CHEMICALS: DINITROPHENOLS

Chairman: Mr. J. A. McMillan

THE EVALUATION OF 2:4-DINITRO-6-ISOPROPYLPHENOL AS A SELECTIVE HERBICIDE

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In 1945 Crafts in a short note on the relationship between biological activity and the structure of some nitrated alkyl phenols claimed that 2,4-dinitro-6-sec-butyl-phenol was more phytotoxic than 2,4-dinitro-ortho-cresol, while in the same year Grigsby and Barrons reached the conclusion that the sec-butyl compound, as the ammonium salt, was a promising material for the selective control of annual weeds in peas. Since that time, no critical comparison of the relative phytotoxicity of a wide range of nitrophenols has been published. There have been references to the relative merits of the sec-amyl and sec-butyl as the alkyl substituents while Seeley (1952) pointed out that for weed eradication in peas optimal selectivity appeared to be achieved with the sodium salt of 2,4-dinitro-6-isopropylphenol. Nevertheless today both in Europe and America the principal dinitrophenol employed for weed control in peas and lucerne is the sec-butyl compound.

At Oxford since 1947 fundamental studies of the biological characteristics of nitrated organic compounds have been in progress and the general relationship between the degree of nitration and activity (Simon and Blackman, 1953) or the interrelationship between activity and the degree of dissociation of weak acids and bases (Simon and Blackman, 1949, Simon, Roberts and Blackman, 1952) have already been reported. Only passing references have however been made to the influence of the length or nature of the alkyl sidechain on the properties of dinitrophenols and it is proposed to review briefly this research since it was the starting point for the eventual selection of the dinitro-isopropylphenol for investigation in the field.

The initial studies of Simon (D.Phil. thesis 1949) showed that for alkyl phenols with 1 to 4 carbon atoms in the primary sidechain nitration in the 2,4 position as against the 2,6 position resulted in a much higher phytocidal activity. It was also observed that for the 2,4 - substitution only - the substitution of a methoxy or ethoxy group in the 1 position considerably enhanced the biological activity but that the further addition of carbon atoms did not produce corresponding gains in activity. It was also apparent that for a given number of carbon atoms the activity of the primary compound was different from that of the secondary or tertiary compound.

These investigations were either based on the effects of spray applications on *Sinapis alba* or the inhibition of the radial spread of *Trichoderma viride* on agar culture media. When these investigations were extended to other species or other methods of assay it became clear that the relative order of toxicity was dependant both on the species and the technique of assay. To illustrate this point some selected results have been set out in Table 1. It is to be noted that in each experiment the comparison between compounds is based on differences in the equi-effective concentration since by this means the most accurate and valid comparisons can be made (Blackman 1952). To obtain this information it is necessary to employ a range of concentrations so that the concentration giving the selected standard response can be evaluated.

Table 1

The concentrations of some 2,4-dinitro-6-alkylphenols required either to halve the rate of increase in root length or to cause a standard degree of necrosis when micro-droplets are applied to the leaves.

	Equi-effective concentrations			
	H. annuus		*H. vulgare*	*P. sativum*
Compound	Leaf necrosis	root growth inhibition	root growth inhibition	root growth inhibition
	g/100ml	p.p.m.		
Dinitrophenol	2.30	0.35	1.80	0.80
Dinitromethylphenol	0.74	0.27	0.75	0.25
Dinitro-*o*-propylphenol	0.09	0.64	0.48	0.76
Dinitro-isopropylphenol	0.12	0.72	0.48	0.90
Dinitro-*sec*-butylphenol	0.08	1.02	0.28	0.95

Examination of Table 1 demonstrates that the relationship between activity and structure, when activity is measured in terms of the inhibition of root growth, is linked with the species - compare for example the trends for *Hordeum vulgare* and *Pisum sativum*. Thus, where basic studies on root growth give some guidance as to the reactions of species to pre-emergence treatments there is evidence that by changing the compound differential effects could be obtained. It is equally apparent that for *Helianthus annuus* the relative effects of the individual compounds on root growth and leaf necrosis are quite different.

Since the laboratory investigations were often so disperate from the original spraying experiments on *S. alba* it was decided to extend the pot culture spraying trials to a number of other species. As before, using equipment designed to give constant spray characteristics, a range of concentrations were employed so that the equi-effective concentrations could be determined. A summary of the comparative results for the ammonium salts of the methyl, *isopropyl* and *sec*-butyl compounds are given in Table 2. Once more it is evident that the general tenor of the data is dependent on the species. For the two most susceptible species *S. alba* and *H. annuus* there is little to choose between the *isopropyl* and *sec*-butyl compounds and both are more toxic than dinitro-*o*-cresol. For the remaining three species the isopropyl derivative is consistently less toxic than the *sec*-butyl compound, the differences being smaller for *P. sativum* than for the other two species. Thus, considered as a whole the pot culture investigations revealed the 2,4-dinitro-isopropylphenol was a promising herbicide for weed eradication in linseed and peas.

Table 2

The concentrations of the ammonium salts of some 2,4-dinitro-6-alkyl phenols required to induce a standard level of response as measured by mortality of the plants, severe leaf necrosis or stem damage. (Spray applications equivalent to 105-115 gal/ac of solution).

Species	Criterion of Response	Equi-effective Concentration (g/100 ml) -methyl	-sec-butyl	-isopropyl
Sinapis alba	50% kill	0.040	0.017	0.017
	" "	0.063	0.009	0.009
	" "	-	0.018	0.029
Helianthus annuus	" "	0.145	0.063	0.140
	" "	0.079	0.029	0.025
	" "	-	0.114	0.100
Linum usitatissimum	" "	0.60	0.17	0.40
	" "	0.50	0.22	0.63
	" "	0.51	0.14	0.18
	" "	-	0.044	0.100
	" "	-	0.065	0.195
Pisum sativum	Stem damage	1.00	0.47	1.00
		0.27	0.11	0.20
		0.48	0.11	0.14
Hordeum vulgare	Leaf necrosis	1.0	0.27	0.60

The field investigations - undertaken with compounds of 98% purity - were divided into two categories; those trials concerned with observing the direct effects on different weed species and those relating to the effects on clean or weed infested crops. The weed data are very extensive, the interactions between species, compound and formulation often complex, while within experiments the probit regressions are sometimes not parallel. Therefore the data have again been selected to bring out the main features.

In the earlier experiments only the ammonium salts were compared and it was found that the isopropyl, as against the normal propyl compound, was consistently more phytotoxic. The relative effectiveness of the *sec*-butyl, *sec*-amyl and isopropyl derivatives was linked with the species while the order of injury to peas was *sec*-amyl > *sec*-butyl > isopropyl > *n*-propyl.

Since from the viewpoint of commercial formulation ammonium salts or the dinitrophenols themselves present difficulties, in later experiments the more soluble triethanolamine salts were included. The complexity of the relationships between species, formulation and the activity of the isopropyl and *sec*-butyl dinitrophenols is illustrated in Table 3. It is to be noted, that taking the triethanolamine salt of the *sec*-butyl compound as a standard over all formulations the isopropyl derivative is more toxic to the first four species and less so to the remainder. Combining the data of both compounds the ammonium salt on average is the most effective and the acid the least. There are clearly also many exceptions: for example the high toxicity of the isopropyl phenol to R. raphanistrum and it's low toxicity to S. media.

Table 3

The relative toxicity of 2,4 dinitro-6-isopropylphenol and 2,4 dinitro-6-sec-butyl-phenol, when applied as the acid * or either the ammonium or triethanolamine salt, to different species of annual weeds. (For comparative purposes the concentration of the triethanolamine salt of the secondary butyl compound causing a 50% mortality has been equated to 1. Spray applied at rate equivalent to 100 gal/ac).

	Relative toxicity					
	isopropyl			sec-butyl		
Weed Species	acid	NH_4	amine	acid	NH_4	amine
Polygonum convolvulus	0.7	0.6	0.6	0.7	0.9	1.0
Sinapis arvensis	-	0.3	0.9	1.3	0.7	1.0
Sinapis alba	1.3	1.0	0.8	3.0	0.8	1.0
Chenopodium album	1.2	1.0	0.7	1.2	1.0	1.0
Chrysanthemum segetum	2.2	1.3	1.7	2.2	0.9	1.0
Raphanus raphanistrum	0.4	1.7	1.7	1.0	0.7	1.0
+Stellaria media	8.0	1.6	3.9	2.8	0.9	1.0

+ response measured as 50% reduction in ground cover

For the other species investigated and comparing only the ammonium salts the isopropyl compound is more lethal to Matricaria ssp. inodora, Polygonum aviculare, Thlaspi arvense, less effective against Fumaria officinalis and Capsella bursa-pastoris while for Urtica urens the two compounds are equal. It should however be emphasized that for some species the conclusions are based on only a single experiment.

Table 4 gives the results of six experiments on peas in which the yield data have been recorded. Experiments 2 and 3 were on relatively weed free crops, in experiments 5 and 6 the plots were cultivated after the observations on weed mortality had been carried out and in experiment 4 the dominant weed was S. arvensis. In experiments 1-4 the yields are given in terms of dry peas but in experiments 5-6 at the National Vegetable Research Station, Wellesbourne the green pods (variety Onward) were collected and weighed. Comparing the general means of the two compounds there are no significant differences in experiments 2, 4, 5 and 6, while in experiment 3 the yield is higher for the isopropylphenol. There are significant interactions between compound and formulation. In experiment 5 the yield is highest for these plots treated with the amine salt of the isopropyl compound and in experiment 1 this holds for the ammonium salt. The mean yield for the "triethanolamine" treatments in experiment 4 is greater than that for the "ammonium" treatments. Where the two phenols as such were included they do not differ in their action from their salts in experiment 2, while in experiment 1 at least for the sec-butyl phenol the ammonium salt at the highest rate is more toxic.

* In this and subsequent tables comparisons between compounds or formulations are on an equivalent acid basis.

To sum up, the field results confirm the findings of the pot culture experiments that the dinitro-*iso*propyl phenol is on balance more selective than the corresponding *sec*-butyl compound while there is less likelihood of damage to the crop if the ethanolamine salt is employed, particularly if the amount exceeds 2 lb/ac. However, where the most susceptible annual weeds can be controlled at low concentrations e.g. *S. arvensis* the ammonium salt because of its greater potency can be applied at lower and "safe" concentrations.

Because of the unequivocable evidence in the pot culture tests that the *iso*propylphenol is less phytotoxic than the *sec*-butyl compound to *L. usitatissimum* no attempt was made to reassess the difference in field trials involving clean crops but two experiments on weedy crops were carried out at the University Field Station in 1955 and 1956. However, in order to interpret the interacting effects of the treatments on the crop and the weeds in each year hand weeded control plots were included.

In 1955 the mixed weed population contained *P. convolvulus*, *P. aviculare*, *Papaver rhoeas*, *Veronica spp.* etc., and there was little to choose in herbicidal efficiency between compounds though the ammonium salts were more effective. In 1956 the two principal species were *P. convolvulus* and *C. album* and again the mean effective kill caused by the two compounds was of the same order.

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Table 4

The comparative effects of 2,4-dinitro-6-isopropylphenol and 2,4-dinitro-6-sec-butyl-phenol on the yield of peas when applied as the acid or the ammonium or triethanolamine salts. (The quantities of material cited in the table were applied in 80-100 gal of water).

	Expt. 1		Expt. 2		Expt. 3		Expt. 4		Expt. 5		Expt. 6	
	Rate lb/ac	Yield cwt/ac	Rate lb/ac	Yield cwt/ac	Rate lb/ac	Yield cwt/ac	Rate lb/ac	Yield cwt/ac	Rate lb/ac	Yield ton/ac	Rate lb/ac	Yield ton/ac
Sec. butyl												
NH_4	0.5	27.2	0.5	18.1	0.5	21.8	0.75	16.3	0.5	4.15	0.5	0.93
Salt	1.0	27.3	1.0	19.2	1.0	20.1	1.5	16.8	1.0	4.26	1.0	1.22
	2.0	24.4	2.0	16.8	2.0	18.5	3.0	11.1	2.0	3.87	2.0	1.13
	4.0	16.0	-	-	-	-	-	-	-	-	-	-
Triethanol-amine	-	-	0.5	17.4	0.5	19.1	0.75	17.1	0.5	4.56	0.5	0.94
Salt	-	-	1.0	18.2	1.0	19.5	1.5	16.8	1.0	3.87	1.0	1.05
	-	-	2.0	18.2	2.0	20.9	3.0	17.7	2.0	4.36	2.0	1.29
Acid	0.5	26.4	0.5	18.6	-	-	-	-	-	-	-	-
	1.0	25.0	1.0	18.9	-	-	-	-	-	-	-	-
	2.0	27.7	2.0	18.8	-	-	-	-	-	-	-	-
	4.0	22.3	-	-	-	-	-	-	-	-	-	-
Isopropyl												
NH_4	0.5	26.0	0.5	20.1	0.5	22.2	0.75	17.8	0.5	4.17	0.5	0.89
Salt	1.0	23.0	1.0	17.0	1.0	21.8	1.5	15.7	1.0	4.07	1.0	1.17
	2.0	25.5	2.0	15.8	2.0	22.7	3.0	8.1	2.0	3.94	2.0	1.10
	4.0	24.0	-	-	-	-	-	-	-	-	-	-
Triethanol-amine	-	-	0.5	16.9	0.5	22.0	0.75	16.8	0.5	4.56	0.5	1.14
Salt	-	-	1.0	17.5	1.0	21.4	1.5	17.8	1.0	4.36	1.0	1.14
	-	-	2.0	18.6	2.0	21.5	3.0	15.9	2.0	4.46	2.0	1.27
Acid	0.5	25.2	0.5	19.6	-	-	-	-	-	-	-	-
	1.0	25.9	1.0	18.7	-	-	-	-	-	-	-	-
	2.0	21.0	2.0	17.2	-	-	-	-	-	-	-	-
Control	-	23.4	-	17.9	-	21.2	-	13.9	-	4.09	-	0.74
Sig. diff. ($P = 0.05$)	-	4.7	-	N.S.	-	3.5	-	2.16	-	N.S.	-	0.27

Table 5

The comparative effects of 2,4-dinitro-6-isopropylphenol and 2,4-dinitro-6-sec-butyl-phenol on the yield of Linum usitatissimum (linseed) when applied as the ammonium or triethanolamine salts.

