WILD OATS

Chairman: Mr. F. R. Horne

WILD OATS: THE FIELD PROBLEM

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"Sowing one's wild oats" is an ambiguous expression, the agricultural sense of which we are here to discuss this afternoon. In this context farmers have been less concerned until recently over the consequences of sowing a few wild oats than they should have been. They are now reaping - or should I say combining - the results of this prolificacy; and unprofitable reaping it is too! We are reminded of the age old nature of the problem by Virgil, who wrote two thousand years ago in his fifth Eclogue, "Too often now, in the furrows where we have broadcast fat grains of barley, the unfruitful darnel and useless wild oats spring up".

It is quite clear that since the War the problem has become far more serious in Britain than it was in the pre-war years. I believe that wild oats are one of the major weed problems of today, and certainly one of the most troublesome. Unfortunately we have no precise means of measuring the increase in the area infested with wild oats over the last quarter century. That it was of less importance pre-war is illustrated by the fact that Prof. H. G. Sanders (1) in 1939 listed 18 other arable weeds as more prevalent and harmful to farmers than wild oats. From a survey in 1951 carried out largely by the N.A.A.S. in the field and reported on by Thurston in 1954 (2), we now know that Avena fatua, the common wild oat, occurs in most of the arable areas of England, and neither Scotland nor Wales are entirely free. The winter wild oat occurs in the South Midlands of England and observation suggests that is is spreading.

During the last few years my colleague Bullen and myself have made some estimates of the seriousness of the problem in the Eastern Counties by carrying out a roadside survey. Our findings for the years 1952-3 were reported briefly in the N.A.A.S. Quarterly Review 1953 (3), and since then we have three further sets of data which generally support our previous conclusions.

You may make such allowance as you think appropriate for the fact that this data relates to roadside fields. Roadside farming is sometimes said to be of a special standard!

Roadside Survey of Wild Oats: Eastern Province 1952/56
Percentage fields "seriously infested" with wild oats

Total No. of fields counted, in brackets

Year	W. Wheat	S. Wheat	Barley	S. Wheat Barley	All Wheat and Barley	Approximate miles of road
1952	30% (392)	12% (49)	16% (377)	15%	22%	280
1953	28% (585)	24% (82)	26% (676)	26%	27%	490
1954	21% (376)	12% (59)	20% (249)	18%	24%	250
1955	33% (182)	29% (24)	54% (171)	51%	42%	125
1956	15% (554)	16% (51)	29% (494)	28%	21%	335

'Serious infestation' is approximately equivalent to 500 wild oats (or more) per acre.

Clearly the problem is a widespread one, but how serious is the problem to the individual farmer troubled with this weed? He will probably complain first of the extra trouble he has with his cultivations to reduce the number of germinating seedlings. The difficulty of keeping clean his peas, his sugar beet, potatoes and other hoed crops, which he expects to keep clean throughout the season, is quite considerable in some years. He will also suspect that the competition between the wild oats and his cereal crops will reduce his harvest yields. The farmer will probably not mention a further reason for his wish to be rid of the pest, one of pride and prestige, but I believe that it is one of the most powerful stimuli to action.

The extra work, especially extra cultivation, which has to be done cannot be measured in any way which is of general application; local conditions vary too much. Nevertheless I believe all will agree that this factor is of real consequence. It is perhaps with root crops that we may find of immediate value any chemical techniques which give even a partial control. Such techniques may make the thinning work very much easier.

Yield loss by competition has not been studied in the detail needed. At what level of wild oat infestation will the yield of a cereal crop be affected? I don't know. In a Swedish Advisory Leaflet it is said that - and I quote from the translation - "it has been shown in many cases that the fall in yield of spring sown grain can be as large as 50% ....". However, I have not seen the data on which this statement is based and cannot enlarge upon the point.

Limited evidence from this country confirms the reasonable assumption that heavy infestations will reduce yield drastically. In a trial this year on

hoeing for wild oat control of Atle spring wheat sown in 14 in. rows, a yield of only 6 cwt of grain per acre was achieved in the face of exceptionally heavy wild oat competition - about 300-350 wild oat plants per sq. yd - in fact many more wild oats than wheat plants! The crop was sown early, before the wild oats had emerged. As a result of tractor hoeing this crop twice, the wild oats between the cereal rows were almost wholly eliminated but many still remained in the row. The yield rose to 14 cwt an acre. Still not a very profitable crop, but a spectacular increase in yield. The field crop of Atle adjacent to the trial was sown two weeks later after a heavy crop of wild oat seedlings had been killed: the field yield was 25 cwt per acre. This experiment serves to illustrate that heavy infestations of wild oats will compete severely with cereals and reduce yield drastically. Light infestation may not affect yield greatly, but in a mainly cereal rotation they will quickly build up until drastic remedial measures are forced on the farmer. The detailed results of this trial and of others to be carried out in 1957 will be published in due course.

Control of any weed needs to be based on a thorough understanding of the biology of the species and of the manner of its introduction and spread in agriculture. Much basic knowledge of wild oats has been given us by the researches of Miss Thurston at Rothamsted and we await impatiently the results of further work there. There is not time now to review known facts of the biology of Avena fatua and Avena ludoviciana and their variant sub-species (4) (5), but I would like to draw attention to a few points which I think are of importance. It is a commonplace observation that wild oats are seldom any problem on farms which practice a rotation including a high proportion of cleaning or smother crops. An increasingly popular sequence of crops in parts of Bedfordshire is brussel sprouts, barley, peas, potatoes, wheat. This, and variants of it, clearly give good opportunity for the eventual control of wild oats. It is principally where cereals predominate in the rotation that trouble is most serious; and it seems to matter little whether the cereals are winter sown or spring sown. Rotations dominated by cereals are sometimes a matter of choice, but are often allegedly unavoidable due to a variety of reasons of which lack of labour and lack of capital are frequently blamed.

The recent enthusiasm for deep ploughing has not helped this problem. On deeply cultivated soils control of wild oats is usually a greater problem than on shallow cultivated soils, presumably because the dormant seeds are distributed through a greater depth of working soil. More years of cultivation will be needed to give the necessary opportunity for all the seeds to be brought reasonably near the surface to germinate and be killed. Furthermore there seems to be some evidence that the more deeply wild oat seeds are buried the longer they can remain viable.

The marked increase which has been observed in the occurrence of wild oats through the last two decades is, I believe, due in part to the increased use of the combine harvester. It is also partly due to the ability of modern cultivation implements to carry out spring seed bed preparation and drilling in a much shorter space of time than was ever possible in the past.

The combine is generally blamed on the grounds that cereals are cut later than by the binder, thus giving a better opportunity for wild oat seeds to shed on the field instead of being brought to the stack yard. Equally important in my view is the fact that no combine is really easy to clean out thoroughly, and wild oats are frequently carried from field to field in the machine.

It seems that the principal means by which wild oats are introduced on to a previously clean farm is by the use of impure seed corn, although travelling threshing machines and combines can, of course, also be blamed on occasion. I believe, and hope, the vital importance of using clean seed is becoming more generally appreciated, since it is far less trouble to prevent the introduction of wild oats than it is to clean up an infestation once the weed has become established. It is of the utmost help that Field Approved seed can be relied upon to maintain a high standard in this respect. The purity requirements of the seed crop for wild oats is that "there shall not be more than 3 wild oat plants per acre". Alternatively, the seed from the field crop should not have any wild oat seeds in a specially drawn 14 lb sample after cleaning. I am interested to learn that in Sweden it is now an offence for there to be any wild oat seeds whatsoever in seed to which the Government Seal is to be attached. Furthermore, in that country any grain sold even for feeding must not contain more than seven wild oat seeds per lb. I feel this matter of seed cleanliness is so important that it is my personal opinion that the wild oat should be declared an injurious weed for the purposes of the Seeds Act.

Spread from field to field on a farm by means of the combine harvester through farmyard manure, old seed bags used for other purposes, etc., can only be prevented by a thorough understanding of the problem by farmers themselves. I cannot see that any form of legislation or regulation can possibly help.

The main methods of control at present of value are rotation and cultivation. Even though the most promising of chemical techniques, of which we shall hear from Dr. Pfeiffer - even if these should come into general use, they can only be regarded as a useful supplement to husbandry methods. Until there is a safe and economic chemical technique for use in cereal crops, normal husbandry methods must remain our principal weapon against the wild oat.

