ROW CROPS AND FLAX

CHEMICAL WEED CONTROL IN SUGAR BEET:

A REPORT OF EXPERIMENTAL WORK IN 1954

C. PARKER, (Norfolk Agricultural Station)

Summary:

Work was continued this year using the same chemicals as in 1953 but this time under a wide variety of conditions. C.M.U.,[x] endothal and an oil formulation of P.C.P. were applied as residual pre-emergence treatments sprayed before weeds emerged, at 11 separate sites in East Anglia. The very variable results obtained have provided valuable information on the reactions of these treatments to soil type and moisture, but unfortunately also suggest that none of these chemicals is really reliable enough for general use as residual pre-emergence herbicides in sugar beet.

I.P.C.[x] was used at 4 sites against Wild Oat (Avena fatua) applied as a pre-drilling spray. Results indicate considerable promise not only against Wild Oat but also against Chickweed (Stellaria media).

No new chemicals were used as post-emergence selective sprays, but solutions of sodium chloride and sodium nitrate[x] were again used and proved successful against most weeds other than Fat Hen (Chenopodium album).

Introduction:

The work is a continuation of that begun in 1953 and reported in the Proceedings of this Conference last year(1). It is sponsored by the Sugar Beet Research and Education Committee, the aim being to find a means of rendering sugar beet brairds free of weeds and so reduce the hand labour required in the singling of the crop (a) directly and (b) indirectly by allowing full benefit to be gained from the use of precision drills and mechanical thinners.

(i) Pre-emergence Trials:

In 1953 it had been found that P.C.P., C.M.U. and endothal all showed some promise, but in order to evaluate them more fully it was essential to test them under a wide variety of different soil and weather conditions and against different weed species. With the co-operation of the British Sugar Corporation it was possible to spray 10 outside trials and have results assessed by the respective sugar factory fieldmen. These small-scale trials were not designed to be carried through to yields but at Sprowston a larger-scale trial was sprayed with the same treatments in order to assess their effects on yields of roots and sugar and also to compare weed control results obtained by spraying at two different times before emergence of the crop.

(ii) I.P.C. Spraying:

Nelson (2) in Canada has reported the successful use of I.P.C. against Wild Oat worked into the seed-bed before drilling of sugar beet. To confirm those findings, 3 of the 10 outside sites at which Wild Oat was present had two I.P.C. treatments included, while a fourth site was laid down to a larger scale trial for assessments of final yields of roots and sugar as well as of Wild Oat control.

---

[x] See end of report for sources of chemicals.

(22394)

448

TABLE I

Pre-emergence Trial Details

No.	Trial Site	Soil-type	Date drilled	Date sprayed	State of seedbed	Days before emergence	Days before rain	Principal Weeds	% Weed Control P.C.P. (rate lb per acre)			Endothal			C.M.U.			% Kill of Beet P.C.P.			Endothal			C.M.U.		
									1½	3	6	1½	3	6	.16	.32	.64	1½	3	6	1½	3	6	.16	.32	.64
1	Rackheath	light	19/3	1/4	fine, wet	16	Nil	Spurrey, Knotgrass Wild Radish	39	57	77	83	84	82	56	81	93	0	8	0	4	5	14	15	12	50
2	Paston	medium heavy	21/4	29/4	fair, wet	12	1	Pimpernel, Chickweed, Wild Oat	13	3	0	-	26	31	-	33	54	1	0	4	-	0	0	-	15	3
3	Manningtree	medium	15/4	23/4	fine, dry	18	7	Wild Radish	0	0	20	11	21	26	31	61	73	8	12	6	22	15	11	0	17	27
4	Stowmarket	heavy	10/4	13/4	poor, dry	28	19	Wild Oat, Chickweed	1	19	0	-	0	5	-	18	17	0	0	0	-	0	0	-	0	0
5	New Buckenham	medium	7/4	13/4	poor, dry	17	18	Wild Oat, Chickweed	0	7	0	-	3	28	-	18	41	0	0	3	-	0	1	-	0	0
6	Riddlesworth	light	5/4	12/4	fair, dry	20	19	Fat Hen, Knotgrass Speedwells, Bindweed	18	23	37	53	81	77	41	56	86	15	0	21	0	1	21	21	41	85
7	Lakenheath	light	6/4	15/4	fine, dry	5	15	Fat Hen, Charlock, Couch	0	0	22	25	14	34	31	49	64	0	0	0	0	0	0	0	0	43
8	West Row	light peat	2/4	8/4	fine, moist	20	21	Redshank, Fat Hen	0	30	22	21	1	7	5	32	45	0	0	16	13	0	0	0	0	0
9	Gayton	light	23/4	30/4	fair, dry	9	Nil	Fat Hen, Brassica spp. Black Bindweed	1	27	57	86	92	97	75	88	85	0	0	32	0	2	6	20	73	91
10	Weybourne	light	29/4	7/5	fair, damp	4	14	Spurrey, Fat Hen	0	0	31	45	63	57	48	83	89	3	11	25	0	5	1	0	26	25
11a	Sprowston	light medium	21/4	26/4	fair, dry	10	4	Fumitory, Knotgrass, Orache, Pimpernel	20	33	53	70	86	93	31	63	62	8	0	9	0	7	14	0	2	32
11b				4/5	fair, wet	2	1		22	50	49	54	65	71	41	20	52	2	15	10	3	7	3	0	3	15