Compound	Rate of application lb/100 gal/ac	Yield of seed-cwt/ac Expt. 1	Expt. 2
Isopropyl- NH_4 salt	1	9.19	8.83
	2	8.63	12.33
	4	3.83	5.43
Triethan-olamine salt	1	9.05	6.66
	2	8.82	11.33
	4	10.1	14.43
Sec.-butyl- NH_4 salt	1	8.91	10.57
	2	5.82	7.67
	4	2.07	2.03
Triethan-olamine salt	1	8.69	7.00
	2	6.85	10.97
	4	7.87	9.60
Control (not weeded)		4.72	3.83
Control (weeded)		10.61	12.30
Sig. diff. (P = 0.05)		3.38	2.88

Inspection of Table 5 shows firstly that in each year weed competition greatly reduced the yield and secondly that the best of the herbicidal treatments were equal in performance to hand weeding. Over all combinations of amount and formulation a higher level of seed production has resulted from spraying with the isopropyl compound. Compared to the triethanolamine salts the ammonium salts are more injurious to the crop when this is not offset by a more effective control of the weeds. For optimal level of yield little advantage is to be gained from exceeding 2 lb/100 gal/ac.

Although the field experiments have concentrated on peas and linseed a single experiment was conducted on Medicago sativa in the early vegetative phase when a range of the ammonium salts of both compounds were compared. Again the isopropyl derivative proved to be less injurious to the crop.

To conclude the present findings have amply demonstrated the superior selectivity of 2,4 dinitro-isopropylphenol for the general control of dicotyledenous annual weeds in linseed, peas and possibly lucerne, save perhaps if S. media is the dominant weed (Table 3). The general evidence is that the triethanolamine salt is "safer" but for those species of weed where the ammonium salt is more toxic, the lower concentration demanded may be equally selective.

Finally it has already been indicated that this account summarises many investigations which have been undertaken either singly or severally by research workers within the Department or by the ARC Unit of Experimental Agronomy. The laboratory and pot culture investigations cited were largely carried out by R. S. Bruce while the field work was undertaken by J. D. Fryer, J. G. Elliott, K. Holly and R. J. Chancellor. For the pea experiments at the Vegetable Research Station and the Norfolk Agricultural Station we are especially indebted to H. A. Roberts and C. Parker.

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(7) SIMON, E. W., ROBERTS, H. A. & BLACKMAN, G. E. (1952). Studies in the principles of phytotoxicity. III. The pH factor and the toxicity of 3:5-dinitro-o-cresol, a weak acid. J. exp. Bot. 3, (7), 99-109.

DISCUSSION ON THE PREVIOUS PAPER

Dr. R. E. Slade

Is there any great difference in the toxicity of dinoseb and 2,4-dinitroisopropyl phenol to animals and human beings?

Professor G. E. Blackman

We have not asked the Toxicology Unit of the M.R.C. to carry out specific experiments, but from the information available I should think that there is very little difference. We have, however, no specific information. If the material is likely to be taken up commercially this is the time to start worrying about its mammalian toxicity.

Mr. P. Gregory

Research Report No. C2 to be presented later by Mr. J. D. Reynolds, with which I had something to do, contains data on the susceptibility of weeds to 2,4-dinitroisopropyl phenol which agree with those given by Professor Blackman.

The results are in favour of dinoseb for chickweed, but for knotgrass they are in favour of the isopropyl phenol, however, the picture in the case of knotgrass is not quite as clear. The 2,4-dinitro isopropyl phenol used by Professor Blackman was not of the same grade as that used by us. His was 98% pure whereas ours was 70% pure. That might account for any slight difference.

Research Report No. C.1.

FACTORS AFFECTING THE SUSCEPTIBILITY OF PEAS TO SELECTIVE DINITROHERBICIDES

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Summary

To Part I:

(1) Soil particles blown by wind affect the wax deposits on the pea cuticle, the cuticle itself, and may also damage the epidermal and mesophyll cells. This damage occurs especially on the lower part of the stem and its extent is positively correlated with the wind speed.

(2) Prolonged strong wind alone (without soil blowing) can produce a similar effect although to a lesser degree. Heavy rain at the same time as wind increases the effect of wind only.

(3) The effect of these factors on the pea cuticle results in an increased susceptibility of the pea plant to sprays with dinoseb due to increased retention and probably increased penetration of the herbicide. Severe damage to a pea crop can therefore occur if crops are sprayed with the recommended rate of dinoseb immediately after a heavy storm or after prolonged strong wind on dry soil.

(4) Increasing the time between soil blowing and dinoseb spraying results in decreasing damage by the herbicide due to an apparent recovery of the pea cuticle.

(5) The susceptibility of the peas to wind and soil-blowing and therefore their susceptibility to dinoseb sprays following such conditions increases with increasing age of the plants at the time of blowing. Very young pea plants are highly resistant.

(6) Triethanolamine dinoseb caused less damage to peas after wind and soil-blowing than equivalent rates of ammonium dinoseb.

To Part II:

(1) TCA and dalapon, even at rates as low as 1.5 lb/ac increase the wettability and probably permeability of the surface of peas and therefore increases their susceptibility to dinoseb sprays. This effect appears to be due to an interference with wax formation and excretion.

(2) The TCA and dalapon effect occurs both with foliage sprays and with ground application but in spite of the effect, low dosages of these chemicals do not affect growth and yield of the crop.

(3) Several weeds were found to be affected in a similar way to the peas and the degree of selectivity after spraying a considerably reduced dinoseb dosage on TCA treated crop weed combinations was found to be of the same order as the selectivity after spraying a full normal dinoseb dosage on the untreated crop and weeds.

Introduction

The relative resistance of peas to certain dinitro herbicides, which allows the selective control of a wide range of weeds in this crop is mainly due to the relatively large quantity of hydrophobic nonpolar compounds (waxes) in and on the cuticle of peas as compared with the cuticle of the major weeds.

Quantity and distribution of the waxes in the cuticle affect speed and amount of penetration of herbicides.

Amount and structure of the wax deposits on the cuticle surface affect spray retention (running off (1) and bouncing (2) of droplets) and the formation of air cushions between retained droplets and cuticle surface (3).

Factors decreasing the amount of waxes deposited in and excreted from the cuticle render the pea plant more susceptible to water formulated dinitro sprays. A similar effect is obtained by the swelling of the cuticle due to increased water content (4).

Information on the effect of environmental factors on the formation and structure of waxes is limited and far from complete.

Increasing moisture content of the soil was found to be negatively correlated with wax formation on peas (5). Temperature also influences formation of cuticle and wax, high temperature producing the highest percentage of wax (6).

It was as a result of observations on field crops that the present investigations were initiated. In 1955, a very windy season, a peculiar type of stem damage on peas appeared, suggesting that it might be worth while to do experimental work on the effect of wind and soil-blowing. Other observations of an increased scorch and control of *Polygonum aviculare* by a normal dosage of dinoseb on fields treated with TCA for wild oats, suggested that this problem should also be investigated. Accordingly the paper is divided in two parts dealing with these respective problems.

Part I: The effect of wind and wind-blown soil particles on the pea cuticle and on the susceptibility of peas to dinoseb.

Material and Methods:

The experiments were carried out in the greenhouse.

Peas, - variety Foremost - grown in pans were subjected to the following treatments in several replicated experiments.

(a) Wind blowing at eleven different wind speeds between 0 and 50 m.p.h. for 16 hours.

(b) Rain blowing at 20 m.p.h. wind speed compared with the same wind speed without rain. Both treatments for 8 minutes.

(c) 6 lb clay topsoil was blown at 25 m.p.h. for 4 minutes at pans with peas.

  (i) in one of the experiments subjected to treatment C the time interval between blowing and spraying dinoseb was varied.

  (ii) in another experiment the soil was blown at plants of different heights (ages).

  (iii) in a third experiment the effects of ammonium and triethanol dinoseb were compared.

All peas in these experiments except controls and experiment C (iii) were later sprayed with 2.31 lb/ac dinoseb (triethanolamine) in 60 gal of water.

Results:

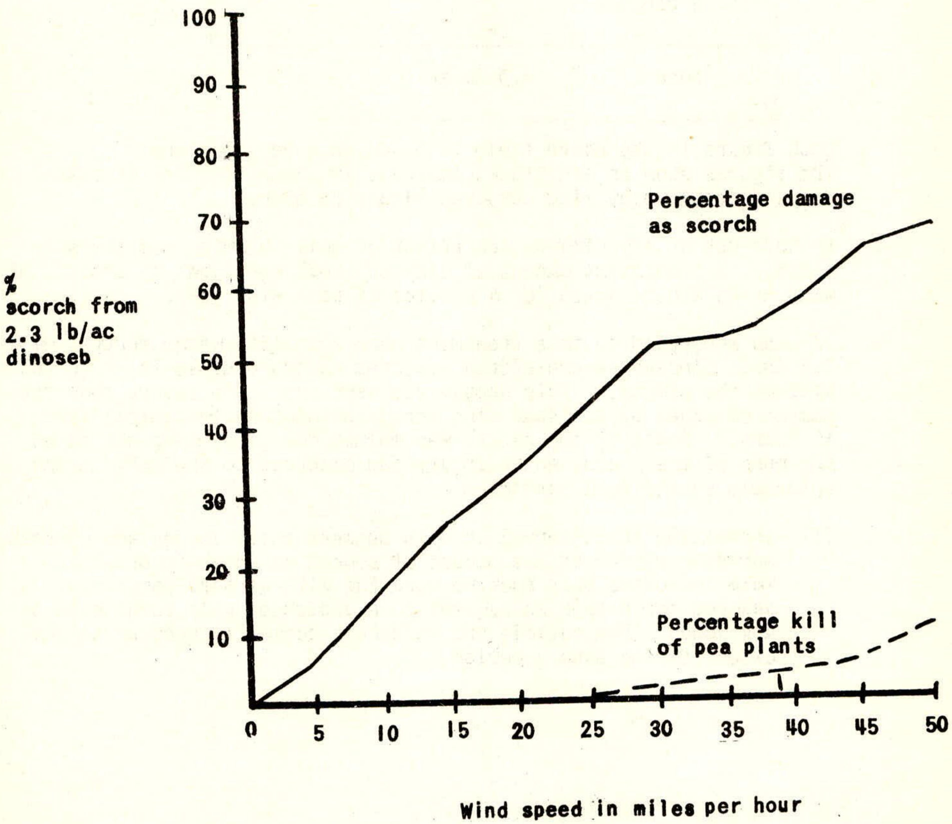
(a) Effect of wind alone at various speeds

Graph 1 shows a positive correlation between wind speed and damage (percentage scorch and percentage kill) caused by the dinoseb spray 28 hours after the wind-blowing was finished.

Cuticular injury was particularly noticeable where plants had rubbed against each other at high wind speeds. Dinoseb often killed the stem tissue at this point. The lower leaves of plants subjected to winds over 20 m.p.h. also often showed bad scorch after spraying with dinoseb.

Graph 1: Effect of wind at various speeds on susceptibility of peas to dinoseb

Wind blown for 16 hours; plants sprayed 28 hours later with 2.3 lb/ac dinoseb.



(b) Effect of wind-blown rain in comparison with wind alone

The following table shows the result of this experiment. All pans were sprayed with 2.3 lb/ac dinoseb 24 hours after end of the wind or rain treatments.

Table 1:

Pre-treatment	Dinoseb dosage 24 hours later	Percentage scorch
Wind without rain at 20 m.p.h. for 8 minutes	2.3 lb/ac	16
Wind (20 m.p.h.) blowing rain for 8 minutes	2.3 lb/ac	27
None	2.3 lb/ac	9

Each figure in the above table is based on 4 replications. The figures show an additional increase in susceptibility if raindrops were blown by wind compared with wind alone.

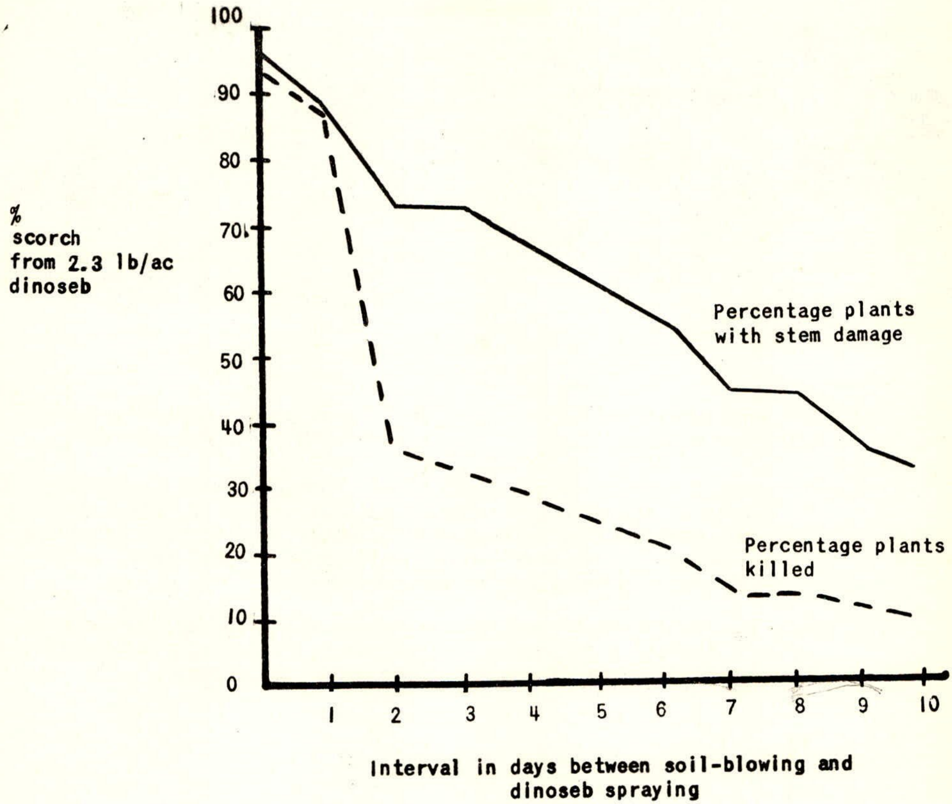
(c) In this set of experiments the effect of soil- blowing was investigated. A consistent amount of clay top soil was blown by artificial wind at 25 m.p.h. speed for 4 minutes at pans with peas.