Grassing down for as long as possible is probably the simplest and likely to be one of the most successful control measures, but an increased grass or ley acreage is seldom welcome on the mainly arable farms where this weed problem is most serious. At the risk of anticipating the result of a field investigation at the Boxworth Experimental Husbandry Farm, it looks as though after grassing down for about 10 years very few viable wild oat seeds will remain. Rotations on individual fields can and should be varied within the limits of available labour and general convenience. The object is to choose a crop sequence which gives the opportunity of preventing fresh wild oat seeds falling on the land, while seeds already there are encouraged to germinate and be killed by cultivation or smothering.

In discussing control measures it is usually the common wild oat one has in mind. The species is by far the commoner and is usually present also in infestations of the winter wild oat. Many of the control measures are common to both.

Field experience shows that much can be done to reduce an infestation of the common wild oat by suitably timed autumn cultivations. These should be preceded where possible by long-stubble or even straw burning, which with the common wild oat appears to have the effect of helping to break seed dormancy, presumably by damaging the seed coat. In this connection it is interesting to note that pigeons have at least some value to farmers. In 1955 two separate instances came to my notice of pigeons having large numbers of wild oat seeds in their crops when shot. In one case there were 985 and in the other 1,355 seeds of wild oat! Much good can follow a delay in spring sowing so as to kill at least one and preferably two crops of wild oats in March and early April.

The Survey figures suggest that the most serious infestations follow autumns when wild oat stubble cleaning has been virtually impossible - the bad 1955 year followed the late 1954 harvest. The most serious infestations of spring corn have also been in years when it has been possible to complete the spring sowing early in a short time without interruption from the weather. In seasons when sowing is perforce delayed and spread out over a number of weeks by rain, far fewer wild oats are seen in July.

In contrast to its robust adult growth the wild oat seedling is generally a puky little fellow which is relatively easily killed or at least discouraged from further growth by healthy crop competition. Vigorous winter sown cereals are rarely infested to the same extent as thin, late sown winter crops.

A technique which is gaining some popularity in parts of the country is inter-row hoeing of cereals. Some farmers hoe narrow rows while others increase the row width to about 12 in. so as to cut more ground and also make the job easier. In either event this method is bound to assist considerably in limiting the build-up of an infestation. Past experiments with clean cereal crops on the effect of increasing cereal row widths to 10 in.-12 in. show little if any falling off in yield.

A farm campaign for the reduction of this weed is bound to occupy a considerable number of years. In planning, should one aim to eradicate the weed altogether or merely to control and maintain the infestation at a low level? In any case is complete eradication practicable? Experience has already shown that with skill and perseverance wild oats can be reduced to a very few indeed, but short of hand rogueing for a number of years it seems unlikely that complete eradication is a practicable proposition. If chemical techniques become safe practice for beet crops and for the pea crop it will clearly help very greatly. But until someone discovers a safe technique for the control of wild oats in cereals, the major problem will remain.

As an Advisory Officer I seek to emphasize to farmers the importance of understanding the general biology, the field behaviour and methods of spread, of the weed before any attempt can be made to tackle it on farm scale. Once farmers understand the facts already discovered, I think we should see a turn in the rising tide of wild oats. May I try and generalise? It should be our aim to ensure that the number of wild oat seeds shed annually onto the land is less than the total number of seedlings which are killed out, using the tools of rotation, cultivation and chemistry. It is only natural that many farmers seek an easy way out of the problem and look to the results of chemical research for a solution, and we shall all listen to Dr. Pfeiffer with great interest when he reviews the present position in that field.

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INTRODUCTION TO THE RESEARCH REPORTS ON WILD OATS

CHEMICAL METHODS OF WILD OAT CONTROL

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Wild oat as an agricultural problem seems to have reached its climax somewhat earlier on the North American Continent than in the U.K. Search for herbicides for selective control of wild oat in the U.S.A. and Canada accordingly started earlier, and certain results of this first exploratory work were usefully applied when research on chemical control of wild oat began on a broader scale in this country a few years ago.

In order to illustrate the magnitude the wild oat problem can reach, I would like to quote figures published by Grindrod on the economic implications of the wild oat problem in Canada. According to this author two thirds of the 100 million acres cereals grown in the prairie provinces are infested with wild oat. The annual damage is estimated as approximately 100 million dollars which is more than the estimated damage caused by cereal rusts. I think nothing can better illustrate the magnitude the wild oat problem can reach than this comparison, and it is not surprising to find that wild oat has become one of the main problems for agricultural research in Canada.

Broadly speaking, one can sub-divide the problem of chemical control of wild oats into two:

(a) Wild oat control in cereals

(b) Wild oat control in broadleaved crops

It does not need much explanation why the first problem is infinitely more difficult to solve than the second. Morphological, physiological and ecological differences between wild oat and cereal crops have so far proved too small to allow the development of a reliable, selective control method.

G. Knowles in Canada first suggested a possible way to control wild oat in cereals by spraying maleic hydrazide when the wild oats are in the milk stage and the crop has passed this stage. This idea was taken up by several workers in this country and in Canada. Two years of experiments have, however, shown that this method is neither practicable nor reliable enough to be recommended. I quote H. W. Leggett from the proceedings of the 1955 meeting of the Western Canadian Weed Committee who said "In my opinion we could gather all the information we now have and possibly conclude our work with this chemical. The reasons for this opinion are that I cannot see it as a practical method of controlling wild oat. There are just too many major difficulties such as the critical timing period, method of application, danger of crop injury and so on, to make it feasible".

Work carried out by three research institutions in this country has led to the same conclusions and the idea of using maleic hydrazide in cereals has been abandoned.

A number of workers in America and Canada reported in 1955 successful experiments with CDAA & CDEC for wild oat control in several crops including barley and

even oats. These first experiments were primarily of an exploratory nature but are being followed up this year on a much wider scale. The results of this year's work in America and Canada are not yet known, but Dr. Friesen and Professor Shebeski from Manitoba University at Winnipeg when I was there earlier in the year were fairly optimistic, and some of the field experiments certainly looked promising.

Dr. Blackett, from Monsanto Chemicals Ltd. now presents a research report on a number of experiments he carried out this year in this country with CDAA & CDEC in a variety of crops including cereals. His results confirm the American and Canadian work and prove, therefore, the existence of a considerable selectivity of these compounds particularly between barley and wild oat.

Dr. Blackett's results, in addition, indicate a correlation between soil moisture and the degree of wild oat control.

At this point I should like to say a few words on the question of general reliability of soil treatments as compared with foliage application of herbicides. All treatments at present suggested for wild oat control are soil treatments. I think it is correct to say that soil treatments are, in general, not as reliable as, for instance, the control of charlock in cereals with MCPA or 2,4-D in foliage sprays. This is due to the fact that a considerably larger number of factors and all possible interactions of these factors influence the performance of a herbicide which has to work via the soil.

A thorough investigation of the influence of all these factors and their interactions would involve years of extensive research and it is problematical whether, the result would be useful since most of these factors are beyond the farmers control.

Agricultural practice urgently needs an answer to the wild oat problem in cereals and I therefore think that priority should be given to extensive reliability tests of any promising method on a wide scale all over the country. Research work on the effect of factors as mentioned above, carried out simultaneously, may lead to an improvement of the recommendations. Dr. Blackett's 1956 results on cereals certainly fall into the category of very promising treatments and should be followed up by a large scale testing in the coming season for their overall performance and reliability, perhaps in a similar way as it has been done this year with TCA for wild oat control in kale, sugar beet and peas.

An even more recent development in the control of wild oat in wheat is reported from America where Dow Chemicals Limited, have found that 4-chlorophenyl-4-chloro-benzenesulphonate known as the acaricide Ovotran, controls wild oat in wheat selectively. Details are at the moment not available.

Dr. Holly in his paper on "The effects of some newer herbicides on annual grass weeds", which he will introduce tomorrow, presents results with 33 new herbicides on wild oat. There can be no doubt of the great importance of this work which considerably helps in selecting promising new materials.

I come now to the chemical control of wild oat in broadleaved crops.

All five research reports deal with this subject. In addition to Dr. Blackett's paper there is one by Mr. Parker from the Norfolk Agricultural Station on laboratory tests with pre-emergence herbicides in sugar

beet, and three papers on field experiments by the Pea Growing Research Organisation and by the weed control section at Chesterford Park Research Station (Fisons Pest Control Ltd.).