(iii) Post-emergence Work:

Trials in 1953 had confirmed that sodium chloride and sodium nitrate had a very definite value as post-emergence treatments. Against the weeds at Sprowston, Fumitory (*Fumaria officinalis*), Knotgrass (*Polygonum aviculare*) and Chickweed, it had been found that a wetter was essential, whilst another trial had suggested that a mixture of the two salts was more potent than either alone. One trial was therefore sprayed to test the synergistic action, whilst observation plots were sprayed at various sites to test the chemicals with and without wetters, against certain other weeds. Several attempts at field-scale spraying were also kept under observation and some useful information gained.

EXPERIMENTAL DETAILS AND RESULTS:

(i) The 10 outside pre-emergence trials:

Treatments: P.C.P. and endothal+ each at 1½, 3 and 6 lb. per acre.
C.M.U. at 0.16, 0.32 and 0.64 lb. per acre.
3 Control plots.
(+ endothal applied at West Row at 4½, 9 and 18 lb. per acre)

Replications: 3 Plot size: 6 yds x 4 yds
Results in Table I.

(ii) Pre-emergence Trial at Sprowston:

Main treatments: Spraying 10 and 2 days before crop emergence.
Sub-treatments: P.C.P., endothal and C.M.U. as in outside trials,
P.C.P. (Sodium) at 3, 6 and 12 lb per acre.
2 control plots.
Replications: 3 Plot size: 12 yds x 4 yds.
Results included in Table I.

(iii) I.P.C. Spraying:

I.P.C. was sprayed in 3 of the 10 outside trials in place of the low rates of C.M.U. and endothal.

Treatments: I.P.C. at 3 and 6 lb per acre.
Replications: 3 Plot size: 6 yds x 4 yds.
Results in Table II.

Table II. I.P.C. Trial Results:

Trial site	Date sprayed	State of field	Cultivations after spraying	Date drilled	% Kills Wild Oat 1½	3	6	Sugar Beet 1½	3	6
Paston	20/4	prepared	pitch pole & harrows	21/4	-	63	72	-	21	42
Stowmarket	25/3	ploughed	heavy & light harrows	10/4	-	52	52	-	0	0
New Buckenham	22/3	cultivated	heavy harrows twice	7/4	-	34	72	-	5	0
Ingham	7/4	prepared	cult., disc harrows, harrows	22/4	71	83	93	0	0	6

(iv) I.P.C. Trial at Ingham:

Treatments: I.P.C. at 1½, 3 and 6 lb per acre, 1 control plot.
Replications: 6 Plot size: 12 yds x 4 yds.
Results in Table II.

(v) Post-emergence Trial:

Treatments: Sodium chloride and sodium nitrate each alone at 300 lb per acre and in combinations of 75 + 225 and 150 + 150 lb per acre. All in 100 gallons water per acre + 1% wetter. 1 control plot.
Replication: 6 in a latin square layout. Plot size: 6 yds x 4 yds.
Results in Table III.

Table III. Post-emergence Trial Results:

Rates lb per acre			% Kill of Chickweed	% Reduction in crop vigour
Sodium nitrate		Sodium chloride		
0	+	300	57	13
75	+	225	63	17
150	+	150	75	18
225	+	75	77	18
300	+	0	77	17

In all trials spraying was carried out with an Oxford Precision Sprayer, all pre-emergence treatments being applied in 25 gallons water per acre. Weeds and beet were counted in 12 18" x 4" quadrats per plot when the beet were in the 2-4 true leaf stage. % kills of beet and weeds were estimated by comparing emergence on treated and untreated plots.

DISCUSSION:

A. Pre-emergence Trials:

(a) Soil type: Both weed control and kill of sugar beet were consistently less on the heavier soils and on the peat soil at West Row Fen. For C.M.U. this accords with the findings of Sherburne and Freed (3) who have shown that organic matter and to a lesser extent clay particles both absorb and reduce the effectiveness of C.M.U. It was very striking also that endothal applied at three times the intended rates at West Row (i.e. up to 18 lb per acre) gave virtually no weed control or damage.

(b) Moisture: There was an unusually dry spell in April lasting for nearly three weeks and 6 of the trials had no rain for over a fortnight after spraying. These dry conditions severely reduced the effectiveness of all chemicals. For contrast 0.64 lb C.M.U., which at Gayton under wet conditions killed 91 per cent. of the beet, at Weybourne under dry conditions killed only 25 per cent.

