may have been due to the spray having been applied too early so that the area of leaf receiving the spray was very small.

Farmer Experience

Virtually complete kills of reed have been obtained in the past two years with dalapon by a number of farmers. In several cases it has been possible to establish the rates applied. These were as follows (dalapon as lb/ac):- (a) 25 lb (150 gal water/ac, 1958); (b) 11 1/3lb (30 gal/ac. 1959); (c) 15 lb (25 gal/ac. 1958 (1 field); 1959 (2 fields)); (d) 17 lb (1959). In some cases the applications were split.

In most cases the chemical was applied on reed regrowth in cereal stubble. There were three cases where flowering reeds were treated. One was a potato crop treated after the haulm had died back; another was a dyke adjoining a treated field and the third a sugar beet headland adjoining a treated stubble field. In the last case kill was better on the sugar beet area where the reeds were flowering than on the stubble land, although the latter received two applications of 8½ lb while the sugar beet strip received only a single application of 8½ lb per ac.

DISCUSSION

In the past, invasion of the reed into arable land has been accepted as one of the difficulties of farming in certain areas of fen, there being no practical method of control.

The trials showed that dalapon rapidly killed leaf growth but the rhizome showed no very definite signs of having been affected when examined prior to summer emergence of the shoots.

While the weed on the first trial did appear to be coming back in the second season, this is likely to be at least partly due to rhizomes having been dragged onto the small plots from adjoining untreated areas by cultivations.

Further work is clearly necessary to determine the most effective stage of application and to assess optimum dosage more critically. It would appear, however, that 15 lb /ac of dalapon can be expected to give a very good control of reed, provided it is applied when there is a good growth of leaf present.

SESSION 7

Chairman: Mr. D. Lowe

WEED CONTROL IN HORTICULTURAL CROPS

WEED CONTROL IN HORTICULTURAL CROPS - PRESENT AND FUTURE

P. H. Brown

Director, Efford Experimental Horticulture Station

In attempting to review the subject of weed control in the wide and diverse field of horticulture a tremendous number of aspects call for consideration. Time, however, will only permit but a few of the more important of these to be taken into account. I therefore propose to discuss the following three aspects only:

(1) The extent of the need for herbicides to assist horticultural production.

(2) Is the present supply of herbicides and more particularly the method and means of applying them satisfactory?

(3) Is the extent of present day research, field experimentation and advice sufficient to meet the needs?

Is the horticultural industry in need of herbicides to assist its production?

This would sound to be an unnecessary question, yet it is one which should be examined and answered, and in so doing the facts must be faced fairly and squarely. The industry at the present time is none too confident of the advantages chemical weed control supposedly offers for the simple reason that performance of many materials is still too uncertain under this or that set of circumstances. Despite this, the answer to the opening question must clearly be "Yes". Firstly because adequate manual labour is becoming an ever-increasing problem and is already, let alone in the future, far too expensive a means of securing weed control in our crops. Let there be no doubt that the economics of the immediate future will no longer permit weed control by manual means, except possibly in the case of a few very high-value crops. I believe we have to envisage the position in the very near future of fewer but higher paid workers on both horticultural and agricultural production - a situation which thus demands a much changed production technique, in which the worker will need to be much more of a technician. A second factor, again for economic reasons, is the need to increase yield per acre as one of the contributing factors towards a lower production cost per unit of produce. In this connection it should be realised that each hour's delay in destroying competing weeds in the crop significantly depresses the ultimate yield of that crop. Therefore as time is the limiting factor chemical control, which is speedier and less disturbing to the young plant, obviously has its necessary and rightful place. The grower, in order to "acclimatise" himself to future requirements, must be prepared to do two things:-

(a) He must adopt a far less conservative attitude in regard to his methods of crop production. For example, chemical weed control both in regard to materials used and more particularly methods of application and the equipment to do so, may necessitate the changing of row-spacings and other cultural practices. If he is to gain the advantages that herbicides can offer he must be prepared to accept new ideas perhaps far removed from current practices.

(b) He must learn to be more precise, for the use of herbicides calls for a precision approach. This requirement, coupled with the necessity for precision approach in other matters concerned with crop production, will increasingly require technicians rather than manual workers to form the spear-head of his staff.

Equally, to further assist the producer, much will be required of the chemical industry, the research worker, the field experimenter and the adviser.

Is the present supply of herbicides and means of applying them satisfactory?

The first point is whether the chemical industry is producing and meeting the needs of the horticultural industry. Could it in fact be that they are producing too many materials, or of the wrong type? Opinion in many quarters suggests that too many chemicals are being put onto the marker as herbicides and for two main reasons. Firstly, it is often suggested many appear to be offered to the horticultural industry because, having been developed for agricultural crops or other purposes, an additional sales outlet would be an obvious advantage. This may or may not be true. It is, however, probably true to say that few herbicides have been developed to specifically meet horticultural needs. The admittedly small and diverse horticultural market does not and possibly cannot interest the larger chemical companies who, because of the potentially small market, are not prepared to infuse money into the development of herbicides for horticultural crops when a very much larger market awaits them for herbicides for agricultural use both in this country and more particularly overseas.

The second reason that causes opinion to suggest too many herbicides are being put onto the market is that these materials are not being sufficiently tested beforehand and in consequence their effects on crops and reaction to soil and climate are not sufficiently known and the user is too often left to find out for himself.

This present position can be summarised thus:-

(1) The lack of sufficient knowledge too often places the adviser in the position of not being able to make positive or sound recommendations to the grower. This is indeed an unfortunate situation.