Mr. Parker is unfortunately abroad. His paper only presents a small part of his extensive work with herbicides on wild oat control in sugar beet and deals with laboratory research using a germination technique in petri dishes. I will come back to some of his results later.

The Pea Growing Research Organisation and the Chesterford Park Research Team worked in the first stages of the investigations together, and joint research reports on a number of exploratory experiments in peas were presented at the last Weed Control Conference in Harrogate. The experimental programme, however, was soon extended by the Chesterford Park research team to sugar beet and kale, and it was agreed to continue in this year independently but on similar lines.

The first approach was based on American experience. TCA, dalaphon, propham (IPC) and CIPC were selected as the most promising herbicides. CDAA and CDEC were not available at that date. The aim in the first two years was to find the optimum dosage and application conditions for each of the four compounds and to decide on the most promising compound and treatment for further large scale testing.

After a careful study of the experimental evidence, both research teams agreed that, on balance, a pre-sowing treatment of 7.5 lb TCA was superior to any other treatment. Dalapon gave more variable results and proved less safe than TCA on the crops. This is now confirmed in Mr. Parker's paper, who found TCA safer than dalapon and also 2,2,3-trichlorpropionic acid in sugar beet, CIPC was found to be less selective than propham in sugar beet both by Miss Holmes and Mr. Parker. Propham has certainly some advantages over TCA. For instance propham controls certain broadleaved weeds as well as wild oat. However, this compound at "safe" dosages in sugar beet gives inferior wild oat control to TCA.

Even in peas on which TCA produces a specific effect, which will be discussed tomorrow, the Pea Growing Research Organisation preferred this compound to propham. Discussing with Mr. Parker at Sprowston his field work in 1955 and 1956 he was in agreement with these results. Time does not allow me to deal in greater detail with the relative merits of the four compounds.

Aim of the final stage of the work was to test the TCA treatment for its overall reliability and performance under a wide range of conditions.

Miss H. Holmes, from Chesterford Park Research Station, this season organised and carried out a large trial programme in close co-operation with farmers. 106 trials, 28 of them well replicated, were laid out covering the main wild oat infested areas. Mr. J. M. Proctor and W. A. Armsby from the Pea Growing Research Organisation, carried out a similar trial programme with the co-operation of about 50 farmers in peas.

For reasons beyond control a certain percentage of the trials did not provide any evidence. For instance, no wild oat appeared on some sites.

In discussing the results I hope the authors will forgive me if I do not deal with each paper individually, but since the farmer trials deal with the same substance and exactly the same recommendations, a summarized discussion will probably be of greater value.

Let us first consider the degree of wild oat control obtained in this large number of trials. I shall discuss the effect on the crops later. Accurate assessments on wild oat control were obtained in 101 trials. This number includes 16 trials in 1955. The mean percentage wild oat control was 77.3%. The table illustrates the distribution of wild oat kill obtained in the individual experiments and the frequency with which a certain wild oat kill occurred.

92%	of	the	experiments	gave	more	than	50%	kill
88%	"	"	"	"	"	"	60%	"
70%	"	"	"	"	"	"	70%	"
52%	"	"	"	"	"	"	80%	"
23%	"	"	"	"	"	"	90%	"

Generally speaking, the control of wild oat is important for three reasons:

(a) the immediate effect on the crop by removing competition between the crop and weeds

(b) reduction of hoeing and singling costs

(c) cleaning the land of wild oat for future crops

The authors agree that the treatment is well worth while in regard to the first two points. The practical value of TCA as a wild oat cleaning treatment, however, may depend on the extent to which the farmer is able to remove the remaining wild oat by hoeing or hand weeding and to prevent them from seeding.

I come now to the discussion on the effect of the TCA treatment on the crops. In peas the treatment did not prove selective enough to be generally recommended. In crops which are not very densely infested, yield depressions of the order of 10 - 20% and in isolated cases up to 50% occurred. In densely infested crops such yield depressions were often found to be more than compensated by removing the competition between the crop and weeds and on such sites yield increases were frequently obtained.

Mr. Proctor and Mr. Armsby in their paper stress the importance of thorough incorporation of the TCA in the soil. They point out that not only will such cultivation bring the chemical into close contact with the wild oat seeds, it will also reduce the concentration of the chemical near the pea seeds, and thus increase the selectivity.

The opinion of the farmers who used the treatment in peas clearly reflects the risk of the TCA treatment in this crop. Only a third of the farmers were definitely in favour of the treatment.

In sugar beet the picture is quite different. The large majority of the farmers were well satisfied with the treatment and only two farmers noticed a slight permanent effect. It is not yet known whether even in these two cases the yield was affected. Unfortunately yield figures of only one experiment could be included in the research report at the time of writing. In this replicated experiment even 10 lb/ac did not affect yield. Further yield results will soon be available but even then it seems advisable for further experiments to be undertaken to confirm the safety of the treatment.

The farmers agreed that singling and hoeing the sugar beet is made up to 4 times quicker. This no doubt is an important economic factor and the main advantage of the use of TCA in sugar beet.

The evidence reported shows that the use of TCA has similar advantages in kale, and no effect on the groth and development of the crop has so far been observed.

May I summarize now in a few words the overall picture of the results of recent research work. A treatment has been found which appears to be well worth while for wild oat control in sugar beet and kale. The same treatment appears to be considerably less safe in peas but well worth using in densely infested peas. It is, however, in my opinion unlikely that the TCA treatment is the final answer for wild oat control in broadleaved crops and further research will probably produce treatments which are even more efficient and reliable. Further development of the work with CDAA & CDEC in sugar beet, peas, and beans by Dr. Blackett will be looked forward to with considerable interest.

Promising compounds for wild oat control in cereals have been discovered recently and I feel convinced that in the not far distant future this problem will also be solved.

It is clear that herbicides will play a very important part in the control of wild oat and there is reason to believe that chemical and mechanical control, if combined in the right way, will reduce the menace of wild oat to a minimum.

EXPERIMENTS TO CONTROL WILD OAT USING α-CHLORO-N,N-DIALLYLACETAMIDE (CDAA) AND 2-CHLOROALLYL DIETHYLDITHIOCARBAMATE (CDEC)

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Summary

Experiments and a method to control wild oat in cereals, beans, peas and sugar beet are described using the herbicides CDAA and CDEC.

Both compounds proved effective in controlling wild oat in barley when applied at 12 lb/ac either as a pre-sowing or post crop emergence treatment. In peas and sugar beet CDEC was the more effective herbicide.

When applying CDAA the experimental findings suggest soil moisture may be closely correlated with the degree of wild oat control.

Introduction

The importance of bringing under control the infestation of wild oat in the cereal growing areas is becoming increasingly obvious. This is especially true in the Eastern Counties of England where a recent survey by Dadd (1) and co-workers showed up to 30% of the cereal acreage was infested with wild oat.

To date cultural methods have been the only means by which a farmer could attempt to control this weed in cereals. There have, however, in recent years been some promising reports of wild oat control by chemical means in field peas and sugar beet but not as yet with cereals.

The grass specific herbicides α-chloro-N,N-diallylacetamide, CDAA, and 2-chloroallyl diethyldithiocarbamate, CDEC, have as a result of extensive field trials been shown to control annual grasses in the U.S.A. Workers such as Friesen and Walker (4), Jordan and Dunham (5), and Sexsmith (7) reported that the compounds could be used without causing damage in a wide range of crops including barley, oats, flax, peas, corn, sugar beet, carrots, etc. Encouraging results against wild oat in barley and flax have also been reported by G. Friesen (3) and L.H. Shebeski (8). It, therefore, seemed justifiable to evaluate thoroughly these two chemicals for the control of wild oat in the U.K.

Experimental results

Laboratory and greenhouse work

Prior to field trials, a series of greenhouse experiments was carried out to ascertain the toxicity of CDAA and CDEC towards wild oat (*Avena fatua* and *A. ludoviciana*) and towards cereals, sugar beet, kale and peas. The duration of toxicity in the soil against the crops was considered to be of particular importance in providing an indication of a practicable technique for field applications to avoid crop damage.

These trials showed that the compounds were toxic to wild oats and to cereals but it was found with both the cereals and wild oat this toxicity disappeared with the appearance of the first leaf, seedlings sprayed with CDAA and CDEC at 3, 6 and 12 lb./ac being unaffected.