When rain did fall, it did not differ markedly in amount between the different sites. Riddlesworth was exceptional in showing high all round activity of chemicals in spite of no rain. 8 cwt per acre of Kainit applied very near to drilling, however, caused very poor germination and growth in the early stages and it is possible that it also attracted and held sufficient moisture to allow solution and enhanced activity of the chemicals in the soil.

(c) Timing: The aim in the outside trials was to spray when there was the minimum risk of any beet being through, i.e. at least a week before general emergence. The actual time interval varied rather but it seems that under such dry static conditions this factor was not of any great significance. At Sprowston there were intentionally two dates of spraying 10 and two days before emergence, and in between these two dates there was 0.85 inches rain. The earlier spraying gave better weed control but also more kill of beet by C.M.U. and endothal, whilst P.C.P. was if anything at the earlier date less effective. This suggests that the C.M.U. and endothal applied earlier either (i) caught the crop and weeds at a more sensitive stage in germination, or (ii) were carried down in greater quantity to the germinating seeds by the rain which the second spraying escaped.

(d) Weeds: The differences in susceptibility to the respective chemicals are summarised in Table IV.

Table IV. % Kill of Individual Species

Species	No. of trials	P.C.P. 1½	P.C.P. 3	P.C.P. 6	Endothal 1½	Endothal 3	Endothal 6	C.M.U. 0.16	C.M.U. 0.32	C.M.U. 0.64
Sugar Beet	10	4	3	11	-	3	5	-	18	32
Anagallis arvensis	2	28	27	36	-	55	74	-	46	61
Chenopodium album	6	41	30	50	37	51	52	61	81	87
Fumaria officinalis	1	37	50	53	45	63	70	37	29	32
Polygonum aviculare	4	4	33	36	-	65	85	-	61	71
Polygonum convolvulus	3	2	6	2	-	67	72	-	67	66
Raphanus raphanistrum	2	33	12	37	19	15	7	51	62	82
Spergula arvensis	3	21	47	43	57	73	87	64	96	99
Stellaria media	4	22	37	31	-	8	26	-	60	74
Veronica spp.	2	3	40	50	70	93	84	27	50	80

It can be seen that endothal was selective against Speedwells (Veronica spp.) Spurrey (Spergula arvensis) Fumitory and the Polygonum spp. but of less use against the more important weeds Wild Radish (Raphanus raphanistrum) and Fat Hen. Bearing in mind that C.M.U. could not be safely applied at much over 0.16 lb per acre on any but heavy or organic soils, control of Spurrey and Fat Hen was fairly good, that of Wild Radish, Chickweed and the Polygonum spp. moderate only and that of Fumitory, Speedwells and Pimpernel (Anagallis arvensis) definitely poor. P.C.P. and P.C.P. (Sodium) showed hardly any differences in species susceptibility nor any great selectivity in favour of the crop.

(e) pH and temperature: It has not been possible to relate any differences in results to soil pH or air temperatures at or after spraying.

General Effects on the Crop:

(a) Vigour: The vigour of the crop was affected seriously by C.M.U., slightly by endothal but hardly at all by P.C.P. Under dry conditions and in heavier soils the stunting effect of C.M.U. was delayed but hardly less severe.

There was some recovery but it was slow and there was still a marked set-back by 0.64 lb C.M.U. per acre in July at 7 of the 10 sites.

(b) Plant Populations: A significant reduction in final crop stand was caused by 0.64 lb per acre of C.M.U. at 7 sites, by 0.32 lb C.M.U. per acre at 3 sites but by 0.16 lb C.M.U. per acre and 6 lb endothal per acre only at site 9. No P.C.P. treatment significantly reduced plant population.

(c) Effect of "Bolting": In the few trials drilled early enough to produce bolters, there was no evidence of any increase in bolting due to spray treatments. This is in accordance with last year's observations.

B. I.P.C. Trials:

(a) Soil type: In these trials the soil type was in each case of a medium or heavy texture and it is not possible to ascribe any differences in results to this factor.

(b) Moisture: This was abundant after spraying at all sites except Paston where there was no rain until nine days after drilling. In view of the results there it would seem that moisture may not be so essential a factor with I.P.C. as with the other chemicals.

(c) Timing: It was intended in all cases to drill within a few days of spraying, but only at Paston did weather permit this. Here damage to the crop was considerably greater, so it may be that an interval between spraying and drilling is safer for the crop.

(d) Cultivations: The disc harrow used at Ingham was probably the most efficient implement, though it is not usually favoured on heavy soil. Harrows alone did not give the best results.

(e) Temperatures: The cultivations did not always follow immediately on spraying but as temperatures in April hardly rose above 60°F. there was little risk of losing chemical by evaporation.