(2) Variable results, apparently due to differences of soil, climate, conditions of crop and possibly other factors unknown, are all too common.

(3) These variable results, due to lack of sufficient knowledge of their performance often puts the herbicide into disrepute when it might, in fact, be

extremely valuable if more information concerning its behaviour were known and understood.

(4) In the absence of sufficient knowledge the risks of residual effects may be quite considerable. Are not such risks being taken to a considerable extent at the present time?

(5) The same case could be argued in respect of risk of toxicity to humans and, possibly, off-flavour in crops.

So far I have said nothing about the application aspect. I fear there is little on which to congratulate ourselves in regard to the present methods of application, apart from the fact that many spraying machines being used are of doubtful design and performance for the application of herbicides. We should seriously ask ourselves questions such as these:

(1) Is surface application of sprays, which has many drawbacks, the only way? Are other methods seriously being explored? Most crops on the horticultural holding are extremely sensitive to spray-drifts and for this reason alone methods of application other than spraying are needed. Granulated herbicides exist, and we are told, in wide use in the United States. Surely this form and the technique of application should be investigated with the maximum of effort.

(2) Is complete spraying of the land occupied by the crop necessary, sensible or economical? - if not why has the technique of band-spraying and equipment to do so not been developed to any extent?

Would it be true to say that the main deterrent to progress in such directions is the relatively low sales-potential of both materials and equipment specifically developed for the horticultural need? I suspect this is the case. It might, for example, be argued that the demand for equipment to apply a band of granular herbicides is too small to interest the manufacturer. But let it be remembered that the use of granulated forms of other materials is also receiving attention - for example granulated systemic insecticides and these will require very similar equipment. The demand may thus not be so small as might be imagined.

Is the extent of present day research, field experimentation and advice sufficient to meet the needs?

It is always too easy, as an excuse for other deficiencies, to cry for more and more research and one must not fall into this trap without being sure the needs exist. I therefore propose to start at the field end to examine the situation. What is the position today? Briefly I would describe it as the grower, anxious to reduce his weed control costs by the use of herbicides but uncertain of which of the many materials the trade offers him he can use with certainty of success and no crop loss. In an effort to find an answer he seeks advice. In turn the adviser finds himself in similar difficulties because so much of his knowledge has necessarily to be based on little more than observations in the field. That is to say his ability to give thoroughly sound advice and recommendations is limited by insufficient factual information from field experiments, both adequate in number and scope. In case I should be misunderstood, please note that I am not saying that no field experiments are undertaken, but that much more is need in this respect, for how little we really know concerning the variable behaviour of many of the present day herbicides. Again in case I am misunderstood, let me hasten to say that within the limitations already indicated, everything possible is being done to acquaint the adviser with all the information available. I refer to the N.A.A.S. Horticultural Herbicides Committee, who collect and review the knowledge available concerning each crop, each year, and issue advice to the advisory officers as to the recommendations they can safely make to the grower. My point, however, is that this knowledge is still far too limited and the advisory officer thus too hampered in his job. So many materials appear to behave in so many contradictory ways and we lack precise information not only of the extent of this but more important still the types of soil (particularly organic soils) and climatic conditions under which these variable performances occur.

And what are we do do about this situation? Here, I think, is a case where field experimentation is the real need as the necessary follow up to the research and development that has already taken place. Aware that what I am about to suggest is no mean task, I am nevertheless of the opinion that full scale field experiments on the maximum number of soil types coupled with a range of climatic conditions and embracing a comprehensive list of horticultural crops is needed. Only in this way do I feel we are likely to acquire the information from which sound and reliable advice can be given to the grower.

Now what do we require from research?

The horticultural industry requires more selective herbicides to meet its particular needs - and their full testing before release. This is certainly the greatest need so far as materials are concerned. I have previously made a brief reference to the risks of residual effects. Whilst some work is going on in this connection much more is needed in order to assure that the residual period of all the materials we use is known and their use can take this knowledge into account.

I have attempted, no doubt quite inadequately, to review the position and needs of the horticultural industry in regard to chemical weed control. I have intentionally tried to do so from the user's angle as I am quite sure the wealth of scientific and technical talent present here at this conference can, and will, fully cover the other aspects of the subject in the course of the deliberations to follow. I have drawn attention to deficiencies - that has been intentional and, if by so doing, it stimulates discussion and consideration during the rest of the conference my objective will have been fulfilled.

May I, in conclusion, summarise.

The horticultural industry must, for economic reasons, make even greater use of herbicides.

This calls for development of new herbicides, and particularly selective herbicides, in new forms such as granulated, and with the need for much fuller testing before release. The existing and future residual types must be investigated much more in regard to their residual period and risks.

Coupled with new materials is the need to develop equipment for their application in which respect band spraying and band application of granulated forms would appear to be high on the priority list.

Advice to the grower must be improved. The prerequisite to this is much more factual knowledge concerning the performance and behaviour of herbicides under a wide variety of conditions, obtained from a much increased field experimentation programme covering the whole country.

Lastly, for the efforts of the chemical industry, the research worker, field experimenter and the adviser to achieve the desired end, the grower must be more liberal in outlook, accept new ideas in place of current practices and above all cultivate a precision outlook, for precision it must be in all matters connected with herbicides.