The residual toxicity of these compounds in the soil against some of the cultivated crops was then investigated. In these experiments, John Innes potting compost was used as the experimental medium, each treatment being fully replicated. The compounds were sprayed on to the soil surface and were then thoroughly incorporated. Observations showed that when sowing four days subsequent to spraying, the germination of ryegrass, wheat barley and oats was severely checked whilst kale, mustard and sugar beet was not affected by the spray.

In later experiments this residual toxicity of the herbicides to the cereals and rye-grass even when applied at 12 lb/ac was found to have disappeared after a period of seven days after spraying.

Field work

With the evident toxicity of CDAA and CDEC towards wild oat and the relatively short residual effect in the soil, a series of small scale trials were arranged to determine crop tolerance to the compounds under a range of environmental conditions, in addition to observations on wild oat control.

Trial sites were arranged in Lincolnshire, Norfolk, Suffolk, Essex, Cambridgeshire, Huntingdonshire and Hampshire, giving a range of soil types from a light sand to a heavy clay.

The crops in these trials were autumn sown wheat, oats, barley and beans, and spring sown barley, oats, beans, peas, sugar beet, sugar beet stecklings and carrots. Spraying was usually presowing, but there were some instances when pre and post crop emergence applications were made.

In each experiment CDAA and CDEC were applied at 3, 6 and 12 lb/ac in 45 gal of water, spraying with the Oxford Precision Sprayer, and except where indicated soil incorporation followed. Incorporation was carried out by harrowing, as soon as practicable, after spraying. Each treatment was replicated twice within a random block arrangement with three controls in each block giving a total of 18 plots for each trial, the individual plot being 2 x 13 yd.

The number of wild oats was assessed by counting those present in a 1 ft x 39 ft strip running along the length and sited centrally in the plot. The degree of control was then evaluated on a percentage basis.

Wild oat control

Emphasis was given to wild oat control in the cereals and therefore experimental results for barley and oats will be presented first of all.

The figures showing the percentage of wild oat control for the various treatments are given in Table I.

Table I

Percentage wild oat control in spring barley in relation to rate of herbicide application; time of spraying, soil type and crop damage

Trial	A3	A6	A12	C3	C6	C_{12}	Soil type and moisture content	Date of Spraying	Days before sowing	Crop Damage
A (3)	39	83	87	20	20	73	Medium loam CC	March 7th	7	None
B (2)	9	24	78	29	50	93	Medium loam CB	March 12th	10	20% A12) C12)
C (1)	0	54	78	67	53	95	Heavy loam CC	March 20th	10	10% A12) C12)
D (5)	10	47	69	35	58	82	Medium loam CC	March 27th	10	25% A12) C12)
E (2)	0	61	50	28	71	49	Heavy loam OA	March 21st	10	None
F (2.5)	36	40	69	36	23	76	Light-M loam CC	March 27th	10	None
G (0.5)	0	5	10	0	10	20	Heavy clay OA	March 16th	10	5% A12
H (2)	0	27	0	0	0	56	M-Heavy loam OA	March 16th	10	None
I (4)	8	0	0	0	10	20	Light loam OA	March 15th	10	None
J (1.5)	40	73	94	0	75	97	Heavy clay IA	March 15th	10	20% C12) A12)
K * (2)	50	54	85	59	50	40	Heavy loam CB	April 3rd	Post emergence	None
L * (3)	0	43	83	9	0	5	Fen clay CB	April 4th	Post emergence	None
M Oats (1.5)	44	27	79	7	35	63	Light loam	April 3rd	10	60% A12 20% C12) A6)

Key A3, A6, A12 indicates CDAA at 3, 6, 12 lb/ac respectively.
C3, C6, C_{12} indicates CDEC at 3, 6, 12 lb/ac respectively.

* Chemicals not incorporated after spraying.

See Overleaf

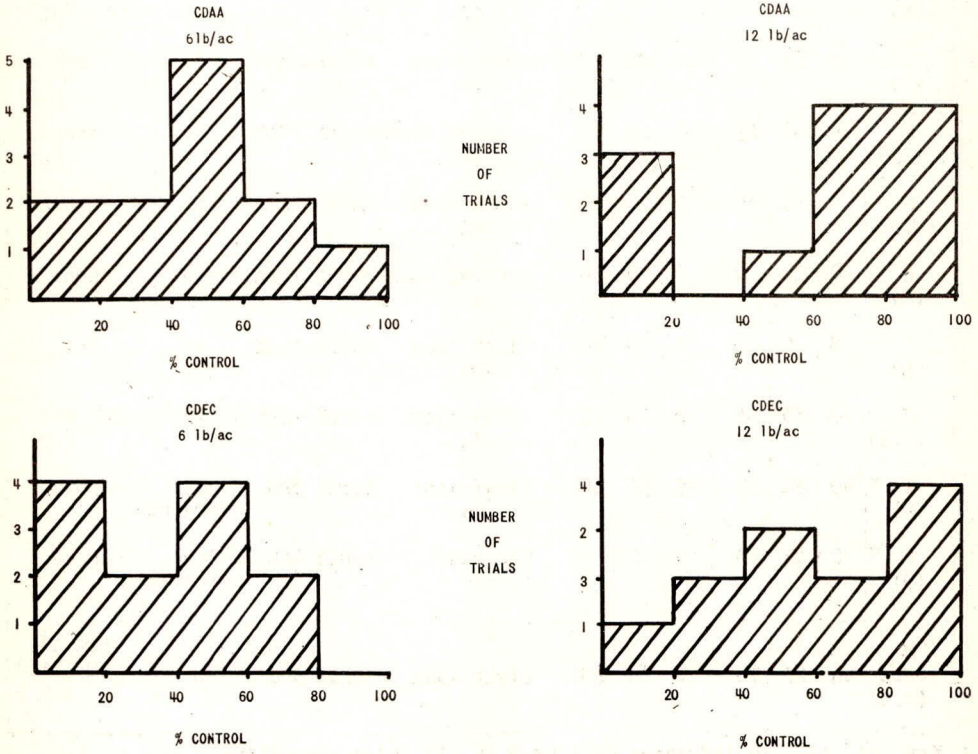
Soil moisture classification

OA	Dry ground
OB	Surface of ground dry
OC	Surface of ground damp
IA	Wet ground (surface wet)
IB	Soft muddy ground

Figure in brackets after trial letter gives wild oat count per sq. ft in controls.

It may be concluded from the above table that both CDAA and CDEC at 12 lb/ac can give a high degree of control, whilst at 6 lb/ac CDAA and CDEC show some inhibitory effect on the weed.

The following histograms illustrating the spread of the levels of control from CDAA and CDEC at 6 and 12 lb/ac help in evaluating these compounds.



The histograms tend to suggest that CDAA when effective provides a higher degree of control than CDEC and give an indication that a single factor exists which influences the degree of activity of CDAA in the soil. Thus three trials were unsuccessful at the 12 lb/ac rate whilst the other experiments show a very substantial measure of control. CDEC on the other hand displays a more gradual effect suggesting that there is no single factor which influences the degree of control obtained.

Other crops

Winter cereals

Experiments spraying winter sown cereals in March and April failed to give any satisfactory degree of weed control, there being only one instance where 50% control of the wild oat was effected.

Peas

The results for the trials in the pea crop are given in Table 2. It is noteworthy that in this series of experiments CDAA gave consistently poor control of wild oat. A suggested reason for this result is the loss of soil moisture from the surface layer when making the seed bed for the pea crop; spraying was usually done on a prepared seedbed. It is thought that soil moisture may not be so important a factor for the effectiveness of CDEC. It is significant, however, that again only satisfactory control was achieved with CDEC at 12 lb/ac.

Table 2

Percentage of wild oat control in peas in relation to rate of herbicide application, time of spraying, soil type, soil moisture and crop damage

Trial	A_3	A_6	A_{12}	C_3	C_6	C_{12}	Soil Type and moisture content	Date of Spraying	Days before sowing	Crop Damage
*A (3)	0	26	43	0	13	77	Medium loam CC	April 4th	2 days post crop emergence	None
*B (2)	0	30	0	31	0	49	Black Fen with clay OA	April 4th	Post sowing	None
C (11)	0	23	0	0	30	75	Heavy loam OA	March 21st	10	None
D (9)	47	30	35	28	30	85	Heavy loam CB	March 20th	10	None
E (1)	0	39	9	0	28	59	Black Fen OA	March 17th	10	None
F (1)	0	33	38	9	0	59	Light loam CB	March 17th	10	None

* Not incorporated.

