Tuesday, November 2nd
Afternoon

RESEARCH REPORTS

Chairman: DR. E. HOLMES

HORTICULTURE

THE USE OF HERBICIDES IN VEGETABLE CROPS IN DENMARK

DR. H. I. PETERSEN, Statens Ukrudtsforsdg, Lyngby, Denmark.

Asparagus.

Good results have been obtained by treating asparagus beds with petroleum-preparations. In addition, calcium cyanamide appears to be very suitable.

Chemical weed control in asparagus is not yet used much in practice.

Strawberries

In strawberries some trials have been carried out using IPC and "Experimental Herbicide No. 1" (2,4 dichlorophenoxyethylsulphate). The treatment has usually been made early in spring.

The strawberry plants however have often been injured to some extent and the effect on the weed has usually been insignificant.

Hitherto chemicals have not been used in practice against weeds in strawberries. But experiments are constantly being carried out with various preparations.

Carrots.

By spraying with petroleum-preparations (20 per cent aromatic), e.g. "Esso Weedkiller 35" or "Shell Weedkiller W, against weeds in carrots very good results have been obtained. This is the case in hotbeds, cold-beds as well as outdoors.

Trials in hotbeds.

Average of 6 trials 10 l, per 100 m^2	Yield in kg incl. tops per frame		Weeds gm per m^2	Weeding time minutes
	1st sort.	total		
Untreated (weeded)	11,4	12,8	542	37,3
"Esso Weedkiller 35"	13,3	15,6	6	0,9
"Shell Weedkiller W"	13,6	15,7	8	1,3

The treatment has increased the yield about 2 kg per frame. The effect on the weed was very great. The total weight of weed per m^2 amounted to 542 g in untreated, but only 6-8 g after spraying with petroleum-preparations. The weeding time was reduced from 37 minutes per m^2 in untreated to only 1 minute per m^2 after spraying. Both of the tried preparations seem to have had very nearly the same effect. Another preparation, "Pentox 1", that was not used in these trials, has shown the same effect as the above-mentioned.

Various amounts of oil. At the State Institute for Weed Research the effect of 5,0, 7.5 and 10.0 litres oil per 100 m^2 has been compared in hotbeds. The results are as follows:

Trials with various amounts of oil.

Average of 13 trials	Yield in/kg incl. tops per frame		Weeds	Weeding time minutes
	1st sort.	total	gm per m^2	
Untreated (weeded)	11,3	12,6	596	25,6
5 l./100^2(equivalent to about 100 cm3/frame)	12,8	14,3	32	2.9
7.5 l./1002(equivalent to about 150 cm3/frame)	12,2	13,8	10	1.6
10 l./100^2(equivalent to about 200 cm3/frame)	11.9	13,3	4	0.5

An amount of solution of 5 litres per 100 m^2, corresponding to about 100 cm^3 per frame has given an excellent result. Thus the weeding time was reduced to a tenth.

By applying 150 and 200 cm^3 per frame a little greater effect on the weed has been obtained. In these trials the greatest increase in yield by the treatment has been got by application of 100 cm^3 per frame.

By early spraying, i.e. when the carrots only have one full-grown leaf besides the seed-leaves, 100-150 cm^3 of oil per frame will be sufficient in many cases. For weeds in large numbers it may be necessary to apply 150-200 cm^3 per frame.

In coldbeds similar results have been obtained as in hotbeds.

The carrots must not be short of water during the treatment, but on the other hand the leaves of the carrots or the soil must not be wet when spraying. Wet tops and wet soil tend to cause the oil to evaporate too slowly.

In frames the following method can be used: The day before treatment water is given as usual; next day in the morning the sashes must be removed to allow the moist air in the frame to escape and the top of the plants and the soil to become dry. After a few hours, spraying may be undertaken. Towards evening the sashes should be replaced, but during the following night sufficient fresh air must be given.

Under these circumstances the oil will evaporate within a few hours. If required, water may be given a day after treatment.

In a part of the trials mentioned above, after harvesting, boiled as well as unboiled carrots were tasted. In no cases did the carrots taste of petroleum, but in some cases, especially when the treatment had stopped the growth, a change of taste was found, so that the taste of new carrots resembled that of old carrots.

Outdoor-trials. Results of 9 trials are given below:-3

Outdoor-trials.

Average of 9 trials 10 l. oil per 100 m^2	Yield in kg per 10 m^2 total + tops	Weeds kg per 10 running meters	Weeding time (7 trials)
Weeding when necessary	34,8	5.4	13.9
Spraying at the seedleaf stage	43.7	1.5	5.1
Spraying when carrots had 3 leaves besides the seedleaves	41.1	2.0	7.9
Spraying at the seedleaf stage and again when the carrots had 3 leaves besides the seedleaves	40.8	0.8	4.4

A great increase in yield has been obtained by spraying, especially after the seedleaf stage. The spraying at this time has had a great effect on the weeds also. Two spraying of which the first one was applied at the seedleaf stage and the second one when the carrots had 3 leaves besides the seedleaves, have had a little greater effect on the weed.

As spraying with the pure petroleum-preparations is rather expensive, in practice one treatment will often be preferred. If so the spraying must be made early i.e. when the carrots have one developed leaf besides the seedleaves. This early treatment will usually be most profitable, partly because the growth of the carrots is not yet checked by weeds and partly because the carrots bear the early treatment best. By late treatment, the leaves of the carrots can be scorched to some extent.

As mentioned under the treatment in frames, the plants, when sprayed, must be dry. Water can be given the day after the treatment. As far as possible the spraying must be carried out when the heaven is clouded, not in the burning sun.

Carrots for Fodder can be sprayed in the same way as eating carrots. Just as in eating carrots it is especially the first growth of weed in carrots for fodder which occasions an extensive weeding so that the spraying must be undertaken rather quickly after carrot emergence.

In three field experiments there was a rather heavy attack of the Carrot Rust Fly (Psila rosae). Spraying with petroleum-preparations in these experiments had no effect on the attack. The cause of this may possibly be that the treatment has been carried out at a wrong time in relation to the attack.

Carrots for Seed. The treatment took place in spring at the beginning of May. Three experiments were carried out. The effect of the spraying was to cause a decrease in seed yield. Treatment in carrots for seed ought to be discouraged until further notice.

Celery.

Celery is more susceptible to petroleum-preparations than are carrots. The treatment must therefore be carried out with prudence. No greater amount of solution must be applied than strictly required, and the method, described under carrots, should be observed closely.

Celery plants that have been pricked out, must be treated before the weed plants are too big.

The influence of solution on weeding time and the growth of the celery plants is indicated in the following table:-

Trials in celery.

	Weeding time in minutes per m^2 100 cm^3 per frame	200 cm^3 per frame	Growth of celery plants in the transplanting bed marks 0-10, 10=most vigorous 100 cm^3 per frame	200 cm^3 per frame
Untreated	29	44	10	9
"Esso Weedkiller 35"	1	2	9	7
"Shell Weedkiller W"	2	2	9	7

No more than 100 cm^3 per frame must be applied and if possible even less. The distribution, made with a fine atomizing sprayer, must be quite regular.

The treatment in the transplanting bed seems not to check the growth of the celery plants later on in the field.

The celery plants, once they have been planted out in the field, must not be treated with petroleum preparations.

Carrots, celery and other umbelliferous cultivated plants resist petroleum only of a special type. Petroleum, used for lighting and motors, may not be applied as its phytoxie properties may be too variable to allow it to be used for weed control in the above crops.

Parsley and chervil.

As a result of trials it maybe stated that parsley and chervil resist spraying with petroleum-preparations.

The treatment however must be carried out before the tops, which are used for consumption, have developed.