Effects on the Crop:

The germination and early growth of the crop was retzrded in all trials moderately by 3 lb per acre and more severely by 6 lb per acre especially at Ingham. This effect was not as prolonged as with comparable C.M.U. stunting and only lasted for more than a few weeks at Paston. Here, however, even the 3 lb per acre rate was still showing some retardedness in July.

C. Post-emergence Spraying Trial:

Kill of Chickweed was slightly greater with sodium nitrate than with sodium chloride. The mixtures gave intermediate kills and not greater ones as had been expected from 1953 results. It may be interesting to note, however, that the greater combined solubility of the mixtures caused an earlier uptake of water and deliquescence of the dried-out spray under damp evening conditions. Under critical humidity conditions it is possible that this effect may cause the chemical to be in solution on the leaves for a longer time and so give a greater effect.

Sodium nitrate is the more desirable of the pure salts for practical use owing to its greater solubility. Mixtures are being tested not only to reduce the cost of the chemical required but also in the hopes that the difficulty of dissolving may not just be intermediate between the two pure salts but actually less than with straight sodium nitrate.

At 2 sites observation plots sprayed with various rates and combinations of the two salts have confirmed that with at least 0.25% wetter present, 2½ cwt in 100 gallons solution per acre will kill Redshank (Polygonum persicaria), but that Charlock (Sinapis arvensis) and Wild Radish, unless caught in the rosette stage not more than 2 inches across may not be completely killed.

When sprayed in the cotyledon stage, beet were rather severely checked and took some weeks to recover, but when sprayed later with at least 2 true leaves, then the check was for a few days only.

In general, results were quickest under hot humid conditions and following rapid growth of the plants, but they were just as good under cool conditions provided spraying was followed by two or three fine days.

CONCLUSIONS:

Pre-emergence Trials: C.M.U. and endothal are selective against only a limited range of the less important weeds and are furthermore very much influenced not only by soil type which could possibly be allowed for, but also by rainfall which could not be predicted. Neither P.C.P. in oil nor P.C.P. (Sodium) in water is sufficiently selective for use purely as residual pre-emergence treatments.

I.P.C. Trials: I.P.C. shows promise for control of Wild Oat, Chickweed and Poa annua at a rate of about 4 lb per acre disced into the seedbed before drilling, but some temporary check to the growth of the crop must be expected.

Post-emergence Sprays: Sodium chloride and sodium nitrate have been used separately and mixed at 2½ to 3½ cwt per acre in 100 gallons of water with at least 0.25% of wetter added. These sprays have given good results against most weeds other than Fat Hen and have been successfully used on a field scale by a number of farmers. The principal limitations to these treatments are really only the time and trouble required to make up and apply the high volume solutions.

REFERENCES:

1. PARKER, C.,
   (1953) Proc. Brit. Weed Control Conf. pp. 274-282.

2. NELSON, R. T.,
   (1952) Proc. Joint Meet. 9th N. Central Weed Control Conf. and 6th W. Canad. Weed Control Conf. pp. 73-75.

3. SHERBURNE, H. R. AND FREED, V. H.,
   (1954) J. Agric. Fd. Chem. 2 (18) pp.937-939.

Chemicals

I.P.C. = from Universal Crop Protection Ltd. - Sprayed as aqueous suspension.
C.M.U. = Du Pont 80% wettable powder.
endothal = Pennsalt S-3003.
P.C.P. = Monsanto formulation RD 4194.
P.C.P. (Sodium) = Monsanto, Santobrite.
Sodium chloride = Saltilizer Salt.
Sodium nitrate = Chilean Nitrate of Soda.

CALCIUM CYANAMIDE AS A HERBICIDE IN ROW CROPS

Prof. Dr. B. RADEMACHER

(Institut für Pflanzenschutz der Landwirtschaftlichen Hochschule)
Stuttgart-Hohenheim, Germany.

Summary

If certain precautions are taken, calcium cyanamide especially the granulated form can be used for weed control in the following row and truck crops:-

potatoes, corn, asparagus, peas, beans (phaseolus), carrots, seedlings of cabbage and onions.

Introduction

With the great shortage of man power efforts are made to use herbicides in row crops. In this respect some success was achieved also with calcium cyanamide, which shall be discussed briefly.

Experiments were made partially by myself and partially by Amann graduate student in my institute on light sandy soils in the neighbourhood of Frankfort and Darmstadt.

Experimental results

In potato crops repeated and intensive tilling of the rows between planting and emergence of the seed constitutes today the foundation of a successful weed control. Furthermore it is possible to apply calcium cyanamide shortly before the potatoes emerge (pre-emergence treatment). In a five year period of experiments we could observe that calcium cyanamide applied at a rate of 300 kg/ha was able to render any further manual work unnecessary. It does not matter if some of the potatoes have emerged and their leaves get scorched, as the potato plants regenerate quickly.