THE USE OF SIMAZINE IN STRAWBERRIES

D. van Staalduine

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Summary: The most important weeds in strawberry plantings in the Netherlands are *Poa annua*, *Senecio vulgaris* and *Stellaria media*. Seedling development of these weeds can be prevented by applications of 0.50 - 0.75 kg simazine/ha. Healthy established plants of all the varieties studied can stand post-harvest applications of 0.50 - 0.75 kg simazine/ha. Applications in early spring may cause damage to the crop. Variety, rate applied, soil type, and amount of rainfall determine the extent of the damage. Strawberry plants are susceptible to simazine applied just before and after planting. Some months after planting, however, treatments seem to be possible again. On runner beds a striking tolerance to simazine has been observed in young plants shortly after treatment.

INTRODUCTION

Keeping strawberry plantings free from weeds commonly entails high expenditure. This is particularly so if the plantings are maintained for some years as beds of about 3 feet wide, as is the case with the varieties Jucunda, Madame Moutot and Oberschlesien. Moreover, because strawberries are at certain times of the year not of such immediate importance as compared to other crops on farms, frequently sufficient labour for hand-weeding is not available at the most desirable moments.

Although the system of growing strawberries in beds is gradually being replaced by the row system, also in this system a weed control technique less expensive and labour dependent than hand-weeding would be very welcome. For this purpose herbicides have been investigated at many places. The results of our own investigations with propham (IPC), chlorpropham (CIPC), 2,4,-D and 2,4-DES were published previously (Van Staalduine, 1957). Although this work did not result in official recommendations for the use of the mentioned herbicides, we tend to agree with the instructions on autumn and early winter applications of chlorpropham, given in the Handbook of the British Weed Control Council (1958).

Since 1956 simazine has been included in our experiments and the results of 4 subsequent years are now available. Initially, major stress was laid on applications in strawberry beds, but with the extension of the experiments to more varieties, also other growing systems were included.

The major weeds occurring in strawberry fields are *Poa annua*, *Senecio vulgaris* and *Stellaria media*. All three species are able to germinate and develop during the greater part of the year. Consequently except for the period from flowering to picking applications were made and studied during the entire growing season. The applications of simazine after picking and in early spring were studied most intensively.

METHODS AND MATERIALS

The experiments were carried out in various centres of strawberry culture. Consequently all soil types on which strawberries are grown were represented. The most important varieties studied were Jucunda, Madame Moutot, Oberschlesien, Senga sengana, Talisman and Deutsch Evern.

A 50 per cent wettable powder formulation was used, but in this report all doses indicated refer to kg of active material per hectare (= 0.89 lb/ac) applied in 1000 l/ha (about 90 gal/ac). The plot size usually was 10 m^2 (= 12 sq yd) and there were 3 replicates of each treatment. The application usually was made on previously weeded plots.

The effects of treatment on weed growth were assessed by estimating the weed coverage on the treated and non-treated plots. In most experiments yields per plot were determined. For comparison hand-weeded plots were also taken up in the experiments. The spread in yield data within one treatment was usually rather great. Data on rainfall were collected. In order to characterize rainfall in the Netherlands the monthly figures for 1956-1960 and the monthly average values for 1921-1950 are plotted in figure 1.

RESULTS

Influence on the strawberry plants

Established strawberry beds

Post-harvest applications of 0.5-0.75 kg simazine/ha were made in July - August under varying conditions of soil type, age of the crop and rainfall. In all experiments with Jucunda on sand and clay soil (12 experiments) no yield depressions were observed in the year following application. The rather great variation occurring usually in the yield data from replicate plots did not allow a statistically significant conclusion to be made. In 4 experiments with Madame Moutot, applications of 0.375-0.75 kg/ha were investigated in post-harvest treatments. Also with these experiments no yield reductions were observed in the year following application. With Oberschlesien (2 experiments) on sandy soil poor in organic matter, similar applications again caused no production losses. The yields of one of these experiments with Madame Moutot and with Oberschlesien are given in table I.

(78178)

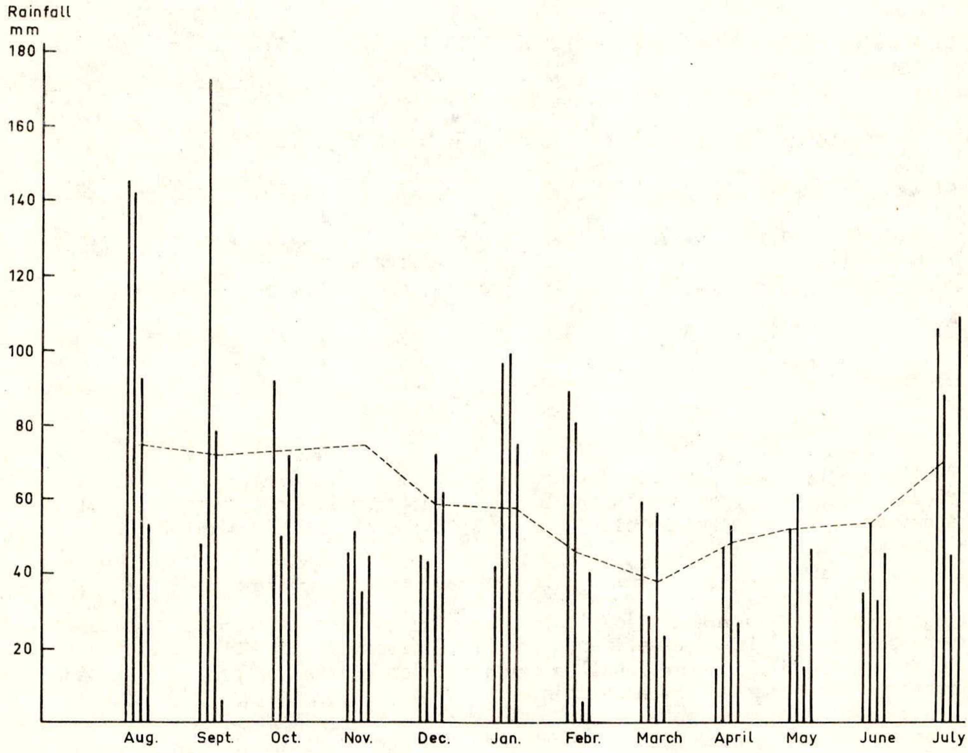

Fig. 1. THE MONTHLY RAINFALL DURING 1956-1960, AND THE AVERAGE MONTHLY VALUES FOR 1921-1950 (DOTTED LINE)