As the odour of petroleum remains in the top after the treatment, all the crops, the leaves of which are to be used for consumption, can no longer be treated once the leaves have developed.

Spraying with these remedies however can be carried out at a very early time.

Potatoes.

At the moment, trials are being carried out with spraying of hormone preparations in potatoes according to the following two schedules:

Schedule I

(a) Untreated.
(b) 2-4 days after planting.
(c) When the potatoes are breaking through the surface of soil.
(d) When the potatoes have a height of 4-6 cm.
(e) At early flowering.

Schedule II

(a) Untreated.
(b) 0.5 kg active MCPA per ha.
(c) 1 " " " " "
(d) 2 " " " " "
(e) 4 " " " " "

According to schedule I the treatment must be carried out at various times and 1 kg MCPA or 1 kg 2-4D is used per hectare.

In schedule II increasing amounts of MCPA are used and the spraying is undertaken immediately before the sprouting of the potatoes.

The preliminary results show that the potatoes resist the treatment with hormone-preparations fairly well.

By spraying, especially after emergence, the leaves can be deformed in such a way that it is impossible to effect "roguing" of virus infected plants in the case of certified feed potatoes.

Therefore the treatment cannot be carried out in potatoes which shall be certified and used for propagation.

Hormone-preparations are sometimes used in eating potatoes. In certain cases the preparations can pierce the soil and give distaste.

Kepa onions.

Especially after early sowing, Kepa onions take a long time to germinate and are in consequence at emergence normally so heavily covered by weed that weed control must usually be carried out by laborious hand-weeding.

Before the emergence.

The experiments have shown that most of the principle weeds, troublesome in Kepa onions, can be controlled even before emergence of the onions. By weed control at this time it appears possible to use flame-throwers and various chemicals as indicated by the following experimental results:

Average of 5 trials 10 l. solution per 100 m^2	Yield of onions kg per 100 m^2	Treatment before emergence of the onions	
		Weeds in g per 10 m running row	Weeding time in minutes
Untreated	204.0	1197	29.6
Flame-thrower	294.4	100	3.9
Petroleum-preparation	264.8	134	5.0
"Aerocyanate" 2 per cent	284.8	217	7.3
"Supersinox" 2 per cent	204.7	143	3.3

The highest yield and also the best weed control has been obtained after use of a flame-thrower. Flame-throwers are very suitable for weed control before onion emergence. It is sufficient to burn away the weed in the row itself because later cultivating follows between the rows.

Petroleum-preparations e.g. "Esso Weedkiller 35", "Pentox I"or "Shell Weedkiller W" also have had a heavy effect on the weed. As the onions are very susceptible to petroleum-preparations, these remedies must never be applied when the onions have begun to germinate or even have begun to break the soil crust.

"Aerocyanate" (potassium cyanate) with a concentration of 2 per cent has had a slightly smaller effect on the weed than had the other herbicides. This material does not have a very strong effect on Fat hen (Chenopodium album), often found in onions. Contrary to the other treatments Aerocyanate can be used after emergence of the onions (see over).

"Supersinox" (Ammonium Salt of DNC). In the trials "Supersinox" has had a strong effect on the weeds, but sometimes it causes considerable damage to the onions even when the treatment is made before emergence. In this respect however Herbanit (Sodium Salt of DNC) is worse because it ruins the onions even by treatment 1 to 2 weeks before their emergence.

Before and after emergence.

The results of experiments, where "Aerocyanate" has been applied partly before and partly after emergence of the onions, are as follows:-

Average of 6 trials 10 l. solution per 100 m^2	Yield of onions kg per 100 m^2	Weeds in g per 10 m running row	Weeding time in minutes
Untreated	148.4	1760	25,1
"Herbanit"(3 trials) "Supersinox" (3 trials) before emergence	87.7	318	5.4
Petroleum-Preparation do.	168.9	574	8.0
"Aerocyanate" 1 per cent do.	193.8	792	12.3
do 2 per cent do.	202.0	546	9.0
do 1 per cent before emergence + 1 per cent after emergence	176.3	523	10.1

In order to control weeds in Kepa onions DNC ought not to be applied, at least not as the sodium salt.

In these trials also petroleum-preparations have had a good effect.

"Aerocyanate" has had the greatest effect with a concentration of 2 per cent. In order not to risk damage to the onions after emergence this material ought not to be applied at a highter concentration than 1 per cent.

In shallots "Aerocyanate" has been tried at a concentration of 1 and 2 per cent; this crop appears to be more resistant than Kepa onions.

Leeks.

Weed control in leeks is especially important while the plants are in seed beds.

Before emergence.

The same treatments and methods may be used as mentioned under Kepa onions. The leeks however are generally more susceptible to chemicals than are Kepa onions.

With good result flame-throwers can be used for flaming the soil immediately before the germination of the leeks so that the plants may emerge in clean soil. The treatment will therefore facilitate the weeding work to a great extent. Often it may be profitable to steam disinfect the soil against weeds before sowing.

After emergence.

"Aerocyanate" is the most suitable treatment,,but if applied after emergence of the leeks it must however be used cautiously. The difference between the susceptibility of the leeks and that of the weeds is not so great as desired.

At the State Institute for Weed Research, trials have been carried out with "Aerocyanate" against weed in leeks in frames. In these trials increasing concentrations were applied with the following results:

Trials in leeks in frames

Average of 15 trials 10 l. solution per 100 m^2	Weeds in g per m^2	Weeding time in minutes	Number of leeks/m^2 uninjured (6 trials)	injured (6 trials)
Untreated	489	36.7	390	0
"Aerocyanate" 0.5 per cent	270	18.8	386	18
do. 1.0 do.	144	9.8	354	31
do. 1.5 do.	129	7.6	342	53
do. 2.0 do.	77	4.9	313	88

Leeks appear to be more susceptible to "Aerocyanate" than are Kepa onions. When applying a solution of 150-200 cm^3 per frame after emergence the concentration ought to be much higher than 0.5-1.0 per cent. It must be remembered that too high concentrations and uneven distribution in the frames may be as dangerous as overdosing.

The treatment must be applied only some time after emergence when the leaves of the leeks are quite straightened out. The sashes ought to be removed 1 or 2 hours before treatment so that the plants can dry.

As mentioned under Kepa onions the treatment ought to be carried out in dry, cool weather on dry plants. High temperature and burning sun during the treatment can greatly damage the leeks.

Peas.

The pea crop is difficult to keep clean mechanically and it is therefore of great interest to discover spraying solutions which are effective against weeds and at the same time harmless to the peas.

In the experiments dinoseb was applied in two doses i.e. 4.5 and 3 litres per ha, of a 20 per cent preparation, and 3 litres 20% dinoseb mixed with 0.25 and 0.125 kg MCPA per ha, and finally MCPA alone: 0.25 and 0.125 kg per ha. The peas, having a length of 10-15 cm, were sprayed with 1000 l. solution per ha.

The mean results of the trials are given the tables below.

1

Spraying of field peas for ripening.

	Seed hkg per ha	Relative yield	Weed kg per 10 m^2	Relative weed	Germination per cent
Number of trials	18	18	16	16	10
Untreated	21.0	100	4.2	100	92.
dinoseb 4.5 l. per ha	23.4	111	1.0	23	92.4
do. 3.0 do. do.	23.6	112	1.4	34	92.8
do. 3.0 do. do. + MCPA 0.125 kg active substance per ha	23.6	112	1.2	28	92.2
do. 3.0 do. do. + MCPA 0.25 kg active substance per ha	23.6	112	1.2	28	94.2
MCPA 0.125 kg active substance per ha	22.7	108	3.1	75	93.0
do. 0.25 do. do. do. do.	22.5	107	2.7	64	93.5

As indicated by the above table, weed control in field peas gives an increase in yield which amounts to about 12 per cent for treatment with dinoseb and the mixtures of dinoseb and MCPA. By applying MCPA alone the increase in yield is 7-8 per cent when compared with the control.