If such success in weed control is to be achieved it is necessary, however to consider the following points:

(a) calcium cyanamide must be applied on moist soil in order to produce cyanamides. The effect can be increased by the application of a harrow immediately before calcium cyanamide is applied,

(b) the field must be free of perennial weeds,

(c) the crops must be well tended, that the rows may soon be covered.

In regions which are infested with Galinsoga parviflora the control of this weed can be achieved in the following way: 200 kg/ha calcium cyanamide are applied before planting. With the emergence of Galinsoga parviflora, the potatoes slightly hoed and grown to medium size, a second treatment is carried out, again this time at a rate of application of 200 kg/ha but in granulated form.

After treatment no further cultivation measures should be conducted in order to prevent a renewed emergence of the Galinsoga.

In corn crops the dose of calcium cyanamide may be subdivided in the following way:

(a) calcium cyanamide at a rate of 200 kg/ha before sowing.

(b) calcium cyanamide in granulated form at a rate of 200 kg per ha at the time of emergence of the corn, or half the dose at the time of emergence and the second half in granulated form when the plants have reached a height of 20 cm = 8 inch.

During the harvest a good weed control with granulated calcium cyanamide is possible in asparagus crops, provided that the soil is moist.

Referring to the investigations of Amann it is possible to apply calcium cyanamide to other truck crops but it should be borne in mind that:

(a) with the application of bigger quantities only the granulated form should be used,

(b) plants treated should be dry,

(c) calcium cyanamide should be applied only during certain stages of development of the plants.

Under these conditions weed control with calcium cyanamide is possible in the following truck crops:

peas, phaseolus beans, carrots, seedlings of cabbage, onions.

THE USE OF SULPHURIC ACID FOR CONTROLLING WEEDS IN BRASSICA CROPS

by

W. Q . CONNOLD, N.A.A.S. Provincial Crop Husbandry Officer,
South West (Bristol)

and

E. I. PRYTHERCH, N.A.A.S. Provincial Crop Husbandry Officer,
Wales (Aberystwyth)

Summary

Sulphuric acid has been used in many parts of England and Wales as a means of dealing with Brassica crops (especially forage Kale) which were in danger of being smothered by Charlock (Sinapis arvensis) Redshank (Polygonum persicaria), Fat hen (Chenopodium album), or other weeds. Crops have usually been treated on the basis of 'kill or cure' when the only alternative would be to plough in a stifled crop. At that stage the crop has been either completely or partially 'canopied' by the taller growing weeds, and it was natural to assume that a crop sprayed in this condition enjoyed a considerable measure of protection from spray damage. As a result of very limited work by technical officers and a few individual farmers, however, it would seem that Kale, and probably many other brassicas, could be treated most effectively with a weaker solution, quicker recovery, and less drain on fertility, by spraying at an earlier stage of growth. Further investigation is needed to substantiate these findings.

Introduction

The origin of this report was in a decision reached by the Conference of N.A.A.S. Provincial Crop Husbandry Officers, to collect as much information as possible about the practice of spraying Brassicas with sulphuric acid, in order to assess the need (if any) for carrying out field experiments. Information was collected in each of the eight Provinces and sent in for summarising by the authors of this paper, which is a slightly abbreviated version of the first report. The names of persons providing information at first or second hand, are with one or two exceptions, all members of the N.A.A.S., and an explanatory note of the abbreviations used to describe their location in the Service is given as a footnote. The authors believe that individual contractors up and down the country probably have additional information which would augment that which is given here.

History of Technique and Distribution of Experience

The earliest work of which we have any knowledge was that of J. R. Stubbs (C.A.O. Buckinghamshire) when stationed in Gloucestershire. He described in Vol. LV. No. 9 of "Agriculture" how he had observed odd plants of kale unharmed in corn-crops which had been sprayed with acid. Also how he had subsequently compared plots of weed-infested kale, sprayed with varying strength of acid, with and without a wetter.

From about 1948 until the present time, technical officers and farmers in Gloucestershire, Wiltshire, Dorset and Devon in particular (of the south western counties) have shown interest in dealing with weedy crops in this way, but their interest has been curbed rather than encouraged through lack of spraying facilities, except in Wiltshire. In each of the other counties, the A.E.C. spraying department has closed down, and few contractors have seen fit to take up acid spraying to replace the A.E.C. services. Wiltshire, however, is fortunate in having a contractor with many years' experience of acid spraying, and amongst other operations he has dealt with a number of weed-smothered kale crops each year (in 1953 - 18 such crops). A few south western farmers possess acid-proof spraying machines and deal with their own and their neighbours' crops, and several with inexpensive non-acid proof machines have toyed with the idea of using them for acid spraying even though it means earlier replacement. The only elaborately designed experiment so far carried out anywhere in the country with the acid spraying of Kale seems to have been that by J. F. Ormrod (then N.A.A.S. Liaison Officer with the A.R.C. Unit Oxford, but now assistant to the P.G.O., East Midlands), in Dorset.