The four vertical lines for each month represent from left to right: 1956-1957, 1957-1958, 1958-1959 and 1959-1960.

TABLE I. EFFECT OF SIMAZINE ON STRAWBERRIES

Variety Madame Moutot Planted spring 1956, sandy soil, 3 per cent o.m.

Date of application	Dose kg/ha	Yield in kg/10 m^2 (mean of 3 replicates)
1) Aug. 6, 1958	0.375	21.5
2) "	0.75	23.1
3) March 16, 1959	0.375	12.9
4) "	0.50	8.2
5) Aug. 6 + March 16	0.375 + 0.375	11.9
6) " "	0.75 + 0.375	12.5
7) " "	0.75 + 0.50	9.2
8) Hand-weeded		22.5

Treatments 1, 2 and 8 differ significantly from treatments 3, 4, 5, 6 and 7 at the 1 per cent level.
Expt IBS 214

Variety Oberschlesien Planted spring 1955, sandy soil, 1½ per cent o.m.

Date of application	Dose kg/ha	Yield in kg/10 m^2 (mean of 3 replicates)
1) Aug. 7, 1958	0.375	23.4
2) "	0.75	21.2
3) March 20, 1959	0.25	22.5
4) "	0.50	17.1
5) Aug. 7 + March 20	0.375 + 0.25	21.3
6) "	0.75 + 0.25	22.5
7) "	0.75 + 0.50	14.5
8) Hand-weeded		21.6

Treatments 1, 2, 3, 5 and 6 differ significantly from treatment 7 at the 1 per cent level. Expt IBS 218

With early spring applications of simazine on Jucunda inconsistent results were obtained. In 11 experiments out of 19 doses of 0.25-0.50 kg/ha resulted in damage and yield reductions, in particular on clay soils poor in organic matter. On sandy soils, higher in organic matter, damage was less common. The same results were obtained with the variety Madame Moutot. From table I it appears that in spring 1959 (rather humid weather conditions) even a dose of 0.375 kg/ha caused a significant yield reduction (treatments 3, 5 and 6). In another experiment in spring 1958 under less humid weather conditions on the same soil a statistically significant difference from the yields of hand-weeded plots could only be observed at 1 kg/ha. Data on an experiment on sandy soil with the variety Oberschlesien are also presented in table I. Early spring applications of 0.25 kg/ha did not result in a statistically significant influence on the yield, but at 0.50 kg/ha important yield reductions may occur (see treatment 7). The same observation has been made in 1960 in the same soil under rather dry weather conditions.

With all varieties simazine symptoms following spring treatments did not occur before the plants had developed a considerable amount of foliage (4-6 weeks after treatment). The oldest leaves showed marginal yellowing, followed by entire browning.

Annual cropping system

In these experiments more recently developed varieties (Talisman, Senga sengana and Macherachs Frühernte) and Deutsch Evern were included. The planting usually takes place in August. Autumn and spring applications of simazine were investigated.

In table II the results are presented of an experiment with Senga sengana and Talisman on an organic sandy soil. Autumn applications of rather high amounts of simazine did not cause significant yield reductions. Rather dry weather conditions in autumn and especially in spring have to be taken into consideration, however (see fig. 1).

TABLE II. EFFECT OF SIMAZINE ON STRAWBERRIES

(Planted Aug 1959, sandy loam soil, 10 per cent organic matter)

Dose kg/ha on Oct 19, 1959	Yield in kg per 10 m^2 (mean of 3 replicates)	
	Senga sengana	Talisman
0.5	17.5	16.8
1.0	18.5	16.9
1.5	16.0	16.7
Hand-weeded	18.0	17.1

All plots were hoed on March 24 and May 25, 1960
Expt IBS 557

In another experiment on sandy soil with a lower content in organic matter neither autumn nor spring applications of 0.25-0.75 kg/ha influenced the yields (table III). This was also observed in Macherach Frühernte. In this case too the rather dry weather situation in spring has to be considered.

TABLE III. EFFECT OF SIMAZINE ON STRAWBERRIES

(Planted Aug 1959, sandy soil, 4.5 per cent organic matter)

Date of application	Dose kg/ha	Yield in kg/10 m^2 (mean of 3 replicates)	
		Senga sengana	Talisman
Sept 29, 1959	0.25	14.1	9.8
	0.50	13.3	9.9
	0.75	13.4	9.6
Nov 9, 1959	0.25	13.2	11.3
	0.50	14.7	10.1
	0.75	14.1	9.5
March 14, 1960	0.25	14.5	10.0
	0.50	14.6	10.7
	0.75	13.5	11.0
Hand-weeded	-	13.9	9.8

Expt IBS 352

Comparing spring applications in Senga sengana and Deutsch Evern on clay soil, in 1959 under rather humid weather conditions Senga sengana did not react on doses of 0.75 kg/ha, but Deutsch Evern already showed severe damage at 0.25 kg/ha. In Deutsch Evern autumn applications caused less damage than spring treatments.