Dinoseb at a concentration of 4.5 litres per ha has decreased the amount of weeds in field peas to about 0.25 of untreated. Nearly the same effect has been obtained by applying 3 litres dinoseb mixed with 0.25 or 0.125 kg. MCPA. On the other hand, 3 litres dinoseb alone has had a somewhat smaller affect on the weed.

Application of MCPA alone for weed control in peas cannot be recommended. The small doses, 0.25 and 0.175 kg. active substance per ha, which are harmless to peas, are unable to give good weed control, essentially because the weeds will always have attained a vigorous growth by the time the peas are sprayed, i.e. 10-15 cm. high.

In the trials, no decrease in germination capacity following spraying has been found.

2

Spraying of eating peas to be picked green.

	Green pods kg per are	Relative yield	Weed kg per 10 m^2	Relative Weed
Number of trials	8	8	7	7
Untreated	127	100	3.5	100
dinoseb 4.5 litres per ha	127	100	0.7	21
do. 3.0 do. do.	131	103	1.1	33
do. 3.0 do. do. + MCPA 0.125 kg active substance per ha	130	102	0.9	27
do. 3.0 do. do. + MCPA 0.25 kg active substance per ha	127	100	1.1	31
MCPA 0.125 kg active substance per ha	126	99	2.3	66
do. 0.25 kg do. do. do.	119	94	2.0	58

The results of experiments on eating peas appear from the table above. It is evident that varieties to be picked green are more susceptible to spray solutions than are field peas grown for ripening. Even if the effect on the weed in green peas was nearly the same as in the trials with ripe peas, it only resulted in a little increase in yield and by spraying with MCPA alone the damaging effect is plainly increased by higher doses.

Instructions for practical use

For weed control in peas for ripening as opposed to peas to be picked green, good results have been obtained with dinoseb. Dinoseb is a strongly scorching herbicide and its effect increases with increasing temperature. The dose must therefore to some extent be related to the weather conditions. The following table gives guidance.

	Herbasol, Sevtox 20 per cent	Aatox 13 per cent
By 15 °C apply per ha	4.5 litres	7.0 litres
" 20 °C " " "	4.0 "	6.3 "
" 25 °C " " "	3.5 "	5.5 "

In some cases it may be expedient to add 0.125 - 0.25 kg MCPA per ha. It depends on whether the weeds have grown so tall that it is difficult to combat them with dinoseb alone.

A greater quantity than 0.25 kg MCPA per hectare, should on no account be applied in peas neither alone nor mixed with DNBP.

CONTACT PRE-EMERGENCE TREATMENTS FOR VEGETABLE CROPS

H. A. ROBERTS, National Vegetable Research Station.

Summary

The development, advantages and limitations of the contact pre-emergence method of weed control are briefly discussed in relation to vegetable crops. Possible chemicals are considered, and experiments with PCP applied in oil or in oil/emulsion are described. It is concluded that this type of herbicide holds considerable promise.

Introduction

It is unfortunately true that despite a great deal of research there are still few vegetable crops for which truly selective chemical weed control methods have been evolved. The first to be developed was dilute sulphuric acid for the control of annual weeds in onions, and the history of this technique has been outlined in a recent review (1). Germination in onions is relatively slow however, and it was found that if spraying was delayed until the crop had reached the stage of tolerance, frequently the weeds were too large for satisfactory control. It was therefore suggested by Blackman (2) that the spray be applied just before onion emergence so as to kill all the seedling weeds present at that time. This method has since been widely used in Britain and constitutes the first instance of a successful pre-emergence treatment.

During the early post-war period many new herbicides were developed and tested in the U.S.A. and elsewhere as possible pre-emergence treatments for vegetable crops. These herbicides differed greatly in their properties, particularly in the period for which they persisted in toxic concentration in the soil, and Barrons noted that some confusion existed regarding the whole subject of pre-emergence spraying. In a useful contribution (3), he discussed terminology and the principles underlying the use of these chemicals, distinguishing between the two principal types of pre-emergence application, 'contact' and 'residual'. He defined contact pre-emergence as "a light dosage of a contact-type spray that leaves a minimum of residue employed to kill all tiny weeds that emerge before the crop", and it is this type of application which will be considered in the present paper.

The Contact Pre-emergence Method

This has been used mainly for crops in which germination is slow, the spray being put on just before the crop comes up. It can also be used for crops which germinate rapidly if the seedbed is prepared a week or so before sowing to allow time for weed seedlings to emerge and the spray applied immediately after sowing. If successful, the seedbed is clean when the crop emerges, competition in the early stages is eliminated and the need for expensive hand-weeding in the rows greatly reduced.

Pre-emergence treatments, however, suffer from certain serious limitations which are worth emphasising here. Sweet (4) noted that while pre-emergence methods in general had met with some success, there had also been many instances of severe crop injury or poor control of weeds. A proportion of these failures, he considered, appeared to be due to limitations inherent in the technique itself, and he summarised his valuable paper with the following six observations:-

1. Selective chemicals are not available.

2. Too long a period of herbicidal activity is often expected.

3. Timing is extremely critical from the standpoint of crop injury.

4. Timing is extremely critical from the standpoint of weed kill.

5. Timing is extremely critical in relation to the weather, especially rainfall.

6. The period of time over which a given field can be treated with little danger of crop injury and with reasonable assurance of weed kill is very short as compared to that where selective sprays are used.

By the first point Sweet was implying that the chemicals used in pre-emergence work are either general contact herbicides, or are selective herbicides used when the crop is in a susceptible stage. Hence, 'selectivity' is achieved only because the weeds have emerged while the crop has not, or because the crop seed is deeper down in the soil than the germinating weed seeds. If the chemical comes into contact with the crop, injury results.

Examination of the literature indicates that there is considerable justification for the second observation. Too often, high rates appear to have been used in an effort to prolong the period of weed control, with resultant crop damage. Contact treatments in particular can only be expected to destroy seedlings which have emerged, and the length of time for which the land remains weed-free afterwards will depend upon temperature, rainfall, the kinds and quantities of weed seeds present, and extent of soil disturbance. The question of timing dealt with in Sweet's remaining points is of great importance in contact applications. In a crop which germinates slowly, like onions, it is desirable that treatment be delayed so that the maximum number of weeds has emerged, and yet no crop seedlings must be present above ground or they will be damaged. If bad weather intervenes during the critical period spraying may have to be abandoned altogether. Contact spraying is also of little value if few weeds emerge before the crop, though in this instance traditional cultural methods are likely to be adequate. The method of advance preparation for rapidly germinating crops like lettuce suffers from the disadvantage that there may be deterioration of the seedbed during the time the weeds are emerging.

It seems clear that contact pre-emergence should be considered as a stop-gap technique which gradually will be abandoned as chemicals are discovered which are selective for individual crops. At present there are few such chemicals, costs of cultivation are increasing, and it would seem that there are many circumstances in which an effective contact pre-emergence spray would be valuable (5)(6).

Available Herbicides

There appear to be certain criteria which must be satisfied by an ideal chemical for contact pre-emergence use. It must be capable of killing rapidly and completely seedlings of most common annual weeds. It must not leave any toxic residue in the soil which can injure the crop as it emerges, nor should it be liable to cause damage to the crop during germination through rapid leaching if rain follows application. It must be effective over a wide range of temperature and moisture conditions, must be non-corrosive, easy to apply, free from serious toxicological hazards, and, last but not least, must be cheap.