The interest of J. R. Stubbs in this subject continued on his transfer to Buckinghamshire, and he appears to have been responsible for carrying the technique into both the South Eastern and the Eastern Provinces. In the former province, a number of crops have been successfully treated, and Professor H. G. Sanders has shown considerable interest in the technique on the Reading University Farm. Isolated cases of successful treatment are said to have occurred in the majority of the counties in the Eastern Province. J. R. Stubbs and his Buckinghamshire colleagues are now investigating the idea of applying sulphate of ammonia along with the acid.

In the East Midland Province, acid spraying in brassicas has, it seems, only been resorted to in a few instances, and although in the main, results were satisfactory, there was some variability due to extremes of weather.

No experiences are available from the Yorks. and Lancs. Province.

The experiences in the Northern Province, and especially on the western side, where redshank is such a menace, have been highly encouraging, and, as in the South West, our N.A.A.S. colleagues there would have no hesitation in recommending acid spraying in suitable circumstances.

Few crops appear tohhave been treated in the West Midlands, but at least two are on record, and in each case the operation was completely successful.

In Wales considerable interest is being shown in areas as far apart as Anglesey and Glamorgan, and as in the other higher rainfall areas, the interest is likely to grow if acid spraying facilities can be made available for this and other purposes.

Types of Brassica Crop

In most cases Marrow-stem or Thousand-head have been sprayed, but not infrequently, Rape. In one instance, however, a weedy field of kale included some Common Turnip, Early Drumhead Cabbage, and the N.I.A.B.'s observation-study range of Marrow-stem (green and purple), Thousand-head, Canson, Hungry Gap, Rape-kale, Cottagers' Kale, Tall Green Kale, White Sprouting Broccoli, Giant Rape and Broad-leaved Essex Rape, and none of these was damaged. (C. D. Price, P.C.H.O., Northern Province). Several years ago some small-scale spraying was tried on Cornish Broccoli, using acid and copper chloride with more or less catastrophic results. (G. A. Toulson, then A.C.A.O. (Adv.) Cornwall). Primo cabbage plants, on the large size for planting out and growing in frames, were sprayed with 10% acid for chick-weed, with only slight foliage damage. (R. A. T. Harris, C.H.A., Buckinghamshire).

Weed Species

A great many of the crops were sprayed for Charlock (Sinapis. arvensis) or mixtures of this and other weeds, but Charlock presented no real problem provided that the strength of acid was increased with maturity of weed and in periods of prolonged drought. The other commoner weeds which frequently threatened crops of kale or rape were Fat-hen (Chenopodium alburn) and Red-shank (Polygonum persicaria). These required higher concentrations of acid, but in the main they were, at least, sufficiently subdued to give the crop the upper hand. There were one or two instances recorded, however, of spraying having to be repeated after the weed had "softened up" after rain, or where the Fat-hen had been observed to set seed despite the spraying. Red-shank is referred to as the worst problem in the highest rainfall areas. Other weeds dealt with in brassica crops with varying degree of success included Cleavers (Galium aparine), Poppy (Papaver rhoeas), Chickweed (Stellaria media), Runch (Raphanus raphanistrum), Knotgrass (Polygonum aviculare), Corn Mangold (Chrysanthemum segetum), Mayweed (various species), Spurrey (Spergula arvensis), and Bugloss (Echium vulgare). No doubt most of these species could be completely eliminated if it were possible to establish a technique of spraying in the seedling stage with no real permanent damage to the crop.

Strength of Acid

As with other crops, where the margin of safety is narrow, it is probably wise to aim at "control" and not at a "kill". All that is needed is to turn the balance in favour of the crop which, in sufficiently fertile conditions, will quickly get the upper-hand.

10 gallons of B.O.V. in 90 gallons of water (or an even lower concentration) appears to be adequate for Charlock in all but those cases where the weed is mature. On mature Charlock plants in a drought year a 16% solution was reported as being necessary. (A. L. Jackson, then D.A.O., Dorset).

On the other hand, whilst reports are to hand of Fat-hen being successfully controlled with 8 - 10% B.O.V., other cases are recorded of its setting seed after being sprayed with a 12% solution. On the whole the Wiltshire practice of using a 15% solution (for control rather than kill) seems about right.

There is less information about strength of solution employed for Red-shank, but 12½% was quoted as giving a good kill in Cumberland. (C. D. Price), and 12% as being standard practice on a farm in Gloucestershire (W. D. Peck, D.A.O.). These remarks (both for Fat-hen and Red-shank) apply to well established or fairly mature plants.

In so far as it is possible to draw conclusions from evidence provided from widely varying circumstances, it does seem that 15% B.O.V. is somewhere near the upper practical limit, and that 20% is liable to cause severe damage. (C. Turner, A.C.A.O. (Adv.) Buckinghamshire).