Runner beds

With the variety Jucunda runner beds are started in spring, with other varieties mother plants are planted in summer. In the following summer runner formation and the development of young plants takes place. Hand-weeding is very difficult, in particular during and after the period in which the young plants become established.

In Jucunda in April 1958 especially pre-planting, but also early post-planting applications of 0.5-1 kg simazine/ha caused considerable growth retardation and the death of plants. With the same variety on sandy soilapplications in June, early in the period of runner formation, were investigated in 1958 and 1959. In addition to simazine also propazine, neburon and chlorpropham were studied. A dose of 0.5 kg simazine/ha (and in 1959 even higher doses, up to 1 kg/ha) did not damage the mother plants or the runners. The young plants becoming established on the treated soil grew normally and a satisfactory weed control was obtained. Propazine and neburon also caused no damage; chlorpropham however, caused considerable growth retardation in the young plants.

With Talisman, Senga sengana, Macherachs Frühernte and Deutsch Evern too an application at the rate of 0.5 kg simazine/ha in the period of runner formation (June-- July) was not harmful to the production of young plants.

Influence on the weeds.

Generally speaking applications in our experiments took place on previously hand-weeded plots, as at the low doses investigated unsatisfactory results would have been obtained with established weeds. Consequently in the experiments reported on, only the residual effect on germinating weeds has been followed. The following tables indicate what may be expected under these circumstances.

Table IV shows the effect of some post-harvest applications of simazine on a sandy soil poor in organic matter. On this soil low rates from 0.25 kg/ha resulted in satisfactory control of the major strawberry weeds during a period of 3 months, although the weather conditions were rather dry (see fig. 1). In the following spring the activity of the chemical on young weeds appeared to have ceased almost completely.

TABLE IV. EFFECT OF SIMAZINE ON WEEDS

(Poa annua Senecio, vulgaris Stellaria, media on sandy soil with 1.5 per cent organic matter)

Dose kg/ha on July 30, 1959	Mean estimation of weed coverage on	
	Sept 11, 1959	Nov 2, 1959
0	7.8	6.8
0.25	1.1	2.1
0.50	1.0	2.3
0.75	0.1	0.4
1.00	0.2	0.0

Three replicates; 0 = no weeds; 10 = complete coverage
All plots were hoed on Sept 12, 1959
IBS 335

TABLE V. EFFECT OF TIME OF APPLICATION OF HERBICIDES ON WEEDS

(On sandy soil with 4.5 per cent organic matter)

Dose kg/ha	Mean estimation on May 16, 1960 after application on		
	Sept. 29, 1959	Nov 9, 1959	March 14, 1960
Simazine, 0.25	5.0	2.3	0.9
Simazine, 0.50	3.8	0.9	0.2
Neburon, 1.50	3.8	3.3	7.0
CIPC , 1.60	4.3	4.0	-
None	7.8	7.8	7.8

Three replicates; 0 = no weeds; 10 = complete coverage All plots were hoed on April 4, 1960 IBS 352

The effect of the moment of application on weed control obtained by simazine is shown in table V, which also gives some results with chlorpropham and neburon. In this experiment the main weeds were Apera spica-venti, Chenopodium album, Poa annua, Polygonum convolvulus and Viola arvensis. The application in September 1959 of simazine, neburon and chlorpropham appeared to have lost its residual effect by May 1960. Applications of 0.25-0.50 kg simazine/ha in November 1959, however, still gave satisfactory weed control in May 1960 and the same was true for treatments applied in March 1960, although weather conditions in spring were dry. The results obtained with simazine were better than with neburon.

According to our experience the effect of summer applications of 0.50 kg simazine/ha has usually worn off in the spring following. Therefore repeated applications (summer and spring) were investigated as well. In table VI the results of such an experiment are indicated. The major weed present in this case was Senecio vulgaris. Also here the residual effect gradually disappeared, although some effect could still be observed after 10 months. In other experiments too the great susceptibility of Senecio to simazine has been noticed. A twofold application in summer and spring of 0.5 kg/ha gave a perfect control of this weed. In this experiment rainfall was rather high (see fig. 1).

TABLE VI. EFFECT OF SIMAZINE ON SENECIO VULGARIS

(On clay soil)

Time of application	Dose kg/ha	Mean estimation of area covered on		
		Nov. 12, 1957	May 31, 1958	July 30, 1958
Aug. 1, 1957	0.50	3.0	3.8	5.7
Feb 21, 1958	0.50	8.5	1.5	3.3
Aug 1, 1957 +) Febr. 21, 1958)	0.50 + 0.50	3.0	0.2	1.3
None	none	8.5	8.0	6.3

Three replicates; 0 = no weeds; 10 = complete coverage
All plots were hoed on Nov. 13, 1957, and June 2, 1958
IBS 115

DISCUSSION

In our experiments with strawberries grown according to various systems (picked for one or more seasons) a striking difference showed up between the susceptibility of strawberry plants to applications of simazine in summer or early autumn to those sprayed in early spring. Whereas during 4 years of experimental work post-harvest applications of up to 0.75 kg simazine/ha did not cause any depression in yield the next year, applications in spring, of doses as low as 0.25 kg/ha caused damage to the crop. The relative resistance of strawberries to summer applications of simazine was also mentioned by Campbell (1957), who reports that doses of 1 lb/ac caused little or no damage to 3-year old plants, 2 lb/ac gave considerable damage, however.