None of the herbicides at present in use by British growers meets this specification completely. Sulphuric acid, though it has the advantage of

negligible residual effect, requires the use of special resistant spray machinery, is unpleasant to handle and is not effective against Poa annua. Mineral oils of the vaporising oil or white spirit type have been used on a variety of crops with good effect, but here the main objection is expense, while again certain species are not readily killed. Proprietary formulations of cresylic acids are used with success in the Evesham area, and a few other chemicals have been tried out on a small scale by growers.

Of the many chemicals tested for pre-emergence work in the U.S.A. few seem likely to be very useful under British conditions. Some with contact activity are highly water-soluble, like PCP sodium salt and salts of the substituted dinitrophenols, and involve a risk of crop damage even from the minimum rates needed for weed control if rapid washing-down occurs (7). Other materials like potassium cyanate are greatly influenced by the weather and may not always produce economic control. A spray which does seem to have possibilities is PCP applied in oil or in oil/water emulsion. Preparations of this type have been tested in the U.S.A. on many vegetable crops, but the results have been somewhat inconsistent. Examination of the reports shows, however, that in some instances there were few weeds present above ground at the time of spraying, while in others rates of more than 10 lb. per acre of PCP were used, and the residual action affected the crop. With rates of about 4 lb. per acre or less, good weed control and no crop damage has been reported, e.g. (8), (9). Such sprays have also been found effective in this country (1).

Experimental

Preliminary experiments were carried out at the N.V.R.S. during 1952 and 1953 considering PCP primarily as a fortifying agent for vaporising oil with the object of reducing the volume of oil required for weed control to an economic level. The trials were of randomised block design with three- four- or fivefold replication and the soil was a sandy loam. The plot size was approximately 1/400 acre, the sprays were applied with a knapsack sprayer and the weed kill assessed by counting random quadrats, the number and size of which depended on the plant density on the control plots. Stock solutions were prepared in the laboratory by dissolving technical PCP in an ordinary tractor vaporising oil with the aid of an organic solvent, incorporating an emulsifier where required. These concentrates were then diluted in the field.

In Table 1 are shown representative data for percentage kill of nine common annual weeds of vegetable crops. In each case three rates of PCP were applied in two series of treatments. The carrier in the first was a 25% emulsion of vaporising oil in water applied at 100 gal. per acre, and in the second, undiluted vaporising oil at 25 gal. per acre. Each carrier was also applied alone, and in addition, 80 gal. per acre of vaporising oil was included for comparison. The weed seedlings varied in size from the cotyledon stage to that of 4 true leaves. In the absence of fortifying agent, vaporising oil at 25 gal. per acre both undiluted and in emulsion proved inadequate, but addition of 1 lb. per acre of PCP gave good control of most species. At the 2 lb. rate the kill was very good, and there was little added effect from increasing the rate to 4 lb. per acre. The reaction of the weeds to the fortified sprays was substantially the same for both oil and emulsion carriers.

The same treatments were used in an experiment with onions (Table 2.). The sprays were applied shortly before onion emergence, counts made 14 days later, and the whole experiment then hand hoed and subsequently kept free from weeds to determine whether there had been any detrimental effect on the crop. The PCP sprays gave a good kill of the main weed species present, but owing to poor germination the stand of onions was low on all plots, and the general level of yield much below that of a good onion crop. There was no visible injury to plants on the treated plots however and the final stand and yield show no sign of having been adversely affected by the spray treatments.

In an experiment with lettuce, the land was prepared beforehand to allow the weeds to come up and the sprays put on immediately after sowing. Table 3. shows that excellent weed control was obtained without any serious effect on lettuce stand. During the period of the experiment the weather was dry, and shortly after emergence it was noted that seedlings on some of the treated plots showed injury symptoms. These took the form of inward rolling of the cotyledons so as to produce a boat-shape, together with chlorosis of the first leaf. Leaves produced later were normal, and within a week or two there were no differences between plants on the different plots.

The effect of reducing the volume of oil still further was investigated in another trial with lettuce, using emulsions only. Even when the volume of oil was no greater than 5 gal. per acre, more than 90% kill of Chenopodium album in the 2 true leaf stage was attained with sprays containing 1, 2 or 4 lb. PCP per acre, and there was no injury to the lettuce. Further evidence that only a small amount of oil is needed when in combination with PCP was gained in 1954 when trials were carried out with an experimental preparation kindly supplied by Messrs. Monsanto Chemicals Ltd. Known as Experimental Herbicide RD 4194, it is an oil formulation of PCP which is miscible with water, and though the results of the 1954 experiments have not yet been analysed, they appear very encouraging. No additional oil was used with this formulation, that present in the concentrate being adequate.

Discussion

The contact kill of seedling weeds by PCP in oil or oil/water emulsion has been excellent in all trials to date. Also, (Table 1.), a wide range of weeds is killed, and it would be expected that with sprays containing two phytocidal constituents, as in the present instance, there is less likelihood of encouraging a few resistant species as may happen with herbicides containing a single active principle. In experiments where the ground was not disturbed and the weather was dry no further weeds emerged for a period of several weeks, while in others they appeared more rapidly. A report of experiments carried out at Fulmer by Monsanto Chemicals Ltd. (10) stated that with a fine tilth and adequate soil moisture, good weed control was given by RD 4194 sprayed immediately after sowing in a clean seedbed. This indicates a residual effect sufficient to kill weed seedlings germinating near the soil surface during the period after spraying. Parker (11) found that there was some residual effect from PCP at 1, 2 & 4 lb. per acre in vaporising oil, and Ivens (12) also noted residual control of Urtica urens with these rates applied in 20% diesel oil emulsion. It seems therefore that though PCP in oil or emulsion must be considered primarily for killing weeds which have already emerged, under suitable conditions its effect can be extended to the control of weeds which are only just germinating near the surface. Such temporary residual action would be an advantage provided the crop is not affected. Transient injury to lettuce has resulted from rates of 2 and 4 lb. per acre (Table 3.), and in 1954 these rates applied in the form of RD 4194 caused some injury to onions in one trial. At present, however, it would appear that there is little danger of lasting injury to onions or lettuce from pre-emergence applications of about 2 lb. per acre of PCP.

The question of persistence, breakdown in soil and effect on soil micro-organisms has been studied by several writers (13,14,15), and it would seem that there is little risk of unwanted residues or undesirable effects from the rates of PCP likely to be used for contact pre-emergence. The contact kill does not seem to be greatly affected by weather, and good results have been obtained at March temperatures. The low solubility in water of PCP (parent phenol), 20-25 ppm at 20°C., makes it unlikely that rainfall after spraying would cause rapid washing down to the zone round the crop seed. The

mammalian toxicity is relatively low, PCP is relatively cheap and formulated preparations such as RD 4194 are easy to mix in the field and require no more than ordinary care in handling.

Hence, the available evidence indicates that PCP in the type of application described satisfied most of the requirements for a contact pre-emergence treatment. Further testing on a larger scale will obviously be necessary and there are several points which need investigation. These include the interaction of tolerance and timing of the spray for different crops and study of the length of time for which PCP can remain active in the surface layers of the soil under varying conditions. The limitations of pre-emergence must always be borne in mind, but it does seem that with further work PCP might at an early date help to solve at least some of the grower's weed control problems.

Acknowledgment

Certain data in Table 1 are from experiments conducted in co-operation with the A.R.C. Unit of Experimental Agronomy, Oxford, and the N.A.A.S. Experimental Horticulture Station, Luddington.