If peas subjected to this treatment were soon afterwards sprayed with 2.3 lb/ac dinoseb severe scorch appeared which resulted in an 80-90% kill of the plants. This damage was very much more severe than the damage obtained by the same wind speed (without soil-blowing) for 16 hours. Death of the plants was mainly due to dinoseb scorch at the base of the stems, where injury had occurred to the cuticle and epidermis by the soil particles.

(i) Increasing the interval in days between soil-blowing and dinoseb spraying decreased the amount of scorch as shown in Graph 2. This indicates that routine spraying with dinoseb should be delayed for a week subsequent to a prolonged gale force wind on dry land. Pea cuticle and epidermis seemed to recover to some extent during such a period.

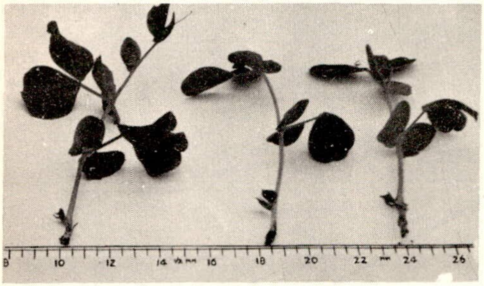
Graph 2

Influence of period between soil blowing and triethanolamine dinoseb spraying on percentage pea plants showing typical stem damage and on percentage plants finally killed.



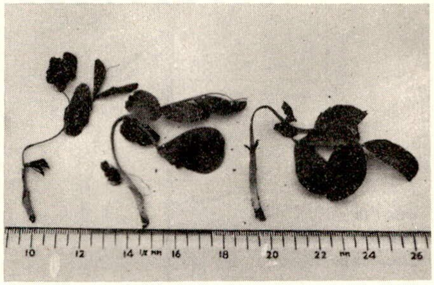
After such blowing a slight smell of crushed peas was noticeable, and there were discolourations (a deeper green) on the stems and leaves. When such peas subsequently grew, badly damaged ones often bent towards the direction from which the soil had been blown. Sections of the stem showed that the epidermal cells were often killed and 2 or 3 layers of mesophyll cells were sometimes damaged too. Dinoseb sprayed on these injured pea plants was retained on the damaged surfaces, and penetrated the injured tissue. Sections of peas (at the stage shown in Photograph 2 right hand side) showed that all living cells of the stem appeared to have been disorganised by dinoseb but the second leaf and the bud were still green and turgid as if the cells of the xylem were still continuing to function satisfactorily. This suggests that once dinoseb is introduced in any quantity into the stem, all unlignified cells are killed. A time interval of a week between soil injury and dinoseb spraying allows for healing by the formation of corky tissue.

Photograph 1



Unblown peas sprayed with 2.3 lb/ac dinoseb

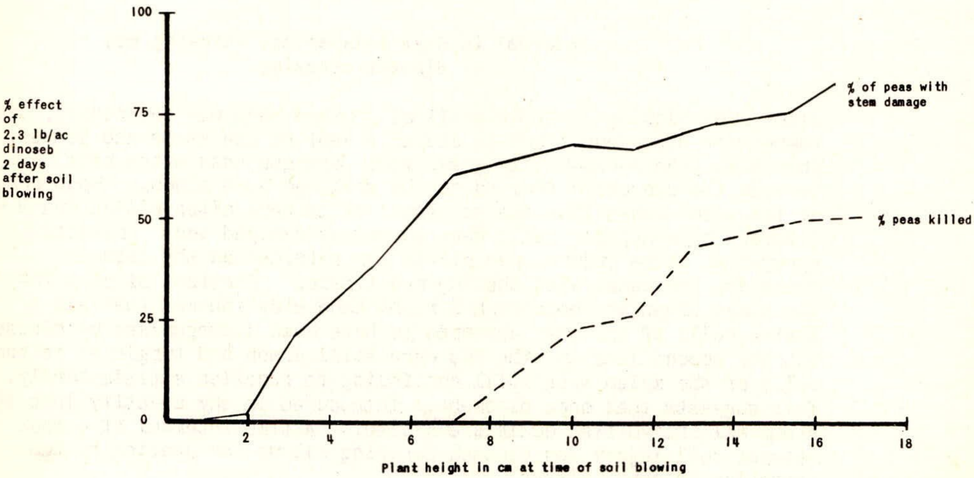
Photograph 2



Soil-blown peas sprayed 2 days later with 2.3 lb/ac dinoseb

(ii) Graph 3 shows that damage to plants increases with increasing height of the plants at time of soil-blowing. Plants under 2 in. when soil-blown were only slightly more scorched than the controls; plants over 7 cm high (1 expanded leaf only) were badly injured resulting in severe scorch.

Graph 3: Percentage of pea plants treated with dinoseb, showing typical stem damage and percentage killed in relation to development stages of plants when soil blown.



(iii) A comparison between the effect of ammonium dinoseb and triethanolamine dinoseb at equivalent rates on peas subjected to soil-blowing showed as expected, a higher toxicity with ammonium salt. The scorch figures obtained at 2.3 lb/ac dinoseb were for ammonium dinoseb 89% and triethanolamine dinoseb 69%. The difference is highly significant.

Discussion

The effect of wind, wind and rain, and wind-blowing soil on pea plants and the susceptibility of such plants to dinoseb sprays is due to these factors injuring cuticle and epidermis and thus increasing retention and penetration of dinoseb.

No convincing evidence has been obtained that wind alone directly affects the wax layers on the cuticle. The injury was found to be mainly an indirect effect of pea stems twisting under the wind force and leaves rubbing against each other.

In the case of wind-blown soil, however, the direct effect of the soil particles can be seen on the wind exposed side of the stem and on the leaves. Quite often this injury is not restricted to the cuticle and epidermal cells can be severely affected.

The damage after dinoseb sprays on the stem is very characteristic and very similar to that found on several of the pea crops sprayed with dinoseb during the 1955 season. After conditions of high wind and soil-blowing the farmer would be well advised to pull up a few pea plants from his crop and examine them carefully. If some surface discolourations are evident, or some soil particles are stuck onto the plants he should delay dinoseb spraying. In cases of severe soil-blowing, a couple of days later the peas will have bent towards the direction from which the wind came; if this occurs at least a week should elapse before spraying to allow the injured parts to heal and the plant to straighten up again.

Part II: The effect of TCA and dalapon on the susceptibility of peas to dinoseb

Materials and methods

The experimental work was first carried out under greenhouse conditions and the main results then verified in field experiments. For most experiments TCA and dalapon were applied to the soil and mixed in before planting the peas.

A description of the main experiments is given in the following table:

Table 2

Expt. No.	In field or greenhouse	Rates in lb/ac			Pea Variety	Chief Weeds	No. of replications
		TCA	Dalapon	Dinoseb triethanol-amine			
d	greenhouse	5	-	2.3	16 different	-	3
e	greenhouse	0,1.5 3	-	2.3	Foremost	-	15
f	greenhouse	0,2,4 8	0,2,4 8	2.3	Foremost	-	6
g	greenhouse	7.5	-	0 to 4.6	Foremost	cleavers knotgrass others	4
h	field	7.5	-	1.15	Foremost	Annual nettle	4
i	field	7.5	5	0-16 vari-able dosage sprayer	Harrisons Glory	Wild oats chalock knotgrass cleavers and many others	12

In the following pages the following terms will appear. They are defined here.

Relative cover is defined as the area of contact between a droplet and the surface on which it rests. The figures quoted of percent increase in relative cover due to TCA pre-treatment of soil is - quotient of the relative cover of 0.01 ml of 500 p.p.m. Teepol solution (calculated from base diameter) on a leaf from treated soil, over the same drop on a leaf from untreated soil. 30 replications were used.

Spray retention is defined as the amount of dinoseb spray retained per plant. It was measured by washing off the spray and measuring the colour in an absorptiometer.

Scorch is defined as the percentage leaf area which is scorched one week after spraying.

Results:

The effect of TCA and dalapon on the wettability of pea leaf surface, the retention of dinoseb sprays, and the scorch damage were assessed in several experiments.

(d) The results of this large experiment using 5 lb/ac TCA on 16 pea varieties are shown in Table 3.

Table 3: Increase due to treating soil with 5 lb/ac TCA

	0.01 ml of 500 p.p.m. Teepol solution	Effect of 2.3 lb dinoseb applied later	
Pea variety	% Increase in Relative Cover	% Increase in Spray retained	% Area of Leaf Scorch
Kelvedon Wonder	68	76	84
Alaska	80	173	79
Canner's Perfection	66	134	79
Canner's 99	43	77	44
Sharpe's Meteor	51	37	59
Gregory's Surprise	78	384	54
Gladstone	77	167	39
Alderman	44	365	84
British Lion	30	116	29
Onward	40	186	69
Early Bird	43	220	39
Harrisons' Glory	86	180	79
Clipper	52	90	64
Pilot	50	57	64
Thomas Laxton	68	105	49
Foremost	117	63	39

All 16 varieties respond to the TCA pre-treatment in all three factors, the figures however, are too variable to allow a comparison between varieties or to draw a conclusion on possible correlations between relative cover, spray retention and scorch.

(e) In another experiment, much more accurate assessments were made on the variety Foremost only, which shows a positive correlation between these factors.

Table 4: Increase as % of control as result of TCA Treatment

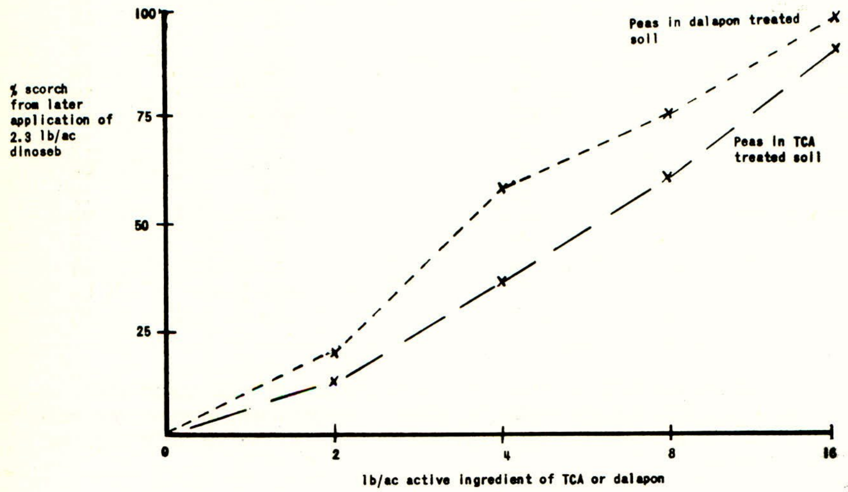
	0.01 ml Teepol solution	Effect of 2.3 lb dinoseb applied later	
Treatment	Relative Cover	Spray Retention	Scorch
Without TCA	0	0	0
1.5 lb TCA	4.54	20.0	105.0
3 lb TCA	16.87	55.0	139.4

The differences between the TCA dosage for each factor are significant.

(f) Dalapon and TCA have been compared in other experiments. At equivalent rates, the increase in relative cover and spray retention are similar but there is a marked trend for dalapon to increase pea susceptibility to scorch from dinoseb more than TCA (Graph 4)

Graph 4

Effect of TCA and dalapon, applied at varying rates, on scorch by 2.3 lb/ac dinoseb in 60 gal/ac water. Dinoseb scorch is plotted against lb/ac active ingredient of TCA and dalapon

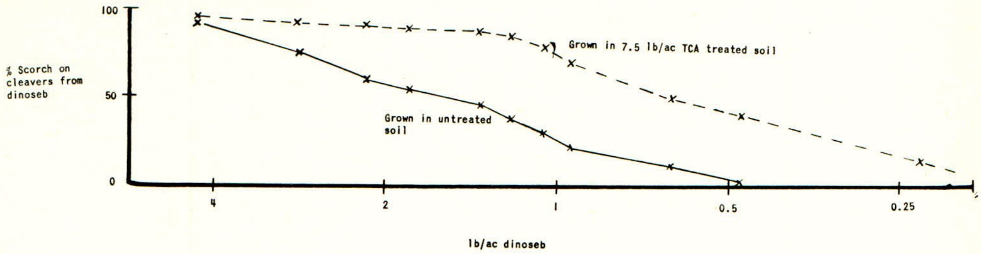


All the results so far discussed indicate that the normal dinoseb dosage used for weed control in peas would have to be reduced if peas are grown on TCA or dalapon treated land. This, of course, would mean unsatisfactory weed control unless the response of weeds to TCA is similar to that of peas. The effect of TCA on dinoseb susceptibility of certain weeds was therefore investigated.