(78178)

Rainfall probably is not a factor of importance in causing these differences. After summer and autumn applications precipitation is usually higher than in spring; still the occurrence of reactions to simazine is more frequent after applications in spring. Although no data are available on differences in root development during the different parts of the growing season for the varieties included in our experiments, according to Mann and Ball (1926, 1928) root formation and extension of the root system in the variety Royal Sovereign is more intensive in summer and autumn than in the same plants in spring. Therefore a closer contact between the root system of the strawberries and the simazine present in the top-soil might explain this higher susceptibility of the plants in spring.

The extent of damage occurring after applications of simazine in spring is determined by several factors. First of all varietal differences exist. In our experiments Senga sengana and Talisman were the least susceptible varieties; Jucunda, Regina and Oberschlesien take an intermediate place and Deutsch Evern and Madame Moutot proved to be very susceptible. Varietal differences in susceptibility to simazine were also mentioned by White (1958). They are known as well from experiments with chlorpropham (Van Stallduine 1957; Robinson 1958). Secondly a group of environmental factors determining the amount of simazine available to the root system of the strawberry plants influences the extent of damage. In addition to the dose of simazine applied, the influence of soil type, in particular the content of organic matter, and the amount of rainfall after applying the chemical appear to be of importance. In particular, doses higher than 0.5 kg/ha may cause considerable damage. After applications of 2 lb/ac in spring Hemphill (1957) has also observed serious damage and yield reduction.

The relative resistance to simazine observed in young strawberry plants on runner beds is striking. This phenomenon has also been observed by Wood and Sutherland (1960). The fact that young plants may development normally in simazine-treated soil can best be understood by assuming a prolonged physoi - logical dependence of the young plants on the mother plants. This theory is supported by the observation that if a mother plant shows simazine symptoms, reactions may also be noticed in the already well-rooted runner plants. Under normal conditions the mother plants do not react to the simazine, however.

In the experiments reported on, a satisfactory weed control was obtained with doses of 0.25 - 1 kg/ha. This low level is caused by several factors. Strawberries are usually grown on soils rather low in organic matter content (5%). The inactivation of simazine observed on soils high in organic matter and the required increase in the dose needed for a satsifactory weed control consequently is of no great importance for applications in strawberries. Good effects are usually assured because of sufficient rainfall during the entire growing season (see figure 1). Applications on humid soil surfaces are to be preferred; this situation appears to promote a good effect of the application. As has been indicated all treatments in our experiments were carried out after removing all established weeds. Weeds germinating subsequently are easily controlled by the doses indicated. Under humid weather conditions small established weeds will also be killed. The applications are rather effective because of the high susceptibility of <u>Poa annua</u>, <u>Senecio vulgaris</u> and <u>Stellaria media</u> to simazine.

Since applications of simazine are possible in established strawberry plantings and in addition the use of simazine in the annual growing system is promising, only the problem of weed control in spring remains. There are indications, that applications of 0.5 kg simazine/ha in October - November may result in good weed control until picking next year. It seems to be justified to continue research in this direction. In addition, however, we shall have to continue our search for other selective herbicides which will be tolerated by strawberries under spring conditions and allow a greater safety at other moments of the year. The use of simazine reported on may result in a considerable alleviation of weed control porblems in strawberry plantings, but has not to be looked upon as the most desirable solution or the final word in this aspect.

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FURTHER PRELIMINARY TRIALS OF CHEMICAL WEEDKILLERS IN RASPBERRIES AND STRAWBERRIES

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Summary: This paper reports small preliminary trials on the control of annual weeds in established raspberries and strawberries, on the control of *Agropyron repens* in raspberries and on the effect of spraying a prepared soil surface with herbicides shortly before planting strawberries. Simazine and atrazine, used at low rates, gave promising results against annual weeds in established plantations of both fruits. In the work with *Agropyron repens*, dalapon gave the best results and amino triazole severely damaged the raspberries. Soil-surface sprays of simazine (2 lb/ac), atrazine (4 lb/ac), monuron ((3 lb/ac), diuron (4 lb/ac) and fenuron (0.5 lb/ac) all caused the death of strawberries planted by trowel two days later.

INTRODUCTION

Herbicide "screening" trials of the type previously reported by Wood and Sutherland (1960) have been continued at Mylnefield as a means of selecting the most promising materials for use in longer-term experiments. The work now described was done on well-drained light or medium loam soils, largely free from perennial weeds but productive of a dense growth of mixed annuals. The application rates for materials are given as weights of active ingredient per acre.

I. A trial of eight herbicides in raspberries in 1959.

METHODS AND MATERIALS

This trial was planted in late March with canes of the variety Malling Jewel, spaced at 6 ft x 3 ft. Plots, two for each treatment, were marked out across the direction of the rows. The ground was rotavated on 9 April and the herbicides were applied by Oxford Precision Sprayer two days later, at a standard liquid volume rate of 40 gal/ac.

RESULTS

(i) Untreated plots

By 29 April these plots carried large seedling populations of *Stellaria media*, *Senecio vulgaris* and *Spergula arvensis*. Other species included *Chenopodium album*, *Poa annua*, *Lamium amplexicaule*, *Fumaria officinalis* and *Galeopsis tetrahit*. Weed-cover was complete soon after mid-May.