References

1. IVENS, G. W., G. E. BLACKMAN & E. K. WOODFORD, (1953). Rep. 13th internat. hort. Congr. 1952, 386.

2. BLACKMAN, G. E., (1942). Ann. appl. Biol., 29, 204.

3. BARRONS, K. C., (1948). Down to Earth, 4 (3), 2.

4. SWEET, R. D., (1951). Suppl. Proc. 5th northeast. Weed Control Conf., 47.

5. PHILP, J., (1954). Proc. Brit. Weed Control Conf. 1953, 18.

6. ROBERTS, H. A., (1954). N.A.A.S. quart. Rev. no. 24, 139.

7. WARREN, G. F., (1951). Suppl. Proc. 5th northeast. Weed Control Conf., 41.

8. WARREN, G. F., (1950). Food Pack., 31 (5), 38.

9. RAHN, E. M., (1951). Proc. 5th northeast. Weed Control Conf., 95.

10. CONDON, L., (1954). Grower, 41, 1364.

11. PARKER, C., (1954). Proc. Brit. Weed Control Conf. 1953, 274.

12. IVENS, G. W., (1952). Rep. Luddington exp. hort. Sta. for 1951, 44.

13. HARVEY, W. A. & A. S. Crafts, (1952). Hilgardia, 21, 487.

14. YOUNG, H. C. & J. C. CARROLL, (1951). Agron. J., 43, 504.

15. KRATOCHVIL, D. E., (1951). Weeds, 1, 25.

TABLE I

Percentage kill of some seedling Annual Weeds

Carrier	PCP lb. per acre	Stellaria media	Urtica urens	Senecio vulgaris	Fumaria officinalis	Veronica spp.	Chenopodium album	Polygonum aviculare	Capsella bursa-pastoris	Poa annua
25% emulsion of vaporising oil in water at 100 gal. per acre	0	50	0	0	53	36	0	19	-	-
	1	63	14	82	83	72	55	64	-	74
	2	87	85	92	99	96	74	80	-	93
	4	96	90	100	100	93	76	94	-	88
Vaporising oil at 25 gal. per acre	0	74	14	34	29	81	65	41	-	-
	1	91	63	90	92	81	82	83	95	93
	2	91	82	94	91	89	74	86	98	97
	4	92	82	92	96	93	78	93	100	96
Vaporising oil at 80 gal. per acre		97	93	94	99	98	79	93	92	-

TABLE 2

The effect of sprays of PCP on weeds and onions when applied shortly before onion emergence

Carrier	PCP lb. per acre	Percentage Kill		Onions	
		Chenopodium album	Stellaria media	Number 1000s. per acre	Yield Tons per acre
25% emulsion of vaporising oil in water at 100 gal. per acre	0	0	18	68.5	3.36
	1	55	69	55.3	3.36
	2	74	87	59.6	3.52
	4	76	89	56.4	3.67
Vaporising oil at 25 gal. per acre	0	65	65	61.0	3.36
	1	82	83	86.7	4.32
	2	74	88	67.2	3.92
	4	78	90	64.6	3.82
Vaporising oil at 80 gal. per acre		79	92	56.2	2.96
Control mean		-	-	55.9	2.70
Density on controls, plants per sq.ft.		78	15	-	-

TABLE 3

The effect of sprays of PCP on weeds and lettuce, the seedbed having been prepared in advance

Carrier	PCP lb. per acre	Percentage Kill		Lettuce	
		Poa annua	Total Dicots	Plants per foot of row	Approximate incidence of transient injury
25% emulsion of vaporising oil in water at 100 gal. per acre	1	74	85	2.09	0
	2	93	93	1.96	5%
	4	88	93	2.01	25%
Vaporising oil at 25 gal. per acre	1	93	90	2.09	0
	2	97	90	1.91	10%
	4	96	99	1.85	40%
Control mean		-	-	2.16	0
Density on controls, plants per sq. ft.		0.7	2.3	-	-

THE WEED PROBLEM IN BULB CROPS

J. WOOD and P. G. LIMB

Kirton Experimental Husbandry Farm

Summary

The importance of the weed problem in bulb crops is emphasised and the special difficulties arising in connection with the choice of control measures are described. The results of preliminary investigations and experiments are given, along with conclusions concerning the value of pre-emergence sprays. The trend of further experimental work required is indicated.

Whenever bulb crops are to be discussed it is always advisable to decide first which plants are to be included in that category; since it is not unusual, in the horticultural trade, to find the term bulb extended in meaning to signify any vegetative structure, not otherwise easily described, that can be used for propagation, easily stored, and transported in a dry state. In this brief survey, therefore, it should be understood that reference will only be made to crops derived from true bulbs and corms of the kinds grown commercially in this country; e.g. daffodils, tulips, irises and gladioli. In each of these crops the bulb is the primary product in the complementary activities of bulb production and bulb flower production, for which the cultural requirements are different. In all bulb crops the weed problem is of major importance equalling, if not exceeding, in complexity the same problem in other crops, presenting special difficulties and the need for conducting investigations and well planned experiments to find suitable methods of weed control.

Factors of the Weed Problem

Of the 6,000 acres of bulb crops in England and Wales, over 3,000 are in South Lincolnshire and the neighbouring counties of East Anglia, 1,500 acres are in Devon and Cornwall, while the rest are scattered thinly over approximately twenty counties. The kinds of bulbs, and even the varieties grown, are to some extent selected because of their suitability to local conditions; nevertheless, the same kinds are grown under widely different environments which exert their influence not only on the crop but the weed populations. The period during which the bulbs occupy the land is itself an important factor in the weed problem. Thus, gladioli may be planted and lifted as a summer crop, tulips are planted in autumn and lifted in the following summer, while daffodils planted in late summer may be lifted after one or two years as a bulb crop, or left down as a perennial flower crop for several years, or until attacked perhaps by some pest or disease which makes lifting imperative.

The weed population is thus a menace not only because it competes with the crops for nutriment but also because some of the weed species are hosts of specific bulb pests and disease producing agents, against which control measures have constantly to be employed.

As some of the bulb pests and diseases are able to affect more than one kind of bulb, it is not now advisable to grow bulb crops in close rotation.

Where possible, bulb crops are not grown on the same land more frequently than once in six or seven years. To achieve this the bulb grower, contrary to general opinion, is obliged to be a farmer; and the bulb crops are interposed at some convenient point in the farm crop rotation. From the point of view of weed control early potatoes are often preferred as a cleaning crop to precede bulbs, but in recent years where weed control measures have been more effective

against weeds in cereals and leguminous crops, bulbs have followed these crops satisfactorily, and some growers have not hesitated in taking a bulb crop after a one year ley.

The Weed Population

Though the number of weed species present may vary in different fields and localities in accordance with the influence of factors already mentioned, a few annuals and perennials seem to vary only in vigour. These are chickweed (Stellaria media), shepherds purse (Capsella bursa-pastoris), speedwell (Veronica sp.), annual meadowgrass (Poa annua), annual nettle (Urtica urens), mayweed (Matricaria sp.), knotgrass (Polygonum aviculare), fathen (Chenopodium album) and bindweed (Convolvulus arvensis).

Early planting of daffodil bulbs favours early germination of annual weeds, mainly chickweed. In a moderately dry autumn this can be checked by harrowing, but in wet weather it is soon impossible to continue surface cultivation. With late planting, as adopted with tulips, weed germination is delayed but takes place often in mid-winter, too early for the soil to be cultivated.

Mechanical Injury to the Crop

The dictum that "bulbs should be handled as carefully as eggs" is a constant reminder of their susceptibility to mechanical injury. It applies equally to the care that must be exercised with the growing plants in the field; for the fear that they may become infected with Botrytis spp. compels the grower to abandon further attempts to control weeds by mechanical means, if crop injury is likely to result, since they are the lesser of two evils. This appreciation of the high susceptibility of bulb crops to injury explains to a large extent why so much hand labour is used in the bulb industry, why every effort to control weeds must be made before the bulb foliage begins to spread in the rows, and why by the end of the growing season what is at first a clean handweeded crop is subsequently allowed to become overgrown with weeds, till ultimately the withered plant foliage and the weeds can be cut with a grass cutter and carted off the land. This then, is the weed problem which confronts the bulb grower. How successfully can weed control in bulb crops be achieved?