Crop Damage

We cannot emphasise too strongly that most of the information we have collected is from crops protected with a canopy of taller growing weed. Our evidence suggests that where the canopy is more or less complete the stage of growth of the crop is of small importance. In sorting out the information sent to us, we have tried to differentiate between crops which were "canopied" and crops which were not.

Where the canopy is patchy or non-existent, then stage of growth of the crop, shape, position, and size of leaf, are of more importance. As a rule it is the older and outer leaves which are most scorched, and recovery of the plants between spraying time and October-December is more or less complete, although some growing points may be damaged and the yield may be reduced in comparison with an unsprayed weed-free crop. When a clean crop of Thousand-head 9" - 10" high (5 - 6 leaves) was sprayed with 12% B.O.V., 50% of the leaf area being destroyed, the yield reduction by the end of October was estimated at 25% (E. I. Prytherch). A weedy crop 10" high was quoted as sustaining less damage than one 18" high (G. R. Pain, D.A.O., Warwickshire), and this trend is supported by another statement: "it appeared that the earlier the kale was sprayed the more effective was the control of the weed and the less depressing was the effect on the kale growth". (R. D. Williams, A.C.A.O. (Adv.) Anglesey). However, there was not unanimity as to the least vulnerable of the later stages of growth.

Probably some of the most reliable information available is that from the one and only replicated trial carried out for one year in Dorset. (J. F. Ormrod). The spraying of clean kale was carried out at the 2, 4, and 6 leaf stage with 9% and 15% acid. The least damage occurred at the 6-leaf stage when only ¼ of the leaf surface was killed and the ultimate yield only very slightly reduced.

Whilst the use of wetters has been advocated by Professor H. G. Sanders and others, the majority view has been that whilst difficult weeds are more easily killed thereby, the margin of selectivity is reduced and the amount of damage to the kale considerably increased.

Similarly, finer sprays tend to give better weed control but more crop damage.

Stage of Growth of Crop

Stage of growth has already been covered to some extent but the following observations give emphasis to the possibilities of developing techniques of spraying at earlier stages. Thousand-head was sprayed with 9% B.O.V. at the 1 - 2 true leaf stage, and whilst the cotyledons were completely scorched the true leaves were little affected. Weed-seedlings were killed 100%. (R. Garrett-Jones, Assistant to the P.G.O., Wales). Similarly, the view was expressed: "From observations, I think it is advisable to spray when the kale is in the 2 - 3 leaf stage (about 3" high). The leaves at this stage are erect, whilst the Charlock, which is approximately at the same stage, has leaves which are practically lying horizontally". (C. Turner).

Nitrogen Top Dressings as an Aid to Recovery

The application of from 2 to 3 cwt. per acre of a nitrogenous fertilizer immediately after, or within a short time of spraying to aid recovery, is widely recommended and seems fundamentally sound, especially where natural fertility is not too high. In Buckinghamshire, the possibilities of incorporating the nitrogen in the spray are being investigated, but it is too early for any recommendation to be made.

Application Techniques

As we have already indicated, the majority of crops have been treated at a stage when the weed has formed a protective canopy, the crop itself being frequently 12" - 18" high. Work with younger brassicas, i.e., from the seedling stage upwards, has been largely experimental. There is at least one case, however, of a farmer who by trial and error for a period of 4 years has reached the conclusion that it is best to spray at 6" - 8" in height (5 leaves) against Red-shank, Fat-hen and Charlock. One or other of these weeds appears regularly in profusion, and his problem is as much one of preventing seeding as of securing a kale crop. He only gets a partial canopy, but considers that earlier and more complete control of the weeds outweighs the greater temporary scorch of the kale plants. The amounts of acid used by him varied from 8 gallons per acre for Charlock and 12 for Red-shank, to 15 for Fat-hen.

The question of acid spraying tends to be tied up with kale crops grown for consumption in situ. For various reasons there is a marked tendency for these to be sown late (i.e., June - early July), and for the crop to be either broadcast or sown with narrow spacing. The farmer referred to in the previous paragraph, who, if he had relatively weed-free land, would sow in early July, actually sows a good fortnight earlier to allow for the set back resulting from spraying. Whilst on the subject of row spacing, one case was reported (S. J. Travers, P.C.H.O., East Midlands) where the contractor considered that kale plants crowded into wide drills definitely suffered greater damage from spraying, and he declined to deal with such crops.

In the majority of cases, the aim has been to apply the spray at 100 gallons per acre, and bearing in mind the "run-off" safety factor, this is undoubtedly sound procedure. Various types of machine have been used although much of the work has been done by the old Tullos barrel type sprayer. In one case with a "Plantector" there was difficulty in applying sufficient volume, and the machine was taken over the same ground twice. Non-acid resisting sprayers have been used from time to time, it being claimed that with thorough washing out immediately after use, little harm would result (P. A. Naylor, D.A.O., Hertfordshire). Low volume machines have on occasion applied neat acid with satisfactory results, and less harm to the machine, but the information collected has been very limited, and we feel that more should be known before this method is advocated.