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(ii) 3Y9 (Falone 2,4-DE Phosphite) (3 lb and 6 lb)

This material gave inadequate weed control, especially of Stellaria media and Poa annua. Chenopodium album and Senecio vulgaris were fairly well controlled at both rates and Fumaria officinalis and Spergula arvensis were possibly reduced in numbers at the 6 lb dose: but the estimated weed cover on 29 May was 40 per cent and 20 per cent at the two rates respectively. The raspberries showed no injury.

(iii) Atrazine (2 lb and 4 lb)

Although weed seedlings were numerous on 29 April on the plots treated with atrazine at 2 lb, nearly all had died by 11 May. None were present on the 4 lb plots. Weed control in late spring was excellent at both rates, the cover on 11 June being below 1 per cent. After being rotavated in late June along with others, these treatments continued very clean for the remainder of the season, the 4 lb-treated plots until as late as November. The raspberries showed no injury.

(iv) Simazine (6 lb)

Few seedlings were present on the plots of this treatment on 29 April, and most of them were dying. The plots then remained clean throughout the summer and were still 95 per cent free from weed cover in early November. The raspberries showed no injury.

(v) Monuron (5 lb)

This gave a good general control of weeds - Senecio vulgaris and Stellaria media, the main species, were completely suppressed - but did not adequately control Fumaria officinalis, Polygonum aviculare, Veronica hederifolia and V. persica. The raspberries in late May showed interveinal leaf chlorosis and necrosis, but the canes were not killed and eventually grew well.

(vi) Diuron (2 lb, 4 lb and 6 lb)

Weed control by diuron at the 2 lb dose was quit inadequate. A dense weed cover which formed in May and June was dominated by Fumaria officinalis, Senecio vulgaris and Galeopsis tetrahit. Although better, the 4 lb dose still left a weed cover in late May of about 15 per cent, composed mainly of Fumaria officinalis with some Senecio vulgaris and occasional plants of Lamium amplexicaule, Chenopodium album and Veronica spp. The 6 lb dose gave the best control but still did not adequately control Fumaria officinalis. The raspberries were apparently uninjured at the 2 lb and 4 lb dose but showed slight marginal leaf chlorosis in early June at the 6 lb dose. After rotavation of the plots in mid-June the 6 lb dose continued to give a moderate degree of weed control during the summer and autumn.

(vii) Fenuron (0.5 lb and 1.0 lb)

Fenuron at these doses failed to give a useful control of weeds. The raspberries showed no injury.

(viii) EPTC (5 lb and 10 lb)

EPTC at 5 lb was almost without effect. The 10 lb dose gave a good control of Stellaria media until the end of May, but Senecio vulgaris was no more than checked and a general and rapid growth of weeds occurred in June. The raspberries grew normally.

(ix) Neburon (2.5 lb)

This treatment also was ineffective. There was some control of Stellaria media but little or none of Senecio vulgaris, Lamium amplexicaule, Fumaria officinalis or Galeopsis tetrahit. The raspberries grew normally.

II. A trial for the control of Agropyron repens in raspberries in 1959.

METHODS AND MATERIALS

This was a trial made on a 5-year-old plantation of seedling rapberries (Malling Jewel x Burnetholm Seedling) of varying habit and vigour, the rows of which were heavily infested with A. repens. The following treatments were applied on 23 March, when the couch grass was starting into growth but the raspberry buds were still unopened: dalapon (8.5 lb), amino triazole (5 lb), atrazine (5 lb), TCA (18.6 lb), and dalapon (4.25 lb) + amino triazole (2.5 lb). Each was applied at a liquid volume rate of 50 gal/ac. No cultivations were given before or afterwards.

RESULTS

(i) Dalapon (8.5 lb)

By 5 April to A. repens foliage was becoming grey and brownish, and by the end of the month had turned completely brown. Poa annua also looked unhealthy and showed some abortion of the growing tips, but dicotyledonous annual weeds grew normally. There was no sign of injury to the raspberries until early June, when the foliage of the young current-season canes was pale in colour. Some regrowth of A. repens began in mid-June.

(ii) Amino trizole

This treatment produced severe chlorosis and pink colouration of the foliage and growing apices of A. repens and of all other weeds present, and the stand of A. repens was much reduced by mid-April. Similar severe effects were produced in the fruiting laterals and new canes of the raspberries, and by 30 April there was scarcely any green growth on the treated plots. Many raspberry canes were killed by the end of May, but there was then a slight re-growth of A. repens.

(iii) Atrazine (5 lb)

This gave a good kill of established Poa annua by the end of April and controlled all germinating annual weeds until autumn: but A. repens was only slightly checked in growth. The raspberries showed no injury.

(iv) TCA (18.6 lb)

With this treatment the leaves of A. repens turned greyish in April, with necrotic tips, but re-growth had begun by the end of the month. Although the vigour of growth was reduced during May, coverage of the rows remained complete. The raspberry foliage developed the severe interveinal chlorosis typical of TCA injury.

(v) Dalapon (4.25 lb) + Amino triazole (2.5 lb)

This mixture gave as good a control of A. repens as amino triazole at 5 lb, with less damage to the raspberries: but the control was rather poorer than with dalapon at 8.5 lb. The raspberries showed chlorosis patchily until mid-June.

III. Effects of spraying a soil surface with herbicides before planting strawberries in 1959.

METHODS AND MATERIALS

Immediately after being prepared for the spring planting of strawberries, areas of soil surface were sprayed on 17 April with the herbicides listed below, at the rates shown and each at a volume rate of 30 gal/ac. Strawberries (variety Redguantlet) were planted with trowels on 20 April.

RESULTS

All the strawberries were killed on plots which had been sprayed with monuron (3 lb), simazine (2 lb), atrazine (4 lb), and diuron (4 lb).