Early Investigations

Over twenty years ago bulb growers were becoming interested in the possibility of controlling weeds by the application of chemicals. With this objective in view in 1936-37 Hargrave and Thompson[1] used sodium chlorate applied as pre-emergence and post-emergence high volume sprays on tulips, at the rate of 10 lbs and 20 lbs per acre. They also compared different quantities of calcium cyanamide: 3 cwts and 5 cwts per acre applied on the same dates as the sodium chlorate sprays. The results were inconclusive but the opinion was expressed that from a practical standpoint calcium cyanamide applied as a pre-emergence dressing at 5 cwts. per acre seemed most promising. Sodium chlorate gave the best kill of weeds as a post-emergence spray, but at both strengths there appeared to be evidence for inferring that the bulb progeny had been checked in development and had consequently given low yields. In 1937-38[2] the experiment was repeated on daffodils, and again the conclusion was that post-emergence applications had given a significant decrease in bulb yields. Meanwhile sulphuric acid was being used by the farmer-bulbgrower to kill the flag on proud wheat, and its use as a pre-emergence spray on bulb crops soon became established practice. And so it remained till DNC, MCPA, and 2, 4-D were used by spraying contractors for weed control in certain farm crops, when their use on bulb crops was contemplated.

In 1947 the Ministry of Agriculture and Fisheries had established one of the first new experimental Husbandry Farms by taking over from the Holland County Council the farm formerly used for experiments and demonstrations at Kirton, where it was intended that bulb experiments would become a major project, and where the first problem stated by commercial bulb growers to be urgently requiring investigation was that of weed control. Fortunately, the A.R.C. Unit of Experimental Agronomy at Oxford was both ready and willing to give all possible assistance, and through their helpful collaboration it has been possible to conduct experiments with greater precision than could otherwise have been attained. The establishment of the Rosewarne Experimental Horticulture Station at Camborne, Cornwall, has provided another centre where bulb experiments are being conducted, and this work at the two centres is already co-ordinated.

Trials of Weedkillers at Kirton 1948-52

The remarkable selective properties claimed for MCPA and 2,4-D were tested on observation plots of daffodils and tulips in 1948 when the plants were several inches high. The results obtained were interesting though disappointing, for weed control was not satisfactory and the crop plants became malformed.

In 1949 an experiment was set up for the purpose of sorting out available herbicides. Sulphuric acid was included as the material with which others could be compared. The materials were applied as pre-emergence treatments followed in some cases by a second application of the same material at the post-blossom stage of the crop, but not always of the same strength or quantity as previously applied. Treatment was continued for two years before the daffodil bulb crop was harvested. The aim was not primarily to assess the degree of weed control obtained, but rather to detect injury to the crop or depression of crop yield.

Experiment 1 Trial of Weedkillers on Narcissus: cultivar King Alfred.

2 years 1948 - 1950

Treatments 25. Replications 3. Layout: Lattice squares.

Size of plot - approximately 4 sq. yds. = 100 bulbs per plot

Sprays - applied by hand sprayer at a rate of 100 gallons per acre

Date of application - Pre-emergence 21st December 1948

" " 16th December 1949

Post-blossom 24th April 1949

" 21st April 1950

Table I

Mean yields in ozs.

Treatment materials	Pre-Emergence Treatment	Post-Blossom Treatment	Mean yield in ozs.
Sulphuric acid	12.5% spray	Nil	288
" "	12.5% "	7.0% spray	184
DNC	0.8% "	Nil	242
"	0.8% "	0.8% spray	211
Sodium chlorate	1.5% "	Nil	225
" "	1.5% "	1.5% spray	267
" "	3.0% "	Nil	301
" "	0.75% "	0.75% spray	270
Copper chloride	4.0% "	Nil	274
" "	4.0% "	4.0% spray	210
2.4-D	0.3% "	Nil	221
"	0.3%	0.3% spray	229
+ MCPA (liquid)	2.0% "	Nil	223
" "	2.0% "	2.0%	202
+ MCPA (dust)	2 cwts. per acre	Nil	213
" "	2 cwts. " "	2 cwts. per acre	232
" "	4 cwts. " "	Nil	198
" "	4 cwts. " "	4 cwts. per acre	216
Calcium cyanamide	3 cwts. " "	Nil	253
"	3 cwts. " "	3 cwts. per acre	214
"	3 cwts. " "	1.5 cwts. per acre	238
Handweeded (once)	Weeds removed once	Nil	302
" (twice)	Weeds removed once	Weeds removed once	301
Unweeded (6 plots)	Nil	Nil	232

+ Proprietory materials

P = 0.05 Significant difference 43 oz. or 18.5% of control yield.

The general conclusion drawn after consideration of the above results, together with general observations on crop growth, were as follows:

Calcium cyanamide delayed weed growth for a short time but subsequently the weeds grew more vigorously than those on the unweeded plots. The MCPA and 2,4-D sprays caused the crop foliage to become flaccid. In dust form the MCPA caused discolouration of the foliage. The remainder of the substances were unsuitable as sprays for use after the bulb shoots emerged but had some value as pre-emergence treatments.

In 1949 PCP (pentachlorphenol) emulsion was used as a pre-emergence spray, and subsequently PCP and DNC were chosen for trial at different concentrations. It was deemed likely that for use in winter, higher concentrations would be necessary, or would have a more lasting effect. In 1950 this appeared to be the case, but though the plots remained almost free from weeds for a long period, the results of the weed suppression were not accompanied by higher crop yields. Moreover, the opinion is strongly held by growers that for bulb crops hoeing in the pre-flowering period is essential.

In 1951 an experiment was conducted in which some of the plots were hoed after having been sprayed with pre-emergence herbicides; when weeds were again beginning to grow freely. The results in terms of crop yields are here tabulated.

Experiment 2 Trial of Pre-emergence Weedkillers in Narcissus cultivar.

Baths Flame. 1951-52

Treatments 8. Replications 4. 50 bulbs per plot.

Layout - Randomised blocks.

Sprays - Applied at a rate of 100 gallons per acre on 16th January 1952.

Plots hoed - 9th March, 1952

Table II

Mean yields in ozs.

Pre-Emergence Treatments	Subsequent Treatment		% increase over weight planted	
	not hoed	hoed	not hoed	hoed
Sulphuric acid 12.5% spray	-	179	-	98.8
DNC emulsion 1.2% spray	176	185	95.5	105.5
PCP emulsion 1.6% spray	165	179	83.3	98.8
Hand weeded once 16th Jan.	175	186	94.4	106.6
Unweeded	157	-	74.4	-

P = 0.05 Significant difference = 12 ozs. or 8% of control yield.

Weed seedlings present when the sprays were applied comprised chickweed, speedwell, groundsel (Senecio vulgaris), shepherd's purse, annual nettle, annual meadowgrass and couch grass (Agropyron repens). All except the grasses were killed by the sprays. By February 17th the grasses were beinning to grow again after being checked, and chickweed seedlings were again present. The plots hoed on March 9th remained clean for four or five weeks. There were no marked differences between the DNC and PCP plots but the yields from some of the PCP plots were unaccountably low.