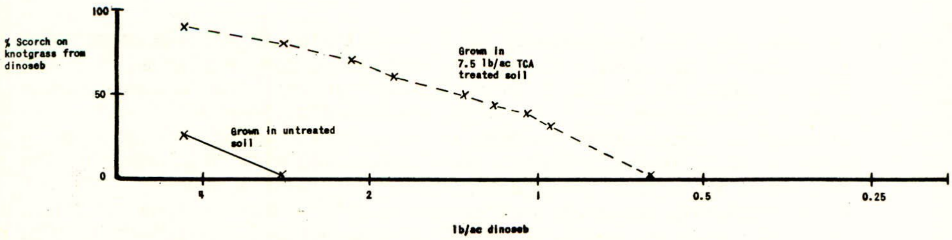
(g) First experiments in the greenhouse on knotgrass, fathen, poppy and cleavers indicated a similar increase in dinoseb susceptibility as on peas. This effect was marked and significant on knotgrass and cleavers; it was less marked but consistent over a certain dosage range of dinoseb on fathen and poppy.

The effect on cleavers was surprising as it is an easily wettable and relatively non-waxy weed (see Graph 5). This result indicated an effect of TCA on permeability of cuticle and possibly of protoplasmic surface layers.

Graph 5: Scorch on cleavers

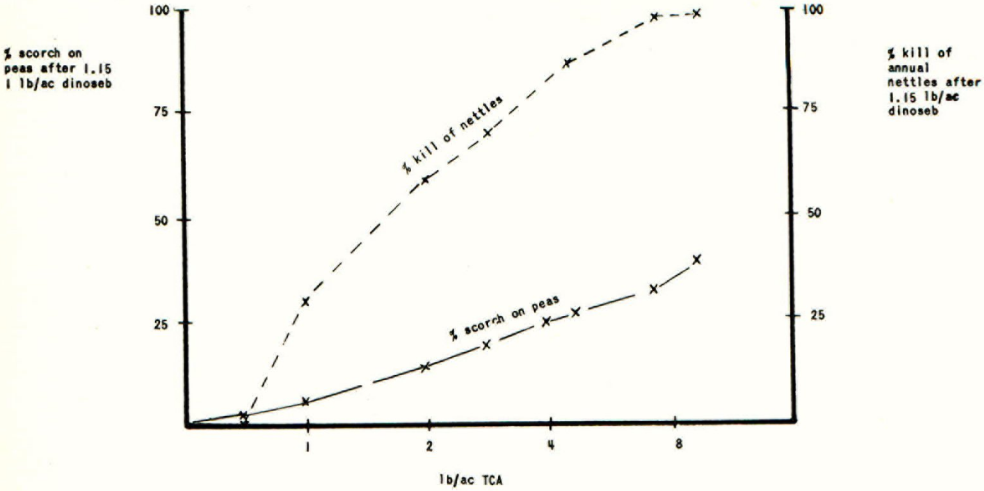


Graph 6: Scorch on knotgrass



(h) A field experiment on annual nettles in peas not only confirmed the greenhouse results but showed a highly significant increase in selectivity by dinoseb on plots which had received more than 1 lb TCA. The stand of nettles looked very similar on TCA treated plots to the control plots, except that the nettles were slightly paler. The results are shown in Graph 7.

Graph 7: Change in scorch of peas and kill of nettles from dinoseb when plants are grown in soil treated with TCA of various rates

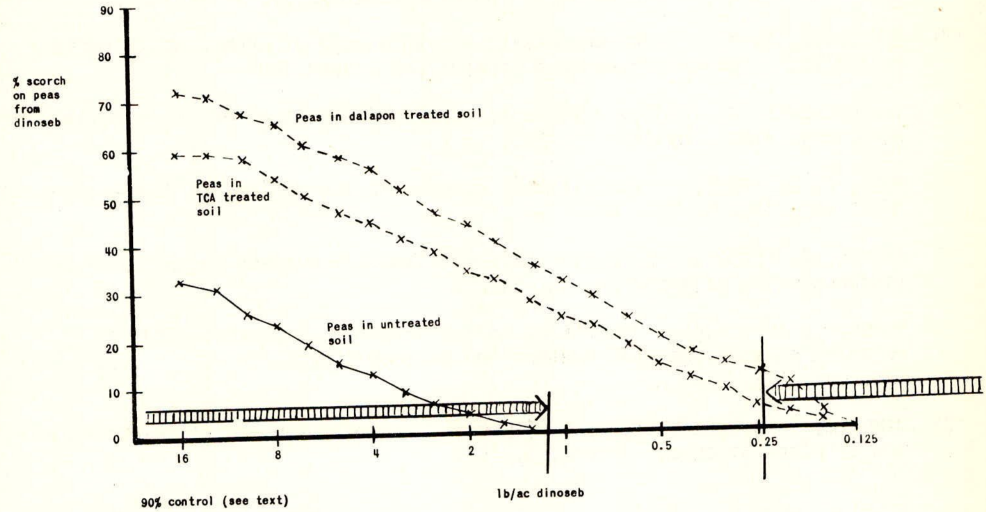


(i) In order to test the validity of the results a large field experiment was laid out in 1956. In this experiment peas were planted on plots treated with 7.5 lb TCA, 5 lb dalapon and on untreated control plots. When the peas were 5 - 6 in. high, dinoseb was sprayed with the Chesterford Logarithmic sprayer at dosages decreasing continuously from 16 lb/ac to 0.125 lb/ac. The main weeds were wild oats (on the untreated plots only), charlock, chickweed, field speedwell, fathen, black bindweed, knotgrass and cleavers. In assessing weed control both wild oats and charlock have been disregarded, the former because it did not appear in the treated plots, and charlock because it was killed throughout down to about 0.125 lb dinoseb. Of the other weeds a 90% control as can be seen from the diagram was obtained with 2.3 lb of dinoseb on untreated soil but only 0.24 lb was needed on the TCA treated land.

The amount of scorch which is normally tolerated by farmers is estimated as 25 to 30%. There was only 4% more scorch on TCA treated peas (i.e. total of 7% scorch) for the same level (90%) weed control on untreated peas. The selectivity therefore was practically maintained at a very much reduced dosage.

Graph 8

Graph showing the reduction of dinoseb rate necessary for weed control on land previously treated with TCA and dalapon



Discussion

The experiment described in Part II of this report shows a marked effect of TCA and dalapon on the wettability and probably of permeability on peas and certain weeds to subsequent sprays with dinoseb. The lower leaves of the pea plants were most affected - this is in agreement with the work by Tibbits & Holm (7) who have shown that most TCA is accumulated in these lower leaves if TCA was applied to the soil. Knowledge of the mode of action of TCA and dalapon in plants is still incomplete and no attempt is made in this paper to explain the mechanism of their effect on wax formation and excretion.

The experimental results showed that relatively easily wettable and non-waxy plants such as the annual nettle respond to a pre-treatment with TCA even more than the highly waxy peas. This indicates that factors other than wax formation and excretion which lead to increased susceptibility are also affected.

The selectivity of dinoseb spray for the control of a number of weeds in peas on TCA treated land was found to be of the same order as on untreated crop-weed combinations. The dosage of dinoseb in agricultural practice often will have to be reduced to obtain equivalent selectivity. The factor by which the dosage of dinoseb should be reduced is, however, not constant and may vary between a very slight reduction which could be commercially ignored and a reduction by threequarters of the normal dosage. Work on a very simple field method to determine the necessary reduction in dinoseb for a crop is in progress.

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DISCUSSION ON THE PREVIOUS PAPER

Prof. G. E. Blackman

Are there any morphological differences in your TCA treated plants?

Miss O. R. Dewey

The only morphological difference is the distinctly thinner layer of cuticle.

Mr. E. R. Bullen

Is there any difference in leaf size following the use of TCA or dalapon?

Miss O. R. Dewey

There is no appreciable difference in leaf size following TCA treatment, but there may be an increase in leaf size from dalapon treatment.

Mr. W. H. Booth

Have you any information to indicate whether or not treatment with TCA can affect the intake of MCPB by peas?

Miss O. R. Dewey

No work on those lines has been attempted.

Mr. W. H. Booth

Have you done any work with MCPA following TCA treatment?

Miss O. R. Dewey

No direct work yet but I expect that with the decreasing amount of wax in the pea cuticle the result of hormone treatment after TCA would be the same as that for dinoseb; that is a reduced rate should follow - but by how much we are not quite sure.

EXPERIMENTS WITH DINITRO COMPOUNDS FOR WEED CONTROL IN PEAS, 1954-55

J. D. Reynolds, Pea Growing Research Organisation, Research Station, Yaxley, Peterborough.

Summary

1. Two comprehensive experiments, each involving a total of 144 plots were carried out in 1954 in conjunction with Fison's Pest Control Ltd., to compare three salts of dinoseb and its isopropyl homologue, each at three dosage levels and at high and low volume application.

2. Best results were given by the triethanolamine salt of dinoseb at the high air temperatures prevailing. The ammonium salts were more phytotoxic and the sodium salts gave poorer weed control. Differences between the two acids were slight but tended to favour dinoseb.

3. It is suggested that triethanolamine dinoseb could replace the ammonium salt with advantage in commercial practice where higher temperatures obtain. Triethanolamine dinitroisopropylphenol or the sodium salts of either of the two acids would be useful substitutes for triethanolamine dinoseb if manufacturing or economic factors favoured one of these compounds instead.

4. Results supported earlier work in demonstrating that the dangers of low volume application have been overrated. This was confirmed by further experiments in 1955.

5. In terms of yield, inter-row hoeing, simulating tractor inter-row cultivation, was as effective as, or superior to, the best chemical treatment in both years. As previous experiments have shown, there is much to commend the cheaper tractor tool-bar method of weed control.

Introduction

The effectiveness of the ammonium salt of dinoseb for controlling weeds in peas, assessed in field experiments from 1948 onwards, was described at the last Conference. (1) Concurrent investigations in the United States by Seely (2) suggested that the ammonium salt and particularly the sodium salt of 2,4-dinitro-6-isopropylphenol - the isopropyl homologue of dinoseb - were superior to ammonium dinoseb against weeds in this crop. In addition, other work carried out in this country in 1951 (1,3) revealed a greater degree of selectivity of the triethanolamine salt of dinoseb compared with the ammonium salt of the same acid.

As a result of these findings it was decided to lay down experiments in 1954 to compare the three salts of the two acids each at three dosage levels, and at high and low volume rates of application. A summary of the results has already been published. (4) Low volume treatments were included in view of the satisfactory results given in experiments in 1952-1953 (5) and the increasing use of low volume sprayers on farms. The investigation was extended in 1955 by experiments which tested low volume application of the triethanolamine salt of dinoseb.

Experimental Methods and Results

1954 experiments

Two experiments of split-plot design were laid down at Brampton and Hilton, Hunts. "Whole plot" treatments comprised all combinations of the two volumes and three dosages, and the six chemicals together with hoed and untreated controls formed the "sub-plot" treatments. Thus there were 48 different treatments and these were replicated three times to give 144 plots per experiment. Each plot was 0.0025 acre and the chemicals were applied by knapsack sprayers at a fairly low but constant pressure. Volumes and dosages were as follows:-

At low volume (15 gal/ac)

0.9 (Low), 1.5 (Medium) and 2.5 (High) lb/ac a.e.

At high volume (60 gal/ac)

1.5 (Low), 2.5 (Medium) and 4.0 (High) lb/ac a.e.

Spraying was carried out in early May when the peas (marrowfats for harvesting dry) were 2-3 in. high with four expanded leaves of "semi-hard" appearance. Details of weather conditions at the times of spraying are given below:-

	Brampton	Hilton
2 days before	Sunny, very warm	Sunny, warm
1 day before	do.	Sunny, very warm
Day of spraying	do. (75-82°F.)	do. (80°F.)
1 day after	do.	do.
2 days after	Cooler	do.
3 days after	Cold, light rain for 5 hours.	do.

Hoeing was done once by hand on the appropriate plots about two weeks after spraying; weeds in and close to the rows of peas were ignored so as to simulate tractor-hoeing.

Percentage kills of the predominant weed species calculated from counts made in permanently defined areas chosen at random within each plot of one replication only, on the day of spraying and again 12-14 days later, are presented graphically in Appendix I. Yield data are tabulated in Appendix II.

1955 experiments

Data on the effect on weeds and yield of the different chemicals tested in 1954 indicated that triethanolamine dinoseb was the most promising chemical. It was therefore decided to carry out further experiments in 1955 to compare a range of dosages and volumes of this chemical with the object of securing more information on the possibilities of low and very low volume application and the maximum safe dosages that can be employed.

Experiments were laid down in pairs at two centres at Kimbolton, Hunts, and Littleport, Cambs., one being harrowed and/or completely hoed according to normal farming practice to eliminate the interaction of weed control and the effect of the chemical on the crop.

A split-plot design was again employed, "whole plots" consisting of four dosage rates (0.9, 1.4, 1.9 and 2.3 lb/ac a.e.) and "sub-plots" comprising four volumes (60, 30, 15 and 7.5 gal/ac) together with hoed and untreated control plots. This hoeing was done by hand between the rows only, to simulate a tractor toolbar, but in the case of the completely hoed experiments, hand-weeding was carried out as well on the plots concerned. The 24 different combinations were replicated six times and individual plot size was approximately 0.0025 acre. Spray applications were made in May when the peas (marrowfats) were 4-8 in. high with 4-6 expanded leaves.

Weed density estimations were made before and after spraying at both centres. Low temperatures prevailed at the times of application and weed kill was poor in consequence, especially at Littleport. Although some scorching occurred it was clear that higher dosages could have been applied. The area occupied by the completely hoed experiment at Kimbolton became waterlogged later in the season. Yield data was obtained only from the other experiment at Kimbolton.