Injury on the monuron and diuron plots first appeared as a marginal leaf chlorosis and developed into an interveinal necrosis leading to a complete collapse of the plants. Most plants on the monuron plots were dead by 11 May, but some on the diuron plots survived for a week or two longer. The plants on the simazine and atrazine plots developed a severe general necrosis and were dead by the end of May.

An almost complete loss of plants also occurred on plots pre-sprayed with atrazine at 2 lb or with a mixture of 2,4-DES (3.6 lb) and fenuron (0.5 lb). The mixture produced leaf symptoms indistinguishable from those of monuron injury. On plots pre-sprayed with 3Y9 (2 lb and 4 lb) or with a mixture of 2,4-DES (3.6 lb) and propham (5.0 lb) there was a temporary distortion of the young leaves. No damage occurred on plots treated with EPTC (8 lb), but this treatment gave the poorest weed control. Weed control on the 3Y9 plots was also poor, and similar to that obtainable with 2,4-DES alone.

IV. Trials of herbicides on established strawberries in 1959 and 1960.

Applications of simazine at rates of 1.5 lb and 3.0 lb were tested in an initial trial in 1959 of a fifth-season Talisman plantation, in which the plants had been maintained separately at their original spacing of 36 in x 18 in. The treatments were applied on 16 March after the rows had been hoed and lightly rotavated. The 1.5 lb dose gave insufficient weed control, but the plots treated at the 3 lb dose remained clean until autumn. Some of the older strawberry foliage on the 3 lb plots showed a marginal chlorosis and necrosis, and severe injury occurred to small runners of the previous year left loosely rooted after the cleaning; but the new season's growth on the established plants was normal and vigorous.

In 1960 the following treatments were tested in a 6 x 6 latin square design on part of the same plantation: monuron (3 lb), simazine (2 lb), atrazine (2 lb), diuron (3 lb), chlorpropham (2.5 lb) + monuron (1.0 lb), and control (normal cultivation). The herbicides were applied on 4 March by Oxford Precision Sprayer at a working pressure of 25 psi, each at a volume rate of 30 gal/ac. The plantation was clean and the foliage dry.

The simazine and atrazine treatments caused no injury to the established plants, although loosely rooted runners of the previous year again showed necrosis. The monuron treatment was disappointing: Stellaria media and Senecio vulgaris were poorly controlled and chlorosis appeared on some of the mature strawberry foliage in April. By mid-May, however, most of the new growth was normal. Diuron gave rather similar effects - a poor control of Senecio vulgaris and Veronica spp. and some interveinal chlorosis of the older strawberry leaves. Both of these treatments slightly depressed vigour as compared with the simazine, atrazine and control treatments. The chlorpropham/monuron mixture controlled weed growth well, except for Senecio vulgaris, but severely stunted the strawberry plants.

The fruit yields from the six treatments (Table I) were in close relation to the effects on growth. The simazine, atrazine and control plots significantly outyielded those treated with monuron and chlorpropham/monuron, and the simazine plots also significienty outyielded the diuron plots.

TABLE I. FRUIT YIELDS OF TALISMAN STRAWBERRIES IN 1960.

Treatment	Yield per plot (lb)		
	Sound	Blemished	Total
Simazine (2 lb)	20.5	2.7	23.2
Atrazine (2 lb)	19.6	2.3	21.9
Diuron (3 lb)	17.1	1.7	18.8
Monuron (3 lb)	15.0	1.6	16.6
Chlorpropham + (2.5 lb) Monuron (1.0 lb)	14.4	1.4	15.8
Control (normal cultivation)	19.9	2.0	21.9
	Sig. diff. (P = 0.05) 3.4		

DISCUSSION

These trials provided only very introductory information on the possible usefulness of the materials tested, since they left almost untouched the variations in rates and times of application that can be considered for perennial fruit crops, particularly deciduous crops like the raspberry. There are also wide possibilities in the use of mixtures of herbicides for these crops. The present results are reported, however, as a contribution to work which is being continued at Mylnefield and elsewhere.

The first trial, with raspberries, gave further promising results from simazine used at a low dose as a residual herbicide. It also showed the possible value of atrazine, which may be the more effective of the two under dry conditions. EPTC and 3Y9 gave disappointing results, and further work is required to determine the value of fenuron, neburon and diuron as herbicides for soft fruit. Monuron can be injurious to raspberries, and probably even more so to strawberries, if applied in spring at rates sufficient to destroy Senecio vulgaris, but its use at other times of the year may repay investigation.

Of the five treatments applied against Agropyron repens in raspberries, dalapon at 8.5 lb seemed the most successful, and slightly better than amino triazole at 5 lb. Damage to the raspberries was greatest where amino triazole was used. With all the treatments there was some re-growth of A. repens by mid-June, and better control may have been achieved if the use of herbicides had been combined with cultivations.

The third trial showed that sprays containing simazine, atrazine, monuron, diuron or fenuron, applied to a prepared soil surface, can destroy strawberry runners planted into the site shortly afterwards. This is presumably because the chemicals are mixed into the rooting zone by the act of planting.

The last of these trials showed promising results from the spring use of simazine and atrazine on established strawberries. It is important to follow-up this work with experiments combining repeated applications of these herbicides with assays of their persistence and movement in the soil, because the value of substituted triazines will depend largely on whether their accumulation in harmful concentrations can be avoided. The possibility of such a build-up makes it still more important to select a range of herbicides suitable for use in any given crop, so that changes can from time to time be made.

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REFERENCE

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