Beans and sugar beet

In these experiments, in two instances with tick beans and broad beans, spraying was post emergence without subsequent incorporation and a reasonable level of control was effected by both CDAA and CDEC at 12 lb/ac on the tick beans and CDAA 12 lb/ac on the broad beans.

In the experiment on sugar beet CDAA was again ineffective at all rates, further supporting the view that in working for the seed bed there had been a loss of soil moisture from the surface layer. The results are summarised in Table 3 following:

Table 3

Percentage of wild oat control in beans and sugar beet in relation to rate of herbicide application, time of spraying, soil type, moisture and crop damage

Trial	A_3	A_6	A_{12}	C_3	C_6	C_{12}	Soil type and soil moisture	Date of spraying	Days before sowing	Crop Damage
Tick Beans (2)	19	44	70	20	11	81	Heavy loam CC	April 3rd	Plants just established	Slight check C12
Broad Beans (1)	0	0	66	0	0	0	Heavy loam CC	March 15th	Plants established	None
Sugar Beet (7)	0	0	20	23	23	65	Heavy loam OB	March 21st	14	None

Crop damage

Observations were taken on the degree of crop damage due to spraying with the herbicides. Damage was associated with a reduced plant stand which was compensated in the cereals by an increase in tillering. An estimate of the reduction in yield when compared with the unsprayed plots was taken as a measure of crop damage. The assessments were made visually due to the small plot size making actual yield determinations difficult.

Table 4

Estimated crop damage when sprayed with CDAA and CDEC
(damage as a reduction in yield)

Crop	Number of trials	Time of spraying: Pre-sowing	Time of spraying: Pre crop emergence	Time of spraying: Post crop emergence	Estimated reduction in yield
Winter wheat	2			Early Tillering	None
Winter oats	1			Early Tillering	None
Winter barley	1			Early Tillering	None
Barley	4	10 days			None
	1	7 days			None
	3	10 days			20-25% A_{12} & C_{12}
	2	10 days			5-15% A_{12} & C_{12}
	2			4-5 days	None
Oats	1	10 days			20% A6) C_{12}) 60% A_{12}
Peas	4	10 days			None
	1		4 days		None
	1			2 days	None
Winter beans	2			Plants well established	None
Tick bean	1			Plants just established	None
	1			Plants just established	Slight check A_{12}
Sugar beet	2	14 days			None
	1	21 days			None
Sugar beet Stecklings	1			Applied 3 weeks after planting	None
Carrots	1	10 days			None

The observations presented in the above table show that in five instances when barley was sown 10 days subsequent to spraying there was up to 25% estimated reduction in yield on the plots sprayed with CDAA and CDEC at 12 lb/ac. On the other hand, in oats CDAA at 6 and 12 lb/ac and CDEC at 12 lb/ac caused considerable damage.

Winter cereals and winter beans, peas, sugar beet and carrots were not affected by the spray, and on the basis of these results the herbicides may be applied safely to these crops.

Discussion

On the basis of the laboratory and greenhouse experimental findings, it was decided to apply the herbicides whenever possible pre-sowing, particularly, in the cereals. In experiments on spring barley, this technique proved very successful and a high degree of wild oat control was obtained when applying the herbicides at 12 lb/ac. The poor results from the 3 lb/ac applications do suggest that in this country between 6 and 12 lb/ac of the herbicide will be necessary to effect a reasonable standard of weed control.

In addition to the good results obtained using the pre-sowing technique, there were two trials in barley when CDAA, 12 lb/ac, was applied post crop emergence and gave a high degree of wild oat control without crop damage. CDEC, 12 lb/ac, however, proved ineffective in these experiments. In one instance, both compounds gave good results when applied post crop emergence at 12 lb/ac on tick beans.

Whilst the majority of the experiments with barley were successful, there were three trials which had poor weed control. A suggested reason for these poor results is that at these trial sites the soil had dried out to such an extent that there was insufficient soil moisture to bring the herbicides into contact with the wild oat seeds. If this postulation is correct, the poor wild oat control in peas and sugar beet from CDAA may also be attributed to a too low soil moisture level; evaporation losses in preparing the seedbed may have appreciably reduced the soil moisture. In support of this contention, spraying in the barley experiments was on the plough furrow, followed by incorporation.

There still remains, however, the discrepancy between the poor weed control obtained in the three trials in barley, when both CDAA and CDEC were ineffective, and the reasonable control of wild oat in peas and sugar beet effected by CDEC at 12 lb/ac. This implies that soil moisture may only be one of a number of factors affecting the efficiency of CDEC, whilst with CDAA it may be crucial. The histograms showing the spread of the levels of wild oat control in the experiments in barley, from CDAA and CDEC, illustrate this latter suggestion.

In support of this argument are the findings of Ebell and Corns (2), who noted that a high soil moisture or a heavy post spraying rainfall increased the effectiveness of CDAA for wild oat control, and at high soil moisture levels they thought soil incorporation unnecessary. On the other hand, however, Maxwell (U.S.A.) (6) reported that the acetamides were quite effective when applied on soils of low moisture content, and 1956 trials in the U.S.A. have shown CDAA to give better weed control under a wide variety of soil moisture conditions, while CDEC gave good weed control only under ample rainfall.

The degree of control of wild oats in these trials with CDAA and CDEC is regarded as encouraging on beans, peas and sugar beet, and they can be used safely on these crops. This is in keeping with the American findings. With regard to cereals, 5 - 25% estimated crop damage occurred in 5 of the barley trials when applying the chemicals 10 days prior to sowing. It may well be that if this period between sowing and spraying is extended to 14 days or more, then crop damage may not occur at all in the cereals. Undoubtedly an early spring spraying on to the plough furrow two weeks prior to sowing can easily be fitted into the farming routine if a high degree of wild oat control is effected. This will enable the chemicals to be incorporated into the soil as part of the seed bed preparation; and during 1956, in the United States, soil incorporation has resulted in wild oat control far superior to that obtained where the chemical was used as a pre-emergence herbicide.

Much further work remains to be carried out before these two chemicals can be considered as acceptable for wide-scale usage. Prior to field investigations, the effect of soil moisture will be fully examined in greenhouse studies and it is hoped that from them a clearer understanding of the importance of this factor may be obtained before undertaking field trials in 1957. In these trials, particularly with barley, attempts will be made to eliminate crop damage by increasing the period between spraying and sowing, without, it is hoped, reducing the control of wild oat. These experiments will be on a field scale basis and will include yield determinations.

Conclusions

1. The herbicides CDAA and CDEC are extremely toxic to wild oat and inhibit development if brought into contact with the seed prior to the appearance of the first leaf.

2. Wild oat can be controlled in barley by applying the herbicides CDAA and CDEC at 12 lb/ac pre sowing. In peas, CDEC at 12 lb/ac gave good control.

3. Further work is required to investigate the correlation between soil moisture and the degree of control effected by CDAA and CDEC.

4. Accurate determinations on crop yields, when applying the herbicides, are required, before they are brought into large-scale usage.

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EXPERIMENTS WITH TCA FOR THE CONTROL OF WILD OATS IN PEAS (PROGRESS REPORT 1955)

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Summary

1. Sixteen trials were carried out on peas using TCA at 5 and 7.5 lb/ac applied at three different times before sowing.

2. The most promising treatment appeared to be TCA 7.5 lb/ac applied one to three weeks before sowing. This gave a control of wild oats ranging from 35% to 98%

3. On average, 5 lb TCA had little effect on yield of peas whereas 7.5 lb reduced the yield by about 10%. The majority of these trials were not densely infested with wild oats.

Introduction

In exploratory experiments in 1954 (1), TCA showed promise as a pre-sowing treatment for the control of wild oats in peas. This report describes the results of a series of trials carried out in 1955. The work was continued in 1956 on a much larger scale and attention is drawn to two papers describing these later experiments (2,3).

A standard experimental layout was used at 16 sites in Essex, Suffolk and Huntingdonshire. Individual trials were small as it was considered more important to test the treatment on as many sites as possible rather than to carry out a small number of more precise experiments.

TCA was applied at two rates and at three different times at intervals of 2 weeks. The intervals between spraying and sowing varied at the different sites because of the different sowing dates.

Observations were made on the growth of wild oats and peas and yields were taken on 14 experiments.