Discussion

In the 1954 experiments low volume application, in general, gave better weed kill than high volume, especially when equal dosages are compared. Differences were less marked, however, at Hilton. Ammonium dinoseb proved very effective against chickweed, and triethanolamine dinoseb was also good in this respect. Considering the effects on the principal weed species collectively, results suggested that the two sodium salts were inferior to the other salts, and that dinitro*iso*propylphenol was very slightly inferior to dinoseb. The similarity of the two acids in this respect has been observed elsewhere (6). It is of interest to note, however, that ammonium dinitro*iso*propylphenol gave better control of black bindweed than ammonium dinoseb (Brampton) and that the sodium and triethanolamine salts of dinitro*iso*propylphenol were more effective than the corresponding salts of dinoseb against knotgrass (both centres).

Severe scorch was caused by both ammonium salts on some plots at both centres within a few hours of spraying and in terms of least crop damage the sodium and triethanolamine salts were to be preferred. This phytotoxicity of ammonium by comparison with triethanolamine salts is now well known (6, 7, 8). The greater selectivity of the sodium and triethanolamine salts was reflected in the resulting yields which were at least 20 - 50% above those given by the untreated plots. The ammonium salts, on the other hand, frequently yielded less than the untreated controls, particularly at the higher dosage levels.

However, it is pertinent to recall that the air temperature at both centres at the time of spraying was at least 80°F which is well above the accepted safe limit for ammonium dinoseb application. At somewhat lower temperatures differences in efficiency between the three salts would probably have been less marked. It was nevertheless clear that the sodium and triethanolamine salts were safer to use at high temperatures; these salts never depressed yields, even at the highest dosage rates tested.

Comparing the two acids differences in yield were insignificant, as has been found elsewhere (7). The ammonium salt of dinitro*iso*propylphenol, however, was slightly more selective than ammonium dinoseb. So far as application rate was concerned, low volume was as effective as high volume both as regards degree of weed eradication and resulting yield.

At Brampton, widely-sown rows permitted efficient inter-row hoeing which proved comparable, in terms of yield, to the most effective chemical treatment. Inter-row cultivation at Hilton was rendered difficult, however, by the narrow row width; as a result higher yields were given by the chemicals, excepting the ammonium salts.

In view of the difficulties encountered no weed kill or yield figures in respect of the 1955 experiments with triethanolamine dinoseb are presented. Data obtained, however, showed a slight trend in favour of low and very low volume over high volume in regard to yield; differences in extent of weed destruction were small and showed no consistent trend. At each application rate, best results in terms of weed kill and yield were given by the highest dosage which suggests that this dosage was below the optimum level in relation to the conditions obtaining. Hoeing was the most effective treatment, if yield is regarded as the criterion.

Conclusions

The 1954 experiments gave results which favoured the sodium and triethanolamine salts of dinoseb and dinitro*iso*propylphenol for chemical weed control in marrowfat peas compared with the ammonium salts of those acids, especially when high temperatures obtain. Since 1. the ammonium salts caused scorching which was reflected in reduced yields, 2. the sodium salts gave poorer weed control than the other salts, and 3. dinitro*iso*propylphenol was, in general, slightly inferior to dinoseb both as regards weed kill and yield, it was concluded that triethanolamine dinoseb was the most effective of the chemicals tested. Applied at any given dosage rate it gave a weed kill comparable to ammonium dinoseb, caused no scorching or other adverse effect on the crop even at 4 lb/ac a.e. and produced the highest yields.

Economic factors aside, results indicated that triethanolamine dinoseb could well replace the ammonium salt in commercial practice, especially at high temperatures; at lower temperatures ammonium dinoseb would be the better proposition. At the same time triethanolamine dinitro*iso*propylphenol or the sodium salts of dinoseb or dinitro*iso*propylphenol could be useful substitutes if manufacturing and economic aspects favoured one or other of these compounds rather than triethanolamine dinoseb.

Further evidence was secured from both the 1954 and 1955 experiments to support the contentions that 1. the dangers of low volume application have been exaggerated (5) and that 2. in terms of yield response and cheapness, there is much to be said in favour of cultural weed control (1).

Acknowledgement

The work described in this report was carried out jointly with Fisons Pest Control Ltd., and the author wishes to acknowledge particularly the co-operation of Mr. P. Gregory, Chesterford Park Research Station, Saffron Walden.

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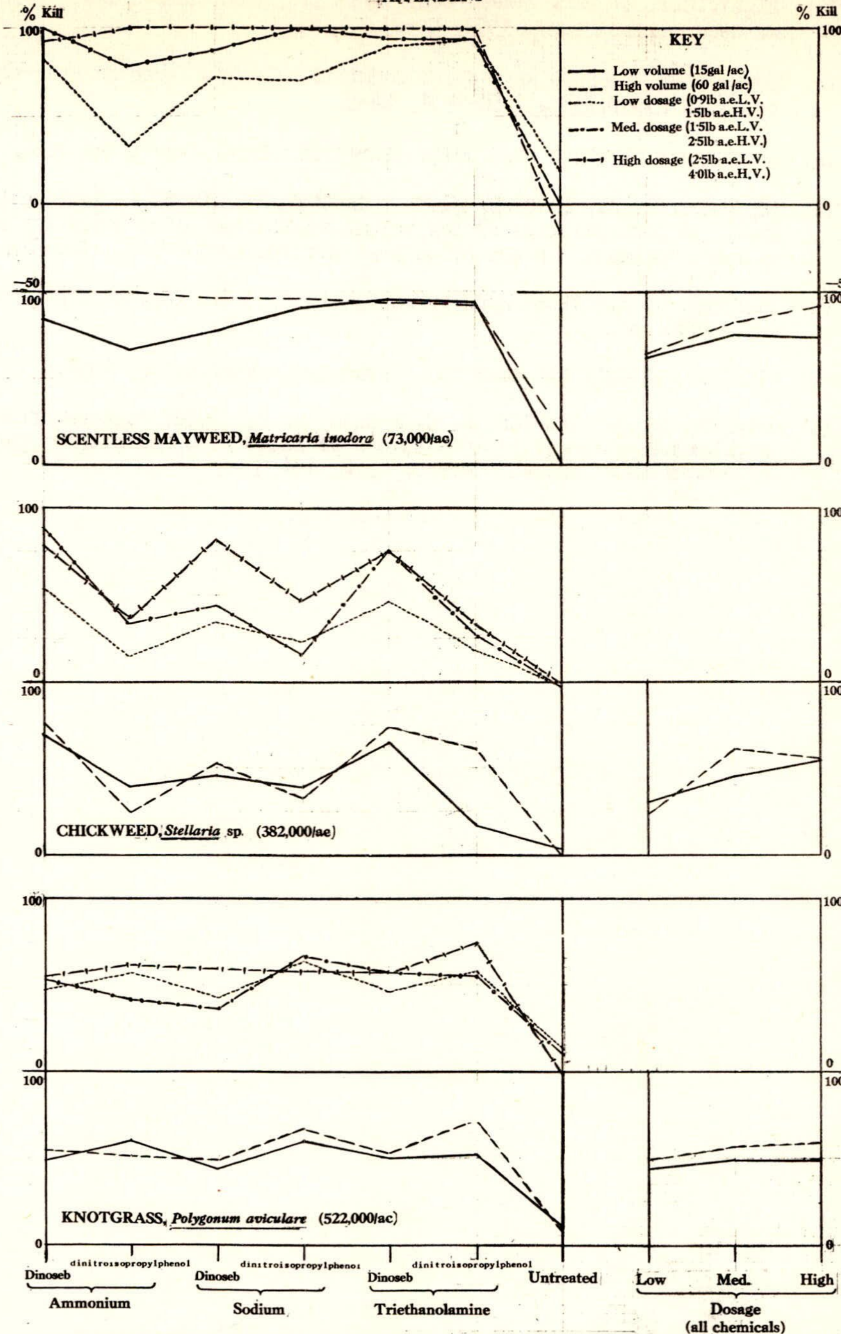

Figure 1. WEED CONTROL AT BRAMPTON (Numbers in brackets denote populations prior to spraying)

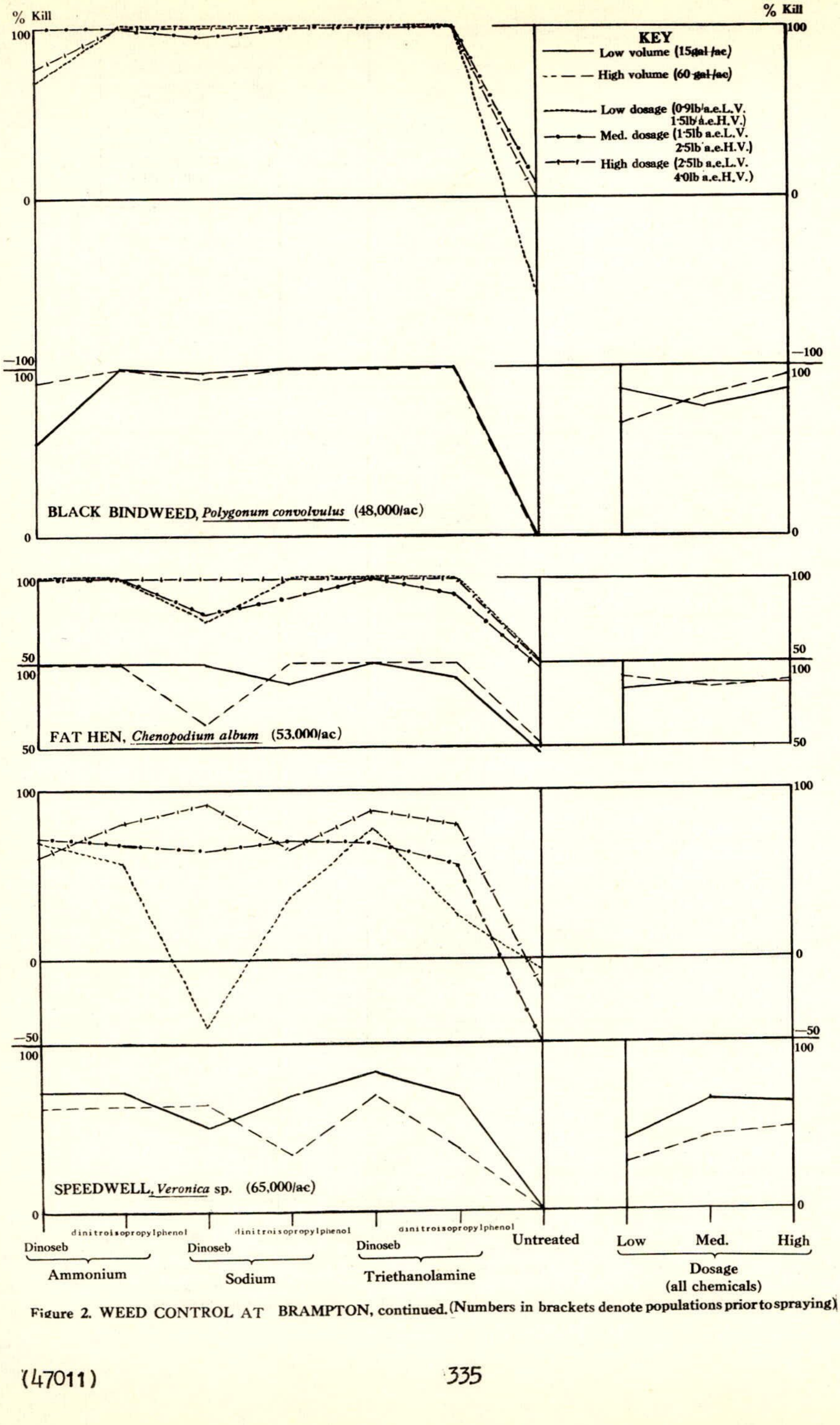

Figure 2. WEED CONTROL AT BRAMPTON, continued. (Numbers in brackets denote populations prior to spraying)