Discussion of Results

From acquaintance with bulb crops and the difficulties which they present when mechanical methods of weed control are employed there can be little doubt about the value to the grower of suitable herbicides. But it would appear to be advisable for the time being at least to concentrate first on treatments suitable for use as pre-emergence applications. Materials such as DNC and PCP emulsions have given encouraging results, but their value will be decided after economic considerations. So far, in experiments with this type of herbicide, the aim has been to delay application as long as possible till the bulb shoots were about to appear at the soil surface. From year to year there is a variation period of several weeks in date of emergence and frequently on newly planted plots the bulb shoots emerge before the weeds commence growth. If cultivation is beneficial, apart from its effect in reducing weed population,

it is only possible in the autumn planted bulb crops in the early part of the pre-flowering period. Hence, to obtain the full benefit from pre-emergence herbicides they must be capable of early application with lasting effect, and from the point of view of producing healthy bulb crops the absence of weeds would probably be advantageous. Substances so far tried have not exhibited these properties to the desired degree. Others such as CMU and dinosam (dinitro amyl phenol) are coming forward with strong recommendations.

Again, through collaboration with the A.R.C. Unit of Agronomy at Oxford, it has been possible to put down co-ordinated experiments at Kirton and Rosewarne in which these more recently introduced substances have been included. One final point not previously stressed relates to the vernalization of bulbs, and the possibility that their normal reactions may be influenced by herbicides. The necessity for testing samples of bulbs from experiments is appreciated and, when facilities are available, testing for such residual effects will be included as an essential part of bulb experiment technique.

In conclusion we would like to express our thanks to the numerous colleagues and fellow investigators who, through a common interest in experimental work, and by their contributions to team work, have played some part in furthering the experiments here recorded.

References

1. HARGRAVE, J. & THOMPSON, F. C., Weed control in tulips. Bulb Rep. Agric. Inst., Kirton. No. 5, 1937. 45.

2. HARGRAVE, J. & THOMPSON, F.C., Weed control in narcissus. Ibid. No. 6, 1939. 6.

OBSERVATIONS ON THE WEED PROBLEM OF ALLOTMENTS BASED ON A SURVEY

S. J. WILLIS, Shuttleworth Agricultural College, Old Warden Park, Nr. Biggleswade*

Summary

A survey is in progress of the allotments of a typical urban area in order to discover the most prevalent weed species and to examine the validity of allotment holders' complaints concerning the source of weed seeds. The results, to date, are presented in this report.

Part 1. The most prevalent weeds on allotments.

Introduction.

The work described in this report is the biproduct of a survey on the importance of Potato Root Eelworm on allotments. This survey involved the taking of a random sample of the allotments of an urban area in Hertfordshire and, subsequently, making a regular visitation of the allotments comprising the sample. As requests for advice on the problem of weeds in allotments are often received from the holders of plots it was decided that it would be useful in the course of the survey to try to assess which weed species are most prevalent.

The method of working is as follows: for each allotment visited a record is made of all the weed species present on the cultivated area, the presence of a species on a single allotment being described as one "occurrence"; thus the "No. of occurrences" (abbreviated to 'o' in the Tables) for a particular species indicates the spread of that species over the allotments in the sample. In order to obtain an indication of the relative prevalence of the various species on an allotment the most common species are given a "Prevalence Rating" of 4 and the remaining species of 3, 2 or 1 depending on whether their prevalence is estimated as $\frac{3}{4}$, $\frac{1}{2}$, or $\frac{1}{4}$, respectively, that of the most common species. In the columns labelled 'P.R.' in the Tables is given the total of all the prevalence ratings for a species over the particular group of allotments being considered. Species which are estimated to be present to the extent of less than $\frac{1}{4}$ of that of the most common species are given no prevalence rating. Where allotments contain very few weeds the species occurring are noted but again no prevalence ratings are given. There have been 11 such allotments to date, so that the maximum 'P.R.' for a single species is 192 (i.e. (59-11) x 4). All the estimates described have been made by eye.

Experimental Results

At the time of writing, out of a total of 93 cultivated allotments in the random sample, 59, distributed over 6 different sites, have been surveyed and the results are given in Table 1.

---

*Work carried out while at the Hertfordshire Institute of Agriculture, Oaklands, St. Albans.

TABLE 1

REF. NO.	COMMON NAME	LATIN NAME	ALLOTMENTS O	ALLOTMENTS P.R.
	MAXIMUM POSSIBLE =		59	192
1	Groundsel	Senecio vulgaris	57	89
2	Speedwells	Veronica spp.	52	89
3	Sun spurge	Euphorbia spp.	52	45
4	Sowthistle	Sonchus spp.*	52	44
5	Chickweed	Stellaria media	46	47
6	Fat Hen	Chenopodium album	46	2
7	Shepherd's Purse	Capsella bursa-pastoris	43	16
8	Annual Meadow Grass	Poa annua	37	33
9	Lesser Bindweed	Convolvulus arvensis	35	34
10	Dandelion	Taraxacum officinale	34	9
11	Purple Dead Nettle	Lamium purpureum	30	2
12	Persicaria	Polygonum persicaria	22	0
13	Scarlet Pimpernel	Anagallis arvensis	19	7
14	Broad-leaved Plantain	Plantago major	14	0
15	Scentless Mayweed	Matricaria maritima	12	1
16	Creeping Buttercup	Ranunculus repens	12	0
17	Nipplewort	Lapsana communis	12	0
18	Black Nightshade	Solanum nigrum	10	4
19	Cranesbills	Geranium spp.	10	0

* Mainly S. Oleraceus

It will be seen that, in the area surveyed, there are seven dominant weed species (Nos. 1, 2,3,4, 5, 8, 9); some others, notably, Nos. 6,7,10,11, occur very frequently but seldom form a high proportion of the weeds present. Altogether at least (some were recorded as groups, e.g. Cranesbills) 58 different species were recorded on the allotments but for the sake of brevity those with less than 10 occurrences have been omitted from Table 1.

Although the most prevalent species were evenly spread over all the allotment sites it is interesting to note in passing that some species appeared to be prevalent on only some of the sites. Details of the four most notable of these are given in Table 2.

TABLE 2

REF. NO.	SITE REF: / COMMON NAME	C	D	E	G	H	I	TOTAL
		No. OF OCCURRENCES						
	MAXIMUM POSSIBLE =	10	9	11	4	11	14	59
13	Scarlet Pimpernel	6	1	10	1	1	0	19
15	Scentless Mayweed	0	2	9	0	1	0	12
19	Cranesbills	0	0	4	0	6	0	10
20	Small Nettle	0	3	0	1	1	0	5

Part 2. The source of allotment weeds.

Introduction

On most of the allotment sites surveyed there were vacant allotments; some had only been vacant for a short period while others had been vacant for several years. Also there are often small areas of waste land on the sites in addition to which, of course, there are paths and verges along the boundary fences. All these areas grow a profusion of weeds and it is often a source of complaint from allotment holders that the seeds produced spread onto their allotments thus magnifying the weed problem. In the course of the survey already described notes have also been made on the weed species present on a random selection of new vacant allotments ('.N.V.' i.e. allotments vacant or uncultivated for a period less than about 2 years), old vacant allotments ('O.V.' i.e. allotments vacant or uncultivated for a period of more than about two years), paths ('P') and waste places including fence verges ('W') in order to see if there is any substance in this complaint. Altogether 9 new vacant allotments, 12 old vacant allotments, 7 random sections of path and 14 waste places and fence verges have been surveyed.

Experimental results

The results of this part of the survey are set out in Table 3. As old vacant allotments, paths and waste land & fence verges are all similar, in that they have remained uncultivated for some years, sums (OV + P + W) of the results for these three categories have been included. For purposes of comparison the figures for 'o' and 'P.R.' of the species concerned on cultivated allotments are also given. At least 65 different species have been recorded on one or more of the categories N.V., O.V., P. or W. but, again for the sake of brevity, those of which the sum, O.V. + P.+ W, for No. of occurrences is less than 6 have been omitted.