Material and methods

At 13 sites the pea variety was Harrison's Glory; the other varieties were Lincoln and Minerva Maple.

TCA was applied at 5 and 7.5 lb in 60 gal/ac at three different times before sowing. The average intervals between spraying and sowing were 34 days for the first application, 20 days for the second and 11 days for the third. The only cultivations done were the normal seed-bed preparations. Plot size was 24 sq. yd. There were two replications at each site. In 14 of the trials the wild oat population was assessed by counting sample areas. In the remaining experiments, dense growth of peas or other weeds made this method impracticable and the plots were therefore scored.

Peas were harvested from areas of 48 sq. ft in each plot. The yield figures shown refer to dry threshed peas.

Results

A. Wild oat control

Wild oats occurred at 13 of the sites though at about half these the wild oat population was not dense.

Table 1 shows the percentage control obtained at the different sites and also the density of the untreated wild oats.

Table 1: Control of wild oats as percentage of control

Exp. No.	Treatments TCA lb/ac						Density of Wild Oats. No. per sq. yd.
	First Spray		Second Spray		Third Spray		
	5	7.5	5	7.5	5	7.5	
2	61.2	79.2	76.5	76.0	76.9	71.6	17
3	52.5	61.2	65.8	89.2	66.9	64.5	26
5	47.0	71.6	37.5	39.6	63.1	62.4	Low
6	29.1	40.0	33.0	36.5	61.3	69.3	45
7	28.8	71.5	75.7	92.4	93.8	85.7	16
8	86.7	93.8	93.8	97.6	73.3	89.6	Low
9	29.7	51.3	38.7	66.3	61.0	58.5	265
10	25.4	34.2	82.4	74.3	29.4	51.1	31
11	59.5	73.6	80.6	94.2	-*	-*	184
12	29.3	37.6	29.9	52.9	64.9	81.6	53
13	9.1	38.0	46.2	42.1	76.7	68.4	8
14	90.5	98.1	96.7	98.2	98.9	94.4	3
16	94.0	96.6	88.4	93.2	90.0	92.9	4
Means	49.4	65.1	65.0	73.3	71.3	74.2	

* Only two pre-sowing applications were made at this site.

It will be seen that, in general, the later applications gave a better control of wild oats than did the earlier and that 7.5 lb TCA was rather more effective than 5 lb.

B. Effect on peas

Fourteen experiments were harvested. The yields expressed as percentage of control are shown in Table 2.

Table 2: Yield of threshed peas as percentage of control.

Exp. No.	Treatments TCA lb/ac							
	First Spray		Second Spray		Third Spray		Means	
	5	7.5	5	7.5	5	7.5	5	7.5
1	90.4	89.6	85.5	60.7	84.2	88.2	86.7	79.5
2	113.6	107.9	115.9	123.6	81.3	75.9	103.6	102.5
3	103.1	88.2	97.4	99.1	109.9	114.0	103.5	100.4
4	83.8	105.2	69.0	75.3	96.3	63.6	83.0	81.4
5	112.5	85.2	87.2	70.5	86.4	77.4	95.4	77.7
6	138.1	115.7	101.7	131.6	105.6	95.5	115.1	114.3
7	120.2	74.4	128.6	66.6	84.9	73.6	111.2	71.5
8	110.5	99.9	113.9	88.6	137.2	93.7	120.5	94.1
9	95.6	104.5	87.5	92.8	97.8	67.4	93.6	88.2
10	72.5	74.3	95.2	90.5	76.3	76.5	81.3	80.4
12	99.6	100.5	99.8	112.8	119.5	104.5	106.3	105.9
13	93.2	108.9	81.1	102.3	98.2	99.5	90.8	103.6
14	84.4	113.4	151.8	130.1	54.0	58.8	96.7	100.8
15	79.2	87.0	93.1	77.0	67.4	57.1	79.9	73.7
Means	99.8	96.7	100.6	94.4	92.8	81.8	97.7	91.0

Statistical analysis of the yield figures of the experiments on Harrison's Glory showed that 7.5 lb TCA gave significantly lower yields than 5 lb TCA (P 0.05). The effect of time of application was not significant.

Discussion

The individual trials described in this report were not sufficiently replicated to give reliable information for any one site and no correlation can be found between the results of one trial and any conditions relevant to that trial. The means of all trials show the effects of the treatments when applied under varying conditions.

The best wild oat control was given by 7.5 lb TCA. On average this treatment gave a 70% control of wild oats but also reduced yield by about 10%. It should be noted, however, that of the fourteen trials harvested, only one was

very heavily infested, and four were moderately infested. It is now thought that, on fields where a dense wild oat population is substantially reduced by TCA, the effect of the removal of the weed will compensate for any effect of the treatment on the yield of peas.

The results of these experiments were not conclusive but they were considered sufficiently promising to justify more extensive trials of the TCA treatment in 1956.

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FURTHER EXPERIMENTS ON THE CONTROL OF WILD OATS IN PEAS: PROGRESS REPORT 1956

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Summary

Three types of trial were carried out in 1956:- (i) a single replicated experiment to assess the influence of time of application and intensity of cultivation on the effects of TCA and propham on peas and wild oats; (ii) two simple replicated trials comparing two rates of TCA; (iii) 29 single strip farmer tests.

It would appear that thoroughness of incorporation of TCA in the soil is of prime importance in obtaining maximum kill of wild oats with least effect on the peas. Time of spraying in relation to the period in which the wild oats germinate is also considered to be important. It is clear that intensity of cultivation affects thoroughness of incorporation.

It also seems that a short interval should elapse between spraying and sowing in order to ensure thorough incorporation by the time the peas germinate. The length of this interval would appear to depend, not only on the number of cultivations but on the amount of rainfall occurring. In the more normal spring of 1955 the optimum interval appeared to be about one to two weeks, whereas it would seem that a longer interval was required in the drier spring of 1956. It would seem apparent that thorough incorporation is likely to be easier on light soils not only due directly to their condition but to the fact that it is far easier to cultivate them.

Results over three years suggest that 7.5 lb/ac of TCA is the most satisfactory rate. Some effect on the peas is inevitable and no more than a 90% kill of wild oats can be expected.

It is suggested that peas may be regarded as a wild oat cleaning crop. The TCA should be applied to the roughly broken down plough land in the last week of February or first three weeks of March. The land should be cultivated thoroughly three or four times in the following 2-3 weeks. The peas should then be sown in moderately wide rows and subsequently tractor hoed. It should then be reasonably economical to remove, by hand, the wild oats remaining in the rows. Mechanical weed control of TCA treated crops is in any case desirable since the removal of the bloom or wax from the leaf cuticle by TCA makes the crop more susceptible to scorch by dinoseb.

Introduction

Work carried out in 1954 and 1955 in conjunction with Messrs Fison's Pest Control Ltd. (1 and 2) indicated that TCA applied prior to sowing at about 7.5 lb/ac might be expected to give somewhere in the region of a 75% control of wild oats with a 10% depression of crop yield. On this basis TCA was considered to show good promise for the control of wild oats in peas.

Variation between the results of individual trials was wide enough to indicate that the factors governing the most effective operation of this

chemical were not fully known. Since it seemed probable that TCA needed to be in the region of the wild oat seeds at the time of their germination, it was decided to carry out work on the influence of time of application and intensity of cultivation. Also to be borne in mind were the effects of rainfall and soil type.

Following discussion with Messrs C. Parker and J. D. Fryer of their 1955 experiences it appeared that further comparison of TCA and propham was warranted. Although the cost of propham would seem likely to exceed that of TCA, it has been shown to have two important advantages over the latter. Firstly it does not remove the bloom or wax from the leaf cuticle and so render the crop more susceptible to scorch from dinoseb, as is inevitable with TCA. Secondly propham does appear to give appreciable control of certain broad leaved weeds whereas TCA is normally quite ineffective in this respect.

Unfortunately propham has been less consistent than TCA in killing wild oats and it seemed likely that the factors involved might well be time of application and intensity of cultivation, apart from the more elusive factor, soil type.

Experimental results

The 1956 programme was divided into three parts:- (i) replicated trials to assess, in greater detail, the influence of time of application and intensity of cultivation on the effects on peas and wild oats, of two dosages of TCA and propham; (ii) simple replicated trials comparing two rates of TCA; (iii) simple farmer tests with TCA to secure data of restricted accuracy, from a wide range of field conditions and to make some assessment of farmer reaction.