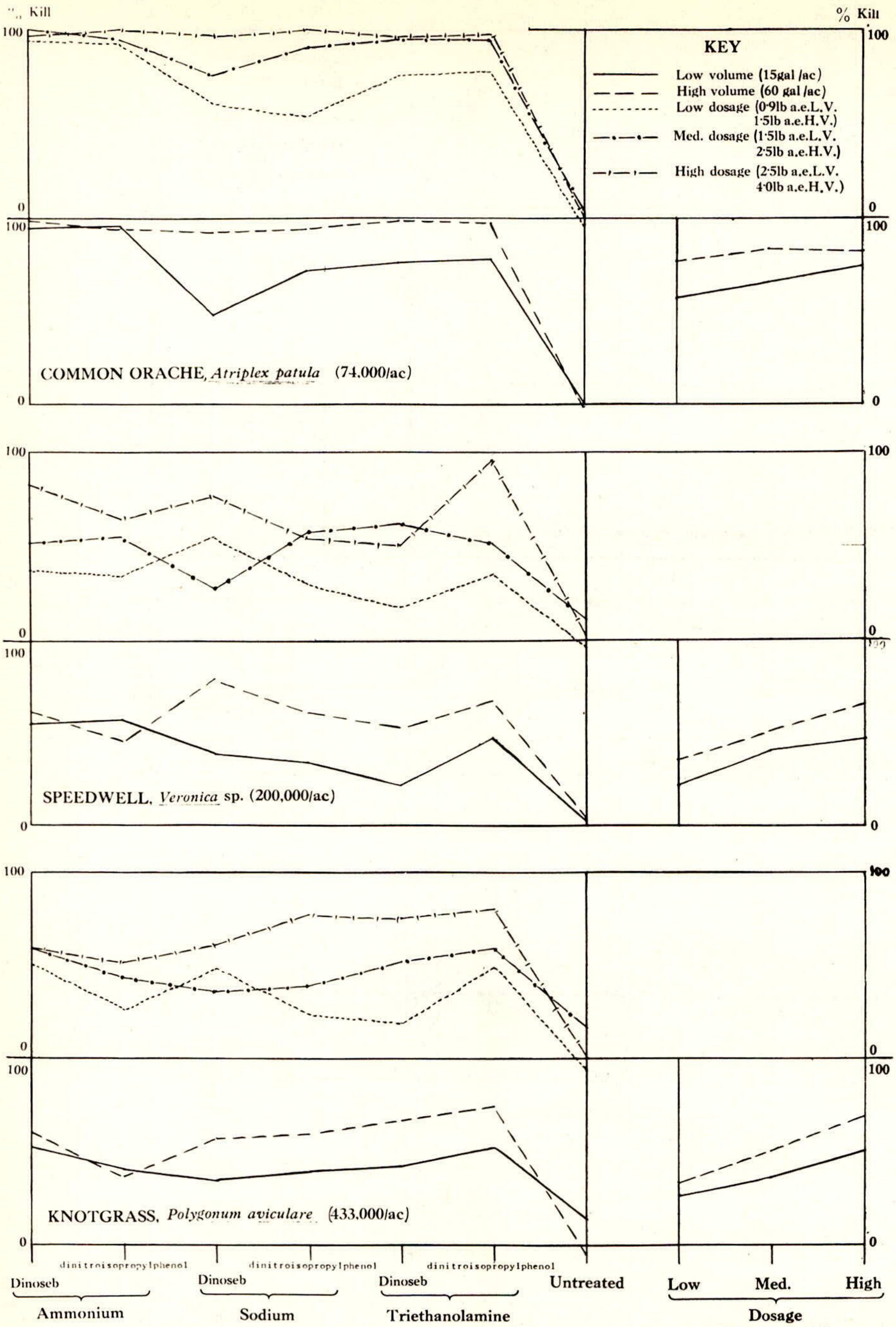

Figure 3. WEED CONTROL AT HILTON (Numbers in brackets denote populations prior to spraying)

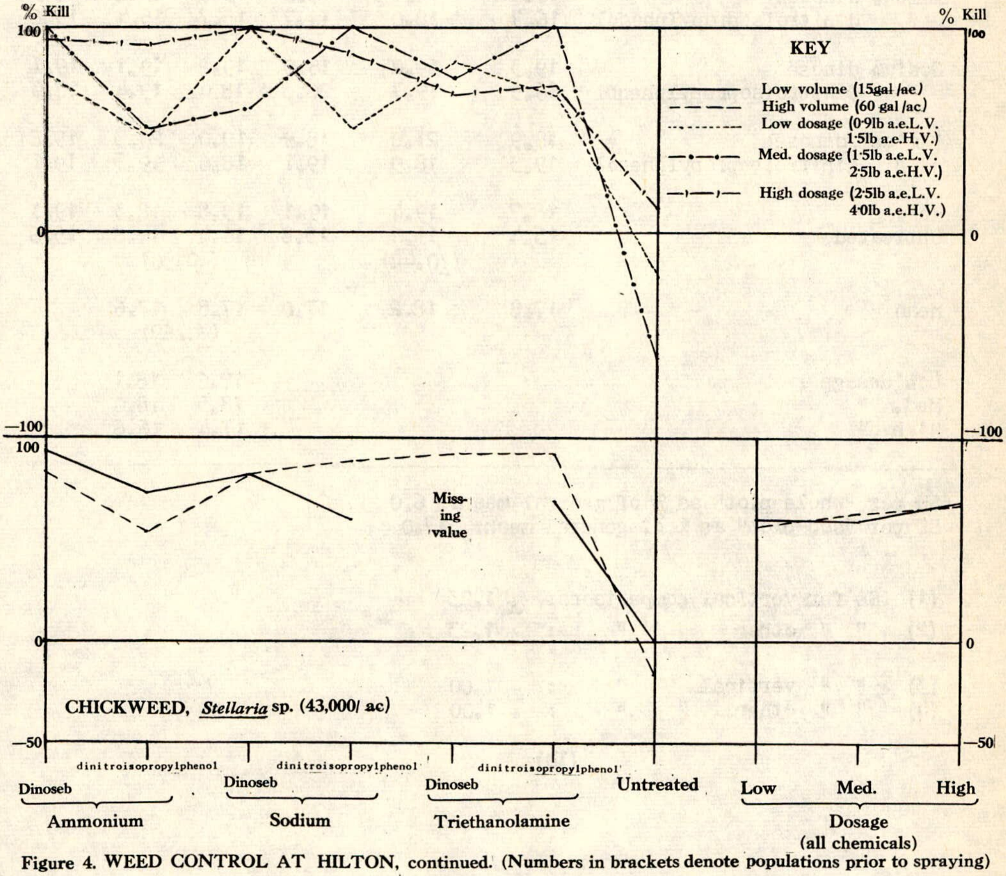

Figure 4. WEED CONTROL AT HILTON, continued. (Numbers in brackets denote populations prior to spraying)

APPENDIX II

Mean Yields of Treatments: 1954 Experiments
(Cwt/ac threshed peas)

Centre: Brampton, Hunts. (Mean Yield of experiment: 17.7 cwt/ac)

"Sub-plot" treatments	Dosage Low	Dosage Med.	Dosage High	Volume Low	Volume High	Mean
		(1) & (2)		(3) & (4)		(+0.71)
Ammon. dinoseb	17.3	14.1	12.2	15.5	13.6	14.5
" dinitroisopropylphenol	16.9	18.0	11.7	15.7	15.4	15.6
Sodium dinoseb	19.3	19.2	18.9	19.2	19.1	19.1
" dinitroisopropylphenol	16.9	19.7	20.3	18.4	19.4	18.9
"Amine" dinoseb	18.9	21.0	18.9	19.0	20.3	19.6
" dinitroisopropylphenol	19.3	18.9	19.1	18.6	19.5	19.1
Hoeing	18.7	19.4	19.1	19.8	18.3	19.1
Untreated	15.4	15.6	15.8	16.4	14.8	15.6
		(±0.44)		(±0.50)		
Mean	17.8	18.2	17.0	17.8	17.6	
				(±0.62)		
Low dosage				17.6	18.1	
Med. "				18.5	18.0	
High "				17.4	16.6	

SE per "whole plot" as % of general mean: 6.0
SE per "sub-plot" as % of general mean: 17.0

(1) SE for vertical comparisons: ± 1.23
(2) " " other " : ± 1.23

(3) " " vertical " : ± 1.00
(4) " " other " : ± 1.00

(10)

Centre: Hilton, Hunts. (Mean Yield of experiment: 7.9 cwt/ac)

"Sub-plot" treatments	Dosage Low	Dosage Med.	Dosage High	Volume Low	Volume High	Mean
		(5) & (6)	(7) & (8)			(±0.67)
Ammon. dinoseb	6.0	5.0	3.3	5.3	4.2	4.8
dinitroisopropylphenol	9.4	5.9	2.3	6.2	5.5	5.8
Sodium dinoseb	10.4	7.7	9.0	10.1	8.0	9.1
dinitroisopropylphenol	10.7	9.2	8.9	10.3	8.8	9.6
"Amine" dinoseb	10.5	7.7	12.0	10.2	10.0	10.1
dinitroisopropylphenol	8.6	10.9	9.3	8.9	10.3	9.6
Hoeing	6.6	8.9	7.5	6.8	8.5	7.7
Untreated	4.9	8.3	6.2	6.6	6.4	6.5
		(±0.49)		(±0.56)		
Mean	8.4	8.0	7.3	8.1	7.7	
				(±0.69)		
Low dosage				9.1	7.6	
Med. "				8.3	7.6	
High "				6.8	7.8	

SE per "whole plot" as % of general mean: 15.2
SE per "sub-plot" as % of general mean: 36.2

(5) SE for vertical comparisons: ±1.16
(6) " " other " : ±1.19

(7) " " vertical " : ±0.95
(8) " " other " : ±0.97

(11)

DISCUSSION ON THE PREVIOUS PAPER

Mr. C. V. Dadd

Mr. Reynolds has just said that peas in narrow rows will give higher yields. He is probably thinking of his early experience with Harrison's Glory. Is that true for the peas we are now interested in from the weed control point of view?

Mr. J. D. Reynolds

My remarks were based on the results of our work with marrowfat peas harvested dry. We do not yet know whether vining peas will react in the same way and there is scope for work in that direction.

Mr. S. J. Willis

As weed control by cultivation is much less expensive than spraying is there a greater financial return from growing in wide rows and cultivating compared with narrow rows and spraying?

Mr. J. D. Reynolds

The only figures I can quote are for trials carried out, using wide rows, in in 1950, presented at the last Conference, where costings showed inter-row cultivation to be the most profitable in nearly all cases. Both spraying with dinoseb and cultivation gave an average of 3 cwt. extra dried peas per acre over no treatment. On the other hand the earlier spacing trials revealed that with wide rows one stood to lose up to 3 cwt per acre compared with narrow rows. Results might well be different for vining peas, and of course, there were comparatively few spacing trials done on marrowfat peas.

A CONTRIBUTION TO THE QUESTION OF THE EFFECT OF LEAF SCORCH BY CONTACT HERBICIDES ON THE YIELD OF CEREALS

P. Gregory

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Summary

I. Winter spraying of winter sown cereals

(i) The positive correlation previously found between the degree of scorch of wheat and the incidence of continued severe frost within fourteen days following the application of activated DNC, is confirmed by a further two years work. This correlation was found to extend to dinoseb and PCP and to barley and oats.

(ii) Reduction of yields due to long periods of frost following closely on the application of contact herbicides was found to occur when plants were killed. No evidence could be obtained that a high degree of leaf scorch alone gave rise to yield decreases.

(iii) Activated DNC at the dosage recommended for winter spraying has proved to be an effective and safe treatment for the control of weeds in all winter sown cereals, provided that spraying is confined to periods free from continued severe frost. In practice this means that winter spraying should be completed before the end of December.

(iv) Dinoseb (triethanolamine) and (ammonium) at the dosage previously suggested, (0.75 lb/ac a.e.), proved as satisfactory as activated DNC, although the degree of scorch was greater. Doubling the dosage of dinoseb gave rise in the event of frost, to some kill of cereal plants and a consequent yield reduction.

(v) PCP (miscible oil) at 1.5 lb/ac a.e., gave yields, on average, inferior to dinoseb and to activated DNC. The degree of scorch was high and almost invariably associated with partial kill of the crop. Doubling the dosage of PCP gave rise, in the event of frost, to a much greater kill of cereal plants and a severe yield reduction.

(vi) Mixtures of low rates of dinoseb and MCPA (sodium) proved as satisfactory as activated DNC from the point of view of weedkill and yield. The degree of scorch was on average even lower than with activated DNC, while in the event of prolonged and severe frost kill of plants was negligible and did not give rise to excessive yield reduction.

II. Spring spraying of spring sown cereals

(i) Activated DNC when sprayed on spring sown wheat, barley and oats did not give more than 20% leaf scorch. Dinoseb (triethanolamine) gave nearly twice as much and dinoseb (ammonium) three times as much scorch as DNC. Yields were not significantly affected by the degree of leaf scorch.

(ii) The intensity of scorch for each chemical was greatest with barley, less with oats and wheat and least with rye.

Introduction

Following the work by Pfeiffer, Gregory and Holmes (1) on the use of dinitro herbicides for the control of weeds in young winter wheat sprayed in the autumn, it was decided to extend the investigations for a further two years.

The aims of this work were:-

(a) To establish whether or not winter spraying is reliable over a period of years and to find what degree of scorch adversely affects the yield of cereal

(b) In addition, the range of chemicals and cereals was extended and the spring spraying of spring sown cereals was included.

In this paper the relationship between scorch and yield and factors influencing scorch are discussed. In addition a comparison is made between the chemicals used.

Full details of the twenty three large yield experiments involved could not be included in this paper.

Materials and Methods

All the experiments here described were carried out in the field on commercially grown crops chosen for their evenness of drilling and the presence of weed populations of the desired species, density and even distribution.

Each experiment was of eight randomised blocks of fourteen treatments including unsprayed controls. Plot size was sixteen square yards.

Spray applications were made with a knapsack sprayer at 60 gal/ac volume. Visual assessments were made of weedkill and corn scorch at various periods after spraying.

The yields of all experiments were recorded.

Temperature records were kept at one site and these records applied to all the results, since distances between them were small.

The following chemicals were used:-

Activated DNC
Dinoseb (ammonium and triethanolamine)
PCP (miscible oul)

The Chesterford Logarithmic Sprayer was used for applying all the sprays in Experiment U. At the sites M to T inclusive, additional strips were sprayed with this machine so as to obtain information on the very wide range of dosage levels that is made possible by this method.

PART I: Winter spraying of winter sown cereals

Two Time experiments were sprayed (L and U) in 1954-55 and 1955-56 respectively at regular intervals over the winter. Temperature was recorded on the site.

The results from these experiments confirm the 1954 experiment which showed that frost after spraying DNC increased the intensity of scorch. Further, the experiments show that the closer to the spraying date that the frost occurs and the longer the duration of the frost, the more serious the damage. Frosts of only one day duration, or a series of such frosts alternating with days of high minimum temperatures appears to have little effect on degree of scorch.

Dinoseb and PCP, when sprayed before frost, show trends closely similar to DNC, although the degree of scorch is nearly always greater.

The table below shows the effect of frost on the degree of scorch from Experiment U at the rate of 4.5 lb/ac activated DNC and 0.75 lb/ac dinoseb (ammonium).