DISCUSSION

It will be seen that in Table 3 only 6 (i.e. Nos. 9,10,16,4,14,17) of the species recorded in Table 1 appear. Of these only three (i.e. Nos. 9,4, 10) can be considered as being dominant species on both cultivated allotments and the various uncultivated areas. Even in the case of these three, they are so common on the cultivated allotments it seems unlikely that their elimination from uncultivated areas would make very much difference to their prevalence. On the other hand it might be argued, particularly in the case of Lesser Bindweed, which many allotment holders consider their worst weed enemy, that the amount of seed produced on uncultivated areas where growth is rampant is likely to be much greater than on cultivated allotments where growth, and consequently seed production, is continually being checked. However, with the possible exception of the three species mentioned, the evidence of Tables 1 and 3 forces one to the conclusion that the allotment holders worst enemy as a source of weed seeds is his fellow allotment holders. Certainly it is obvious from Table 3 that the large majority of the weeds on the uncultivated areas are of little importance in cultivated allotments.

TABLE 3

REF. NO.	COMMON NAME	LATIN NAME	NV o	NV PR	OV o	OV PR	P o	P PR	W o	W PR	OV+P+W o	OV+P+W PR	ALLOTS o	ALLOTS PR
		MAXIMUM POSSIBLE =	9	36	12	48	7	28	14	56	33	132	59	192
21	Docks	Rumex spp.	6	0	9	10	6	0	11	11	26	21	9	0
22	Tall Oat Grass	Arrhenatherum avanaceum	4	5	6	8	4	0	11	23	21	31	3	0
23	Larger Bindweed	Convolvulus sepium	4	0	8	14	2	0	8	10	18	24	7	0
9	Lesser Bindweed	Convolvulus arvensis	8	20	5	7	5	3	6	8	16	18	35	34
24	Yorkshire Fog	Holcus lanatus	3	1	8	7	2	0	5	1	15	8	2	0
10	Dandelion	Taraxacum officinale	7	4	7	4	6	2	2	0	15	6	34	9
25	Creeping Thistle	Cirsium arvense	2	0	6	8	1	0	7	9	14	17	7	1
26	Stinging Nettle	Urtica dioica	1	0	2	1	1	0	10	26	13	27	4	0
27	Couch	Agropyron repens	2	0	5	9	2	0	6	6	13	15	9	0
16	Creeping Buttercup	Ranunculus repens	3	0	7	8	2	0	4	1	13	9	12	0
4	Sowthistle	Sonchus spp.*	7	8	5	4	3	0	5	0	13	4	52	44
14	Broad-leaved Plantain	Plantago major	5	1	2	1	6	9	4	2	12	12	14	0
28	White Clover	Trifolium repens	1	0	4	0	4	8	4	0	12	8	1	0
29	Artimesia	Artemisia vulgaris	0	0	3	0	1	0	8	1	12	1	0	0
30	Soft Brome	Bromus mollis	1	0	3	0	5	0	2	0	10	0	5	0
31	Wall Barley Grass	Hordeum murinum	2	2	2	0	5	2	2	0	9	2	4	0
32	Sterile Brome	Bromus sterilis	4	8	1	0	4	0	4	1	9	1	3	0
33	White Dead Nettle	Lamium album	0	0	1	0	4	0	4	1	9	1	2	0
34	Cocksfoot	Dactylis glomerata	1	0	3	0	3	0	2	0	8	0	0	0
35	Perennial Ryegrass	Lolium perenne	1	0	0	0	6	0	1	4	7	4	3	0
36	Toadflax	Linaria vulgaris	4	0	2	0	1	0	4	0	7	0	7	0
37	Ribwort	Plantago lanceolata	0	0	1	0	4	4	1	0	6	4	2	0
38	Willow Herb	Epilobium spp.	4	3	5	4	0	0	1	0	6	4	6	0
17	Nipplewort	Lapsana communis	3	2	3	3	0	0	3	0	6	3	12	0
39	Vetches	Vicia spp.	1	0	4	2	0	0	2	0	6	2	0	0
40	Hawksbeards	Crepis spp.	3	1	3	0	3	0	0	0	6	0	6	0

* Mainly S. Oleraceus.

Mr. A. D. Harrison: I notice that Mr. Petersen did not mention the use of tractor vapourising oil for the control of weeds in carrots. A very large proportion of the carrot acreage in this country is sprayed with this material and I wonder why it is not recommended in Denmark. Another point in his paper which is I think of interest, was the suggestion that the use of 'hormone' weed killers for the control of weeds among potatoes had tainted the tubers. We are particularly interested in taint and some more information from Mr. Petersen on that point would be appreciated.

Mr. Roberts is to be congratulated in selecting a particular subject and sticking to it. He has given us a very satisfactory survey of the present position regarding the usefulness of the contact pre-emergence method of killing weeds. One point which he did not make in his summary and which I think looms very largely in the economics of the use of the material recommended, PCP, is that some very satisfactory results have been obtained with varying quantities of PCP in as little as five gallons of oil per acre.

Mr. Wood, rightly I think, was very cautious in his approach. All the new materials certainly are not being received with open arms as far as the bulb grower is concerned, but again CIPC, DNC and PCP have promise. The bulb growers have a specialized problem and I think it is in very good hands at Kirton and Camborne Experimental Horticultural Stations.

I would like Mr. Chairman, to bring Dr. Warran Shaw into this discussion as there was no time for questions after his paper this morning. He stated that the rate of sulphuric acid used in the U.S.A. was 3 to 5 per cent. This is a very much lower strength than we use for 'pre-emergence' weed control in onions and other crops. Could Dr. Shaw give an explanation as to why these differences exist?

Dr. Warren C. Shaw: We use about 100 gallons of 2 to 3 per cent sulphuric acid for the control of small weeds in onions. The concentration of the acid is increased to 5 per cent and even higher as the weeds increase in size. The lower concentrations used in our country may be partly because we apply the acid earlier and partly because the temperatures are much higher than in the United Kingdom.

Mr. E. J. N. Cakebread: Mr. Wood has mentioned the use of sodium arsenite for weed control in bulbs; as results with this compound do not appear in his paper, can he give more information on it please, and indicate the latest safe stage at which it can be used?

Mr. James Wood: We have used sodium arsenite only on small observation plots and in these experiments we have been impressed by its capabilities. The growers who previously used sulphuric acid to kill their potato haulms have now started to use sodium arsenite and as it is easier to use the same material for more than one purpose they have started using it for weed control in their bulbs. They are so impressed that it is likely to become standard commercial practice.

We shall still go on experimenting with the other materials in the hope that we shall find something which will have greater residual effect. So far CIPC is the herbicide which has given us most promise.

Mr. W. Ochiltree: We have three years' work on the control of weeds in bulbs by the use of sodium arsenite. Our recommendations are to use 10 lbs. of active material in 100 gallons of water and to spray before either daffodils or tulips emerge.

Mr. H. C. Mason: I am particularly interested in the use of MCPA for weed control in potatoes. I may be badly informed, but so far as I am aware there is no work being done on it in this country. If there is I would be interested to know what experience has been gained and just what are the conditions under which taint is likely to occur?

Mr. H. I. Petersen: In experiments with MCPA in potatoes, as reported in my paper, we have tried applications at different times after planting. The first application was made when the potatoes were breaking through the soil surface, the second when they were 4 - 6 cm. high and finally at flowering. When the spray was applied at the very early stage the leaves were not as deformed as when the 2,4-D was used later. Treatment at this early stage has been used by some farmers but they have experienced trouble with off-flavours, in consequence we are not recommending the procedure in Denmark.

Dr. E. Holmes: My own firm have done a considerable amount of work with MCPA on potatoes and I believe the A.R.C. have also been interested in this subject. We have found that varieties differ considerably in their susceptibility to damage.