(i) Time of application/cultivation/dosage trial

Of three trials laid down, two were subsequently abandoned due to serious pest damage. The surviving centre was looked after extremely well by the farmer concerned. This site was at Takeley in Essex, on a medium-heavy clay soil; the peas were Zelka (Harrison's Glory). The nature of the main treatments is given below with relevant Takeley details in brackets. The whole trial area was spring-tine harrowed once to prepare the seedbed, on 29th March, the day of drilling. It was observed on the day when the late applications were made (20th March) that wild oats were beginning to chit ($<$ 1.5 in. long).

MAIN TREATMENTS

"E" - Early application (29th February)

"EC" - Early application/extra cultivations (heavy harrowed on three separate dates prior to preparation of seedbed)

"L" - Late application (20th March)

"LC" - Late application/extra cultivations (heavy harrowed three times, six days prior to drilling).

Each plot consisted of treated and untreated sub-plots.

Sub-Plot Treatments

"T 5" - 5 lb/ac TCA)
"T 10" - 10 lb/ac TCA) in 60 gal/ac of water
"I 3" - 3 lb/ac propham)
"I 6" - 6 lb/ac propham)

"C" - wild oats removed by hand (by 11th May)

Unfortunately the propham formulation proved unsatisfactory, tending to crystallise out in the sprayer. The actual dosages of propham therefore are not known and the effects of this chemical have been largely ignored.

Treatments did not affect plant density.

TCA affected plant growth very materially, causing loss of bloom and some contortion throughout. The effect varied noticeably with main treatment in the following order of increasing severity:- EC, E, LC, L. In each case the higher dosage was affected to an appreciably greater degree, there being some scorch on LC/T10 and much scorch of the stunted plants on L/T10.

Table 1

Main Treatment	Percentage kill of wild oats				Wild oat density (per sq. yd on Untreated Plots)
	T 5	T 10	I 3	I 6	
E	51	84	Increase of 14	32	187
EC	77	94	Increase of 48	Increase of 1	179
L	29	66	52	42	191
LC	Increase of 8	48	14	54	165

Table 2

Main Treatments	Scoring for degree of control of wild oats (0-9) July 11th				
	T 5	T 10	I 3	I 6	C
E	4	6	2	1	9
EC	4.5	8	0.5	1.5	9
L	4.5	6.5	2.5	4	9
LC	4	5.5	2	4	9

Table 3

Main Treatments	Yields of peas (in cwt/ac)					
	T 5	T 10	I 3	I 6	C	Untreated
E	9.3	7.7	5.3	5.6	14.5	5.2
EC	9.2	8.5	4.7	5.8	12.1	4.9
L	8.5	5.7	7.2	8.1	13.4	5.5
LC	7.3	6.0	6.8	8.3	11.9	5.6

Table 4

Main Treatments	Percentage reduction in "yield" of wild oats (whole plants)					Yield of Untreated Plots (cwt/ac)
	T 5	T 10	I 3	I 6	C	
E	76	95	6	33	100	78
EC	73	99	Increase of 21	23	100	90
L	51	92	19	32	100	66
LC	52	83	26	18	100	73

The data presented in Tables 3 and 4 is not as accurate as would be desired due to the very difficult harvesting weather.

At one of the abandoned centres it was noted that TCA had given an appreciable control of a number of grasses and broad leaved weeds including couchgrass, Agrostis, wild oats, thistle and mayweed.

(ii) Replicated TCA trials

Of two trials laid down, yields were obtained from one only. Each plot consisted of treated and untreated sub-plots. Cultivations were those normally employed on the farms in question for seedbed preparation.

Sub-plot Treatments

"T 5" - 5 lb/ac TCA)
) in 60 gal/ac of water
"T 10" - 10 lb/ac TCA)

"C" - wild oats removed by hand

Table 5

CENTRE:-	Stowmarket, Suffolk	Braintree, Essex
Soil type	Medium heavy clay	Medium heavy loam
Date sprayed	1st March	1st March
Cultivations	(Spring-tine harrowed (twice (drilled and harrowed	(Light harrowed once (drilled and harrowed
Date sown	17th March	24th March
Pea variety	Zelka	Zelka
Date wild oats removed	18th May and 10th June	
	Wild Oat density (per sq. yd) on untreated plots	
	316	91
TREATMENT	Percentage kill of wild oats	
T 5	87	76
T 10	93	85
	Yields of peas (in cwt/ac)	
T 5	16.0	Farmer estimated that chemical treatments did not reduce yields
T 10	15.2	
C	21.5	
Untreated	7.2	
	Percentage reduction in "yield" of wild oats (whole plants)	
T 5	74	
T 10	84	
C	100	

Treatments did not reduce crop emergence but crop growth was affected by the TCA at both centres being much more pronounced at the higher rate. At neither site did stunting reach serious proportions.

(iii) Farmer tests

Approximately 50 farmers co-operated in this work. In several cases, farmers who were treating whole fields with TCA were kind enough to leave untreated strips. For the most part, however, farmers were supplied with sufficient TCA to treat half an acre at the rate of 7.5 lb/ac. Instructions were that the TCA should be applied at high or low volume to the ploughed land just before preparation of the seedbed. It was pointed out that application on the prepared seedbed, or after drilling would be less effective and more dangerous to the crop and also that very early application was likely to be less effective than that made immediately prior to seedbed cultivation.

Each site was visited at least once during the season when assessments were made of wild oat kill, crop density and crop damage. Comparison was made between the TCA treated strips and closely adjoining untreated areas. Results of some value were obtained from 29 sites. It was possible to make rough estimates of yield at only 7 sites.

On average treatment did not reduce the number of peas emerging although the effect on plant form, size and vigour varied greatly.

An attempt was made to relate factors such as soil type, intensity of cultivation, interval between spraying and volume of application with degree of wild oat kill and crop damage. Further investigation showed that the factors were so inter-related that no clear evidence could be deduced. For instance, while wild oat kill appeared to be poorer and crop damage more severe on heavier soils it was also true that cultivations tended to be fewer on heavier soils and, strangely enough, that the period between spraying and sowing was less on the heavier soils and date of sowing earlier. It also turned out that in the sample of farms in question, Zelka peas were sown earlier and on heavier land than Lincolns whereas it had seemed that Lincolns were more resistant to TCA than Zelka (Harrison's Glory). It was clear, however, that intensity of cultivation, linked with soil type, and a period of 2-3 weeks between spraying and sowing were together related to most efficient use of TCA.

Mean wild oat density (excluding centres where density was too low to estimate treatment effect) was 128 per sq. yd with a range of from 6 to approx. 500 sq. yd. Mean percentage kill was 88 with a range of 65-100.

Table 6

Wild Oat density (per sq. yd)	Percentage Kill	Yield Effect	Factors which may have noticeably influenced the result
204	65	40% decrease	Soil heavy, cultivations light and only 4 days interval between spraying and drilling
122	98	41% increase	Deep cultivations
58	100	68% decrease	Heavy soil. Drilled on day of spraying.
40	90	22% increase	Heavy cultivation and 14 day interval
15	90	23% increase	
12	98	18% increase	Heavy cultivations and 14 day interval
6	67	6% decrease	

In considering the above results it must be borne in mind that each farmer made some attempt to control the wild oats by mechanical means after wild oat density had been assessed. If this action had not been taken it is likely that "treated" would have outyielded "untreated" more frequently.

Farmer reaction

Although the effect of TCA on the peas themselves was occasionally severe enough to cause some alarm, most farmers were well satisfied with the wild oat kills obtained. It is known that several of the farmers intend to use TCA on a larger scale in 1957.

Discussion

(1) Time of application/cultivation/dosage trial

TCA. In consideration of the results of this trial and bearing in mind the earlier work on this subject and the other trials carried out in 1956, the mode of action of TCA, on peas and wild oats, might be conjectured as follows. Firstly, it is assumed that the more thoroughly this chemical is mixed with the soil, the less damage is caused to the crop and the better is the kill of wild oats obtained.