No. of days before frost	Duration of frost	DNC Scorch %	Dinoseb Scorch %
11	1	0	2
6	5	2	20
6	10	2	15
4	9	2	35
0	6	10	82
0	12	85	95

Very severe frost following closely on the date of spraying gave rise not only to a high degree of scorch but also to a kill of cereal plants in some cases. Estimated kill varied from 5 to 100% and was greatest in the oat experiments. Reference to Appendix Table 3 Experiments N and R shows low yields for the PCP treatments and for the higher rates of dinoseb. These treatments were all associated with a marked reduction in plant numbers (40% - 10%). Experiment Q was sprayed one day before frost. Frost also occurred 4th and 5th and continuously from the 16th to 25th day after spraying. Reduction in stand of oats was severe and occurred in all treated plots, reaching as much as 90% in the case of PCP 3 lb/ac.

At Experiment Q, the Logarithmic spraying was done 16 days later than the standard spraying and so coincided with the beginning of the 9 day frost period. The Logarithmic strips were harvested in narrow bands and Appendix Table 1 shows the reduction in yield due to the proximity of severe frost, compared to the standard spraying at comparable rates. Kill of plants even with DNC was 100%. At other experiments Logarithmic strips were sprayed at the same time as the standard experiments and no significant differences were detected between methods of spraying.

It is shown that for winter spraying 0.75 lb/ac dinoseb (triethanolamine) or (ammonium) are safe and satisfactory weedkillers, providing that as with DNC, periods of frequent frost are avoided.

Reference to Tables 2 and 3 show that this is so, while Table 3 shows the increased amount of scorch that can be expected from this treatment, Experiment Q in the same Table demonstrates the danger of spraying with contact herbicides before severe frost periods. Raising the dosage of dinoseb to 1.5 lb/ac generally gives rise to a kill of plants and is to be avoided.

PCP (miscible oil) at the rate of 1.5 lb/ac was on average inferior to DNC or dinoseb. It appears that plants sprayed with this material are more susceptible to slight frosts than plants sprayed with the other two chemicals.

At 3 lb/ac, PCP proves to be damaging and in the event of frost serious kill of plants results.

Mixtures of low rates of dinoseb (triethanolamine) and MCPA (sodium) were used in Expts. M to T and gave very satisfactory weed control; the damage by frost appeared to be less when the rate of dinoseb did not exceed 0.5 lb/ac. This treatment gave on average the highest yield on oats and was not inferior to DNC on wheat.

PART II. Spring spraying of spring sown cereals

Appendix Table 2 shows the effect on yield of wheat, oats and barley, of dinoseb and Activated DNC.

Dinoseb gave high scorch at times in these experiments, but the most severe scorch (over 50%) produced by 2.0 lb of dinoseb (ammonium) was not associated with a yield depression, indeed, two of the highest yield increases obtained (36% and 32% Expt.G) were associated with a leaf scorch of over 50%.

In the same experiment, however, DNC gave similar yield increases without a high degree of leaf scorch.

Discussion

With the adoption of the practice of winter spraying of cereals, it is thought that the results of these experiments covering the past two years may be of value. They fully confirm the results reported in 1954.

It is now fairly clear that winter spraying with activated DNC, or dinoseb can be recommended providing that the dosages of 4.5 lb and 0.75 lb respectively are not exceeded.

It is clear, however, that a warning must be issued of the very great danger which may arise if severe frost periods follow closely on spraying.

In practice the safe period should not be considered to extend beyond the third week of December. If spraying cannot be done before that date it should be delayed until the danger from frost has passed (early March).

In the case of spring spraying of cereals, it is clear that dinoseb ammonium or triethanolamine can be used with safety. Both compounds have the advantage over DNC that they can be sprayed at lower volumes. Dinoseb (triethanolamine) which can be used at volumes as low as 15 gal/ac or even 7.5 gal/ac is, of course, a very suitable material for use in the now common low volume machine.

The dosage levels of dinoseb can and must be higher than those used for winter spraying if effective weed control is to be achieved. It appears that in this respect cold winter conditions help the weedkilling effect of low concentrations of dinoseb. It is self evident, therefore, that winter spraying has an economic advantage over spring spraying.

One of the most effective chemicals used in some of the experiments described in this paper is a mixture of 0.5 lb of dinoseb (triethanolamine) and 0.3 lb of MCPA (sodium). This mixture has been used more extensively elsewhere by the author and others and is very useful in spring and in undersown corn infested with such difficult weeds as Polygonum aviculare and Polygonum persicaria.

The weed population in the various experiments varied in density from under 10 to nearly 700 per sq. yd. As expected, yield increases were positively correlated with weed density.

References

(1) PFEIFFER, R. GREGORY, P. and HOLMES, H. (1955). The use of dinitro weedkillers on winter cereals. Proc. British Weed Control Conference, 1954, 433-445

Appendix. Table 1

Yields from experiment Q sprayed at two different times with the same treatments expressed as % of control

Time 1 16/12/55 - 1 frost two days later and 5 and 6 days later
" 2 2/1/56 - Followed by 8-9 days of frost.
Maximum temperature very low

Chemical	Rate	Time 1	Time 2
Activated DNC	6 lb 4.5 lb	73.5 89.8	0 0
Dinoseb (Trieth)	1.5 lb 0.75 lb	80.6 89.8	0 0
Dinoseb (Ammonium)	1.5 lb 0.75 lb	55.1 89.8	0 20.2
MCPA (Sodium)	0.75 lb		120.2
Dinoseb (Trieth) + MCPA (Sodium)	1.5 lb 0.3 lb	90.8 89.8	20.2 7.7
PCP (miscible oil)	3 lb	12.2	4.8
Untreated Control		100	100

(47011)

Appendix. Table 2

Yields for experiments A and B expressed as percentage of untreated control

Expt	Salt	Dinoseb					Activated DNC		Sig.Diff. at P = 0.05	
		0.4	0.6	0.9	1.35	2.0	4.5	6.0	Btwn treats	Btwn cntrls and treats
A Winter Wheat	(Ammonium) (Trieth)	102.5 108.1	112.8 109.9	104.0 105.6	105.1 102.3	106.2 100.1	115.7	117.9	8.3%	7.2%
B Winter Wheat	(Ammonium) (Trieth)	102.5 103.3	101.3 100.8	100.0 95.6	96.2 96.7	98.3 98.1	102.1	96.7	Not Sig.	Not Sig.
MEAN % of 2 Expts	(Ammonium) (Trieth)	102.5 105.7	107.1 105.4	102.0 100.6	100.1 99.5	102.3 99.1	108.9	107.3		

Appendix. Table 3

Yields for experiments M to T, expressed as percentage of untreated control.
Scorch as percentage leaf area killed

Expt.		Act. DNC.		Dinoseb (Trieth)		Dinoseb (Ammo.)		MCPA 0.3 lb + Dinoseb(Trieth)		PCP (misc ble oil)		Sig.Diff.at P=0.05	
		6 lb	4.5 lb	0.75 lb	1.5lb	0.75 lb	1.5 lb	0.5 lb	0.75 lb	1.5 lb	3.0 lb	Btwn treats.	Btwn contrl. & treats.
M Winter Wheat	S*	7.25	7.5	8.2	17.2	6.0	15.0	5.6	6.7	15.4	35.6		
	Y*	107.8	105.5	98.1	106.3	102.7	97.1	100.9	99.2	94.0	97.0	11.2	8.8
S Winter Wheat	S*	16.9	7.5	11.25	17.25	9.4	21.5	6.25	10.0	24.3	40.0		
	Y*	89.7	90.6	98.9	93.6	97.2	89.0	96.7	93.1	86.6	83.4	8.6	7.0
N Winter Oats	S*	10.0	5.0	15.0	15.0	10.0	40.0	7.5	6.25	22.5	77.5		
	Y*	118.5	122.9	121.8	109.9	119.8	101.7	128.8	123.1	111.4	75.3	12.9	10.5
Q Winter Oats	S*	27.75	14.0	18.0	33.0	23.0	59.4	11.0	13.4	58.0	85.6		
	Y*	73.2	89.4	89.8	79.8	89.7	54.7	89.9	89.2	52.6	12.5	15.1	12.0
R Winter Oats	S*	18.75	21.25	25.6	57.0	22.0	65.6	12.0	21.6	31.25	77.0		
	Y*	96.2	100.2	110.9	78.3	106.0	79.9	105.6	102.0	100.1	69.1	16.4	13.3
T Winter Rye	S*	6.1	4.9	2.3	4.8	3.3	10.1	2.5	4.5	6.1	30.6	not sig.	not sig.
	Y*	118.5	108.7	109.8	105.6	92.6	106.6	106.7	98.6	103.8	102.4		
Mean % of 6 Expts		100.6	102.9	104.9	95.6	101.7	88.2	104.8	100.9	91.3	73.3		

S = Scorch Y = Yield

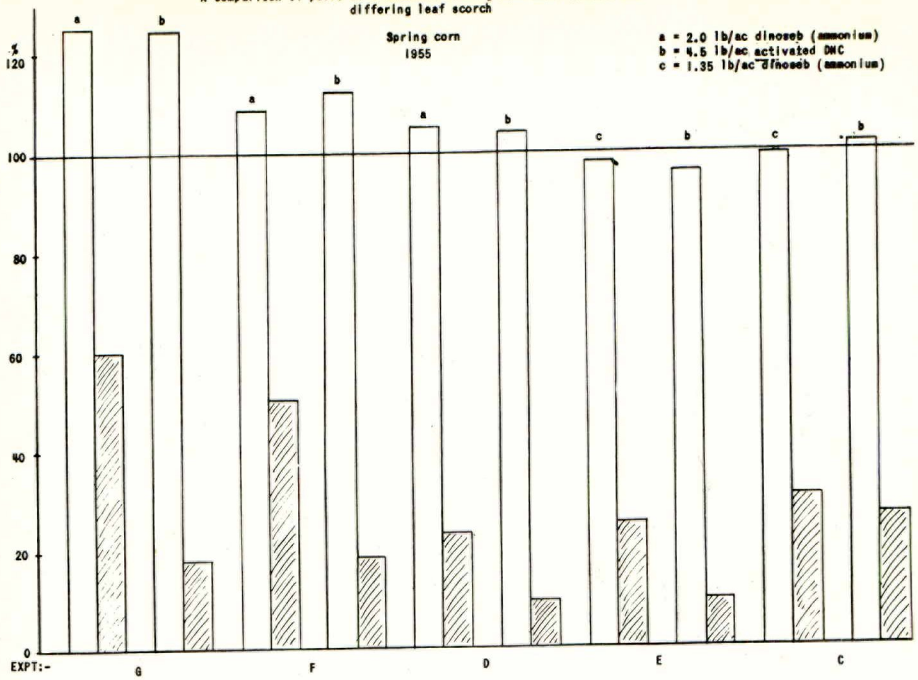
Appendix. Table 4

Yields for experiments C to H expressed as percentage of untreated control

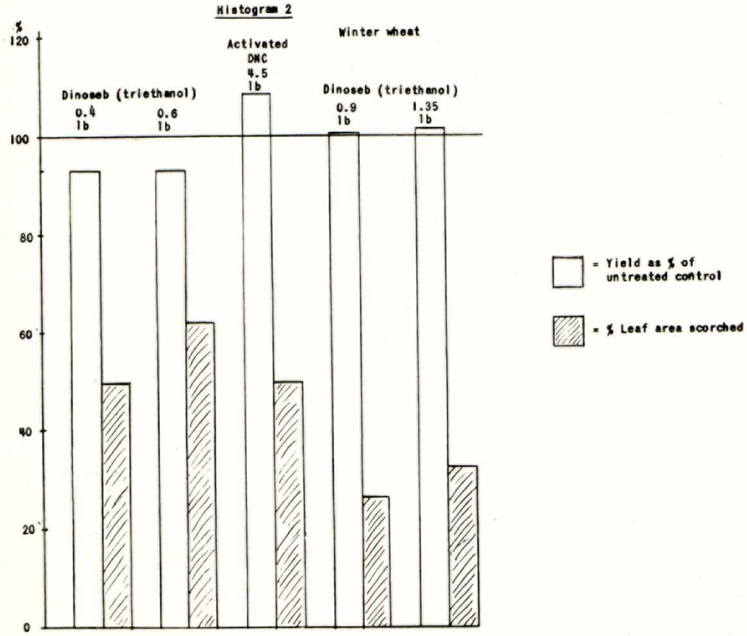
Expt	Salt	Dinoseb lb/ac a.e.					Activated DNC		Sig.Diff. at P = 0.05	
		0.4	0.6	0.9	1.35	2.0	4.5	6.0	Btwn. treats.	Btwn controls and treats.
G Spring Wheat	(Ammonium) (Trieth)	116.4 125.4	132.8 123.4	124.3 109.4	136.4 121.3	132.2 122.6	132.4	136.4	17.35%	15.0%
H Spring Wheat	(Ammonium) (Trieth)	103.4 101.4	111.5 110.2	108.4 108.9	108.5 107.3	99.9 106.3	106.1	111.1	Not Sig.	Not Sig.
C Spring Barley	(Ammonium) (Trieth)	103.0 97.7	100.7 100.2	99.3 97.3	100.0 96.5	96.6 96.1	101.4	104.0	Not Sig.	Not Sig.
E Spring Barley	(Ammonium) (Trieth)	99.8 97.9	92.8 100.3	102.1 99.9	98.2 96.7	96.0 99.3	98.1	96.7	Not Sig.	Not Sig.
D Spring Oats	(Ammonium) (Trieth)	105.8 96.9	110.6 92.9	102.1 98.7	101.5 101.5	107.2 98.7	104.9	103.7	Not Sig.	Not Sig.
F Spring Oats	(Ammonium) (Trieth)	105.3 101.1	115.0 115.9	124.8 122.3	124.9 117.8	110.0 120.6	111.7	113.8	12.7%	11.0%
MEAN % of 6 Expts.	(Ammonium) (Trieth)	105.6 103.4	110.6 107.2	110.2 106.1	111.6 106.9	107.0 107.3	109.1	111.0	--	--

Histogram 1

A comparison of pairs of treatments showing equivalent yields and differing leaf scorch



Histogram 2



(47011)

COMPARISON BETWEEN THE ACTION ON FIBRE FLAX AND WEEDS OF NITROCRESOLS (DNC-PREPARATIONS), MCPA AND MIXTURES BETWEEN THEM

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(Communication No. 95 from the Swedish Seed Association)

Summary

In Sweden about 80 per cent of the fibre flax acreage at present grown - a total of 4000 hectares - is sprayed with weedkillers. The spraying is practically wholly concentrated on the control of dicotyledonous weeds. Monocotyledonous weeds - Agropyron repens is the worst - are chiefly controlled by cultivation. As a rule, fields infested by Agropyron are not used for fibre flax sowing.

The worst dicotyledonous weeds in Sweden are: Chenopodium album, Polygonum persicaria, Centaurea cyanus, Polygonum convolvulus, Galeopsis species, Matricaria inodora. Against these weeds we recommend either MCPA-preparations using 8 to 10 per cent active substance at 2.5 to 4.0 litres per hectare (in 200-350 litres of water per hectare) or mixtures of DNC + MCPA, in Sweden called "KOC"-preparations, at 8 to 10 litres per hectare. 1 litre "KOC", used in our experiments, contained 130 g DNC + 32 g MCPA.

We use the sodium salt of DNC in "KOC". When applying DNC-preparations alone, we have obtained good results with the ammonium salt.

Spraying is invariably done when the flax plants are 4-7 cm high. The weeds are then rather small and easily controlled. The weather should be dry but not too sunny and hot. If burning sun and high temperatures occur, we always recommend the growers to carry out the spraying in the late afternoon and evening.

MCPA-preparations alone are recommended when moderate quantities of weeds, susceptible to this herbicide occur. In doing so, we think mainly of Chenopodium album.

The mixture "KOC" is recommended when larger numbers of weeds occur, among which are species which it is not possible to control by concentrations of MCPA which will not spoil the fibre quality too much. Polygonum persicaria is a good example of such a weed.

Our experiences with DNC and dinoseb (DNBP) on the whole indicate that the use of these agents is rather hazardous and that it is not very easy to obtain uniform control. Occasionally the effect is very satisfactory, occasionally astonishingly low. Sometimes - and this is indeed a bad thing - the "burning effect" on the flax of DNC and especially dinoseb is obviously considerable, particularly in sunny and hot weather.

Introduction

In a report, presented at the British Weed Control Conference in 1954 (1), the authors described experiments with chemical weedkilling in fibre flax in Sweden. This report dealt chiefly with three types of chemicals, viz. 1, preparations with contact action (DNC, nitrocresols), 2. preparations with systemic action (MCPA), and 3. mixtures of DNC and MCPA preparations.

This former report stressed the value of mixtures of DNC and MCPA in cases where large numbers of weeds occur, which are rather resistant to either DNC or MCPA alone. Our experiences at that time were, however, based on only a few years' trials; hence we found continued studies necessary. Below a short report is given of results from continued field trials along the same lines as in the first report of 1954. As before, the work was carried out in close co-operation with The National Agricultural Research Centre (Statens Lantbruksförsök), the Flax Laboratory at The Swedish Seed Association in Svalöf, and The Swedish Flax and Hemp Federation (Riksförbundet Lin och Hampa) in Stockholm, the headquarters organization of the Swedish flax and hemp factories. The straw was treated at the Flax Laboratory, deseeded, processed and its quality studied as necessary. Unfortunately the weather conditions during the last four-year-period were very unfavourable for the development and harvesting of flax. Hence many promising trials had to be discarded, partly or wholly. In certain cases it has, therefore, been necessary to report results of only isolated trials instead of from the larger trial series wished for.

During the years 1953-1955 we chiefly studied the action on flax and on weeds of MCPA-preparations (Agroxon" and "P-46"), mixtures of DNC + MCPA and to a certain extent of DNC and other preparations (dinoseb and others). The results of straw and seed yield, long-fibre yield and long-fibre quality are found in Tables 1, 2, 3 and 4.

Results, comments

In Table 1 the results from a trial at Tönnersa in the county of Halland 1953 are reported. Here we studied the action of "P-46" (MCPA) at a rate of 240 g MCPA per hectare, and of the mixture "KOC" (DNC + MCPA). The latter was applied at two different doses: 8 litres per hectare (1042 g DNC + 256 g MCPA), and 12 litres per hectare (1562 g DNC + 384 g MCPA). The content of active substance in the various preparations has been calculated with the aid of the producer's or seller's declarations. The preparations were sprayed either in 200 litres, or in 400 litres of water per hectare. The flax plant height at spraying was 5-8 cm.

The yield of deseeded straw was somewhat raised at a volume rate of 200 litres per hectare. Otherwise, the results obtained were practically identical at 200 and 400 litres.

As seen in Table 1, the "KOC" preparations increased the seed yield by 120 and 100 kg per hectare respectively in comparison with untreated flax plots, at 8 and 12 litres respectively per hectare. The long-fibre percentage and the total fibre yield was also favoured by the "KOC" preparation both at the lower and the higher rates. The MCPA-preparation "P-46" at 240 g active substance per hectare increased the seed yield somewhat (+ 80 kg per hectare), but the straw yield and the total fibre yield were somewhat lower than in the untreated flax.

"KOC" preparations at both dosages were obviously more active against the weeds (Chenopodium album, Polygonum persicaria, Galeopsis species and Polygonum convolvulus) than MCPA alone, when the latter was used at a concentration causing little injury to the flax.

Similar results were produced from an average of four trials in 1955 in Scania and Halland. Here the MCPA-preparation "Agroxon" was compared with "KOC", as seen in Table 2. It is obvious that here "KOC" has also been superior as regards straw and seed yield, long-fibre percentage and total fibre yield, both in comparison with untreated and with 320 g MCPA per hectare. Observations on weed development, shortly after spraying, confirmed also that here the weedkilling effect of the "KOC" was perceptibly more rapid, larger and more universal than that of the MCPA alone. The spraying was carried out at a plant height of 5-8 cm when the weeds were relatively little developed. The weather was favourably dry and moderately sunny.

In 1954 a trial was made at Svalöf with MCPA, the mixed types "KOC" and "KMOC" and different dinitro-preparations. In this year the weather conditions were unusually bad - little sunshine, excessive rainfall - for the flax, leading to abnormally low fibre-yields. Table 3 gives the names of the various preparations, the dosage per hectare and the content of active substance together with the yield. In the right-hand column the weight of weeds gathered from the different trial plots at the flax harvest is given. All weeds - including those consisting of "bottom vegetation" - were sampled with their roots and weighed after drying in the open air. As seen from Table 3, the weed-killing effect has been considerable for both the mixtures, DNC and dinoseb. Among the mixture, the flax was rather perceptibly damaged by the "KMOC"-preparations, and heavily by the DNC-preparation "Aadinol-supra", the "Denocate" and the dinoseb types "Aatox", "Sevtox" and "Sinoxi S-87". In the KMOC the DNC-content is 63 g and the MCPA-content is also 63 g per litre, i.e. considerably less DNC and more MCPA than in "KOC".

Relatively humid weather shortly after the spraying followed by very humid weather caused the growth of the flax, damaged by the spraying, to be unusually satisfactory. Hence the damage was not visible at harvest, nor is apparent in the yield figures. The very interesting observations in this trial confirm earlier observations and also practical experience: if the weather conditions for a successful growth are optimal, even flax severely damaged by spraying may develop quite satisfactorily.

Also, in this trial the "KOC" displayed a favourable effect on seed yield, straw yield and the weeds were uniformly killed. The percentage weeds at harvest was only 31 per cent compared with the untreated flax plots. The percentage of long-fibre in the "KOC" plots was equal to that in the untreated plots, but the retting and processing revealed an additional production of 182 kg per hectare of fibre, compared with untreated. The use of "Agroxon" in concentrations low enough not to cause spirilization of the stems proved to be less effective against the weeds and had less favourable effects on straw, seed and fibre yields in comparison with the mixtures and - under better conditions - also DNC and dinoseb preparations.

The reaction of fibre flax to spraying at different stages of development is illustrated in Table 4 where one trial in Halland in 1952 is reported. In this trial the flax was sprayed at a height of 5 and 15 cm with the MCPA-preparation "Agroxon", the DNC preparation "Stirpan" and the mixture "KOC". The results indicate that "KOC" can be used also at a height of 15 cm without diminished yield of fibre, straw or seed. The "Agroxon" treatment, on the contrary, caused a rather marked decrease in fibre yield and a certain loss of straw, if the spraying is done when the flax is at a height of 15 cm. The

"Stirpan" spraying at 15 cm height does not perceptibly damage the flax - the long-fibre percentage was even somewhat higher in this trial - but the straw yield was considerably diminished. In our opinion the "Stirpan" treatment at 15 cm height was only slightly active against the weeds which were well developed and resistant at that time. This caused a higher weed frequency in comparison with the earlier spraying, in its turn causing a depression of the straw yield. It should be noted that in this trial the "KOC" plots showed an increase in seed yield in comparison with the "Agroxon" and "Stirpan" plots, but above all in comparison with the untreated plots. The trial was on the whole successfully planned and sown on a homogeneous field; nevertheless repetitions would be necessary for drawing more definite conclusions. Since, unfortunately, many growers tend to postpone their weedkilling activities until the weeds are too well developed, it is valuable to find that the "KOC" mixtures do not act too unfavourably in such cases. The use of "Agroxon" and "Stirpan" at a more advanced stage of flax development is definitely not to be recommended.

References

(1) Fröier, K. and Zienkiewicz, H. Survey of Swedish experiences of chemical weed killers used in fibre flax during the years 1940-1953. Proc. Brit. Weed Control Conf., 1954, 475-492.

Table 1. Results from spraying experiments in fibre flax 1953 at Tönnersa gård, Halland

(Means from 1 trial)

Treatment	Straw kg/ha	Seed kg/ha	Longfibre per cent	Longfibre class	Tow per cent	Total fibre (long-fibre + tow) kg/ha
No treatment	5010	650	12.1	II-	5.2	867
MCPA, 240 g/ha	4980	730	12.4	II	4.3	832
"KOC", 8 l/ha (= 1042 g DNC + 256 g MCPA)	5000	770	13.2	II-	4.7	895
"KOC", 12 l/ha (= 1562 g DNC + 384 g MCPA)	4970	750	13.1	II-	5.3	914

Table 2. Results from spraying trials in fibre flax 1955 in Scania and Halland

(Average from 4 trials)

Treatment	Straw kg/ha	Seed kg/ha	Longfibre per cent	Longfibre class	Tow per cent	Long-fibre kg/ha	Tow kg/ha	Total fibre kg/ha
No treatment	5373	975	14.6	II	5.3	784	285	1069
MCPA, 320 g/ha	5128	996	14.7	II	5.3	754	272	1026
"KOC", 8 l/ha (= 1042 g/ha DNC + 256 g MCPA	5542	1034	15.2	II	5.2	842	288	1130

Table 3. Results from spraying in fibre flax 1954 in Svalöf (Scania)
(Means from 1 trial)

Treatment	Straw kg/ha	Seed kg/ha	Long-fibre		Tow per cent	Total fibre kg/ha	Weeds	
			per cent	class			kg/ha	relative figures
No treatment	3309	827	10.0	III+	5.4	510	1270	100
Agroxon, 4 l/ha (= 320 g MCPA)	3875	1052	12.0	III	4.9	655	830	65
"KMOC 63", 8 l/ha (= 504 g DNC + 504 g MCPA)	4234	1061	10.6	III	6.3	716	500	39
"KOC", 8 l/ha (= 1042 g DNC + 256 g MCPA)	4297	1148	10.2	III	5.9	692	400	31
Denocate, 8 l/ha (= 2400 g DNC)	4556	1081	10.2	III	5.8	729	500	39
Aadinol supra, 4.5 kg/ha (= 2225 g DNC)	4525	1077	9.7	III	6.6	738	210	17
Sevtox, 4 l/ha (= 680 g dinoseb)	4053	1013	11.4	III	5.3	677	550	43
Sinoxi S-87, 6 l/ha (= 660 g dinoseb)	4044	1014	11.2	III	5.8	687	600	47
Aatox, 6 l/ha (= 732 g dinoseb)	4281	1006	11.2	III	5.6	719	430	34

Table 4. Results from spraying against weeds in fibre flax at two different stages of flax plant development. Locality: Tönnersa gård, Halland. Year: 1952

Treatment	Straw kg/ha	Seed kg/ha	Long-fibre		Tow per cent	Long-fibre kg/ha	Tow kg/ha	Total fibre kg/ha
			per cent	class				
No treatment	6135	900	17.0	II	3.3	1043	202	1245
x) Agroxon, 3-5 l/ha, flax height 5 cm	6123	968	17.1	II-	3.5	1047	214	1261
Agroxon, 3-5 l/ha, flax height 15 cm	6020	983	15.8	III÷	3.4	951	205	1156
xx) Stirpan, 6 kg/ha, flax height 5 cm	6310	965	15.9	III+	4.1	1003	259	1262
Stirpan, 6 kg/ha, flax height 15 cm	5900	970	16.2	III+	3.4	956	201	1157
xxx) "KOC", 12 l/ha, flax height 5 cm	6090	1010	16.5	III+	3.5	1005	213	1218
"KOC", 12 l/ha, flax height 15 cm	6175	1045	16.8	III+	3.3	1037	204	1241

x) = 240-400 g/ha MCPA
xx) = ca 1200 g/ha DNC
xxx) = 1562 g DNC + 384 g MCPA