Rainfall at Takeley, from the beginning of February till the end of May was:- first week March, 0.5 in. mainly on one day; over last two weeks March, 0.5 in.; first week April, 0.25 in.; second week April, 1 in.; last week May, 0.5 in. It would seem that, by the time that the peas had germinated the small amount of rainfall had been sufficient for "E" to have become reasonably well incorporated in the soil. This is supported by the following arguments. Treatment "E" nearly equalled "EC" in lowness of crop damage and excellence of wild oat kill. Since the early applications were markedly superior to the late applications it seems reasonable to suppose that the "E" treatment TCA became almost as well mixed in the effective depth of soil - i.e. depth from which wild oats germinate, say 6 in. - as on the "EC" treatment. The superiority of "EC" over "E" in wild oat kill was really only recognisable at the lower rate suggesting that the greater amount of chemical at the higher rate was sufficient for it to penetrate to the full effective depth of soil more quickly - without cultivation - than the lower rate.

The differences between main treatments in their effect on pea damage almost certainly depended upon degree of mixing of the chemical in the soil and its gradual downward movement and dilution in the top layers. The point is that the peas are sown at a depth of approximately 2 in. while the wild oats germinate from a greater depth and as time progresses the TCA is moving downwards. "EC" was superior to "E" because there was still a rather greater concentration nearer the surface in the case of "E". There was at the late application an even higher concentration near the surface and consequently in contact with the pea roots and possibly to an even greater degree with the pea shoots. "LC" was naturally rather better than "L" as the TCA was somewhat dispersed by the cultivations.

So far as wild oats are concerned it seems fairly certain that they are killed most readily where the TCA is in contact with the seed. It follows that a greater concentration is necessary to effect equal kill after germination has occurred. Except for the apparent superiority of "L" over "LC" the trial results clearly confirm that thoroughness of incorporation is essential to success. This exception must next be considered.

Since the wild oats were germinating when the late applications were made they would be at a stage at which a higher concentration might be expected to be needed to effect a kill. The relatively undisturbed layer of TCA on the

"L" treatments was presumably of a sufficiently high concentration to effect a reasonable kill when the wild oat shoots encountered it. The cultivations received by the "LC" treatments presumably caused such a dilution that the wild oats were relatively unaffected. Actual date of application - probably within quite wide limits - in relation to germination of wild oats would therefore seem to be important.

The higher rate of TCA gave much better control of wild oats throughout but was excessive - so far as the crop was concerned - in the case of the late application.

In relation to propham, it would seem that TCA had a growth retarding effect on the wild oats since yield of the latter was much higher in relation to initial kill on the propham plots than in the case of TCA.

Propham. It is probably safer to infer that more chemical went through the sprayer with the late application rather than to consider the better kill from these treatments to be due to a "time" effect. It is worth noting as referred to above, that propham did not appear to exercise a depressing effect on wild oat growth after emergence as is obvious in the case of TCA.

Until late in the season there was practically no growth of other types of weed so that no assessment of the effect of propham, in this respect, was possible.

(ii) Replicated TCA trials

These trials provided little additional information although giving very satisfactory results. It is of note that only very light cultivations were carried out at the Braintree site yet good control of wild oats was obtained. This could well be related to the lighter nature of the soil facilitating more intimate admixture of the chemical. Spraying was done early at both sites.

It is interesting to consider the effort needed to keep peas free from wild oats by non-chemical means. At the Stowmarket site, an adjoining 5 ac of the crop was tractor hoed 5 times (2 men) followed by three weeks of hand weeding by three men. The result was still by no means a completely wild oat free crop. In spite of the fact that all species of weed had been hoed out, the estimated yield of 19 cwt/ac did not compare too well with the "C" plots although the field peas were longer in the straw and healthier in appearance.

(iii) Farmer tests

As discussed above, the main finding of these tests was that intensity of cultivation, linked with soil type, and a period of 2-3 weeks between spraying and sowing were together related to the most efficient use of TCA. No idea of the effect of actual date of sowing was obtained.

The only real evidence of a difference in varietal susceptibility occurred at a site where dun peas, occurring as rogues in a crop of Zelka, were practically unaffected by TCA in marked contrast to the crop variety. It is clear that further research is urgently required on the question of varietal susceptibility to TCA.

A practical point which appeared from these tests was that spray applied on the unbroken furrow tended to reproduce the pattern of these furrows in

alternate strips of good and poor control of wild oat. It is obvious that the top soil containing the greater part of the TCA, became concentrated in the furrow bottoms by the levelling cultivations. There is thus a good case for rough cultivation, prior to application of TCA, where the furrows are standing well.

At several sites grasses other than wild oats were encountered. Where it was impossible to distinguish between them, the data from these sites was ignored. It did appear however that couch grass was controlled more satisfactorily than blackgrass.

There was evidence at one site of some control of cleavers by the TCA treatment.

General discussion

It is important to note that the spring of 1956 was extremely dry. In a more normal season it would be far more difficult to cultivate most soils as thoroughly as would appear to have been advisable in 1956. On the other hand the extra rainfall might largely compensate by washing down the TCA. This is clearly a point which requires further elucidation. It was however suggested as a result of the 1955 trials that the period between spraying and sowing should be 7 to 14 days; the 1955 spring was a more normal one! Lest there be any confusion that the interval between spraying and sowing affects wild oat kill, it should be considered that this would pre-suppose an effect on wild oat germination by sowing itself, or the cultivations which go with sowing. Actual date of spraying in relation to germination of the wild oat must be the important factor, but how far cultivations initiate germination is not known. A single test at Yaxley this season was inconclusive on this point though it did seem that germination occurred irrespective of cultivation, in these particular circumstances. This is a further aspect requiring research.

Serious objection has been taken by heavy land farmers to the advice that heavy cultivations should follow TCA applications. The danger is that heavy rain falling on the worked down land could easily destroy the tilth for the remainder of the season. Further research would seem necessary to establish whether a compromise system might be satisfactory. The TCA might be applied rather earlier, on the plough and extra heavy cultivations made immediately prior to drilling. Unfortunately there is evidence that peas grow better where seedbed cultivations - especially on the heavier soils - are kept to a minimum.

Conclusions

It would appear that thoroughness of incorporation of TCA in the soil, is of prime importance in obtaining maximum kill of wild oats with least damage to the peas. Time of spraying in relation to the period in which wild oats germinate is also considered to be important. It is clear that intensity of cultivation affects thoroughness of incorporation. It appeared that, in the relatively dry conditions which prevailed, an interval of 2-3 weeks between spraying and drilling was desirable in ensuring that the chemical became thoroughly incorporated in the soil by the time the peas germinated. Thus the TCA would be at "maximum" dilution and so do least harm to the peas.

It is considered that a certain amount of rainfall greatly assists in the thorough incorporation of TCA. The length of time between spraying and drilling would therefore depend largely on the amount of rain falling after spraying.

It would seem that more work should be done on the movement of TCA in different soils in relation to rainfall and cultivations.

It would seem apparent that thorough incorporation is likely to be easier on light soils not only due directly to their condition but also because it is easier to cultivate them.

It would appear that 7.5 lb/ac of TCA is a reasonable dosage. While 10 lb may prove to be safe enough on certain varieties, it is conceivable that severe damage might occur if weather or other conditions made it impossible to follow the ideal recommendations for usage. On the other hand, 5 lb per acre may well give satisfaction under ideal conditions but it would seem wise to employ the slightly higher rate to cover more normal farm conditions.

It would appear that some damage to the peas is inevitable with TCA, though this need never be serious.

Further work is obviously required on the susceptibility of different varieties and also on the effects of cultivation and time in wetter springs, with special reference to the difficulties of cultivating heavy soils.

It would appear that not more than a 90% control of wild oats can normally be expected. While this degree of control is sufficient to ensure a full crop of peas, it is not sufficient to make peas a wild oat cleaning crop. It would appear that the use of TCA should be combined with mechanical weed control. The crop should be sown in rows wide enough to permit tractor hoeing. The wild oats then remaining in the rows should be few enough to be economically removed by hand. Since TCA, by removing the bloom or wax from the pea leaf, makes dinoseb spraying somewhat risky, tractor hoeing for the control of general weeds is to be recommended. Tractor hoeing has already been shown to be quite as attractive as dinoseb for general control of weeds in peas.

Acknowledgements

Grateful thanks are due to all farmers who co-operated in the trial work, particularly to Mr. G. W. Brown who carried out the main experiment. The supply of TCA for all the work by Messrs Fison's Pest Control Ltd. is gratefully acknowledged as is also the supply of propham by Messrs Mirvale Chemical Co., Ltd. The help afforded in the work by our colleague Mr. R. A. Hind is also acknowledged.

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