Weather Conditions

Many have stressed the important influence of weather conditions before, during and after spraying, on the success of the operation. It should preferably be dry for 24 hours after spraying, and if the weed is wet at spraying time the concentration of acid should be increased. Even the effects of dew on the weed can give markedly poorer results. (K. MacLeod, D.A.O., Durham). This trend must, however, not be confused with the need for higher concentrations of acid to get the same degree of weed control following drought periods. There is evidence supporting the latter both from the South West and East Midlands. (W. Q. Connold and S. J. Travers).

Scope for Acid Spraying on a Commercial Scale in the Future

There is obviously much greater interest in the development of this technique in the north and west of the country than in the east, not because of ineffectiveness in the drier eastern climate (indeed the contrary seems to have been amply proved) but because labour and machinery for dealing with row crops are still relatively plentiful, and the older established methods of early planted kale in wider drills possibly predominate. Whilst climatic conditions in the higher rainfall areas are bound to increase the cost of mechanical and hand weeding (one farmer in South Wales put his labour costs for cleaning his kale crop in 1953 at £25 per acre) and so make spraying an attractive alternative, the writers of this report feel convinced that with the steady trend towards higher labour costs, the acid spraying of brassicas is certain to gain in popularity and to extend into areas where it is at present regarded with indifference or contempt.

The greatest obstacle at the moment to the spread of the practice in those areas where its value is recognised, is the absence of contractors who are prepared to use acid. This is a serious matter from other points of view (e.g., the lack of facilities for burning off potato haulm, and for dealing effectively with many growth-regular-resistant weeds, such as Cleavers in cereals, Chickweed and Knotgrass). We believe that County Agricultural Committees could use their influence, as is being done in Dorset (A. T. Haesler, A.C.A.O., (Adv.)) to persuade contractors of the need for this work.

Even where contractors exist with facilities for acid spraying, they cannot of course, be expected to take full responsibility for damage which may arise from the acid spraying of Brassicas; but, as in Wiltshire, where no catastrophies known to us have occurred, and where each crop is inspected before spraying by a senior member of the firm and a signed chit obtained from the farmer that he accepts full responsibility, they can suitably safeguard themselves.

For those crops which would otherwise have had to be ploughed-in because of weed smother or where the farmer would have had to face a prodigious expense in hand-weeding, acid spraying at a cost of about £3 per acre, followed by an expenditure of £2 - £3 per acre on a top dressing of nitrogen, has in almost every case, apparently, resulted in a crop of 15 - 25 tons per acre of kale, and the farmers have been satisfied or delighted with the result.

Acknowledgments

May we take this opportunity of thanking all those who have contributed information for this summary. As was inevitable, much of the evidence was conflicting and much of the material sent in, as well as many of the names, have had to be omitted. We hope, however, that our summary has done something towards clarifying the position and that it will be of interest to the Conference.

List of Abbreviations

D.A.O.	District Advisory Officer
A.C.A.O.	Assistant County Agricultural Officer (Advisory)
C.A.O.	County Agricultural Officer
C.H.A.	County Horticultural Adviser
P.G.O.	Provincial Grassland Officer
P.C.H.O.	Provincial Crop Husbandry Officer
N.I.A.B.	National Institute of Agricultural Botany
A.R.C.	Agricultural Research Council

The photographs appended are intended to illustrate (1) the possibilities of spraying with acid while the weeds are still young and, of course, before they afford any protection to the crop; and (2) the type of leaf damage observed in the crop. The crop is on Mr. D. H. Feren's Great Ambrook Farm, Ipplepen, Newton Abbot, where the various treatments were arranged by D. G. Baglow, D.A.O., Newton Abbot in consultation with G. E. Furse, C.H.O., Starcross, and one of the authors who took the photographs.

Photo A Sprayed on left; unsprayed on the right.
Photographed 42 days after spraying with 7½% acid; at the time of spraying the kale was mostly still at the 2 true-leafed stage, and the charlock in the rosette stage.

Photo B Sprayed on the right; unsprayed on the left.
Photographed 30 days after spraying with 10% acid; at the time of spraying the kale was at the 4-5 true-leafed stage, 11" high, with the charlock up to 2 feet high and flowering. (The flower heads in the sprayed area shot up from the unharmed lower portion of immature stems).

Photo C Sprayed on the left; unsprayed on the right.
Photographed 17 days after spraying with 10% acid; at the time of spraying the kale at much the same stage as in B, but the charlock being a little higher, in full flower and with some pods formed. This is the stage at which spraying usually takes place in a last attempt to save the crop. (The absence of flower heads is attributed to the inability of the mature plants to throw up new growth, as happened in B).

Photo D Typical spray damage to the crop. (17 days after application.)
After spraying, the immediate affect on the crop is disturbing, to say the least, but recovery is rapid, depending on stage of growth and soil fertility.

PHOTO A

PHOTO B

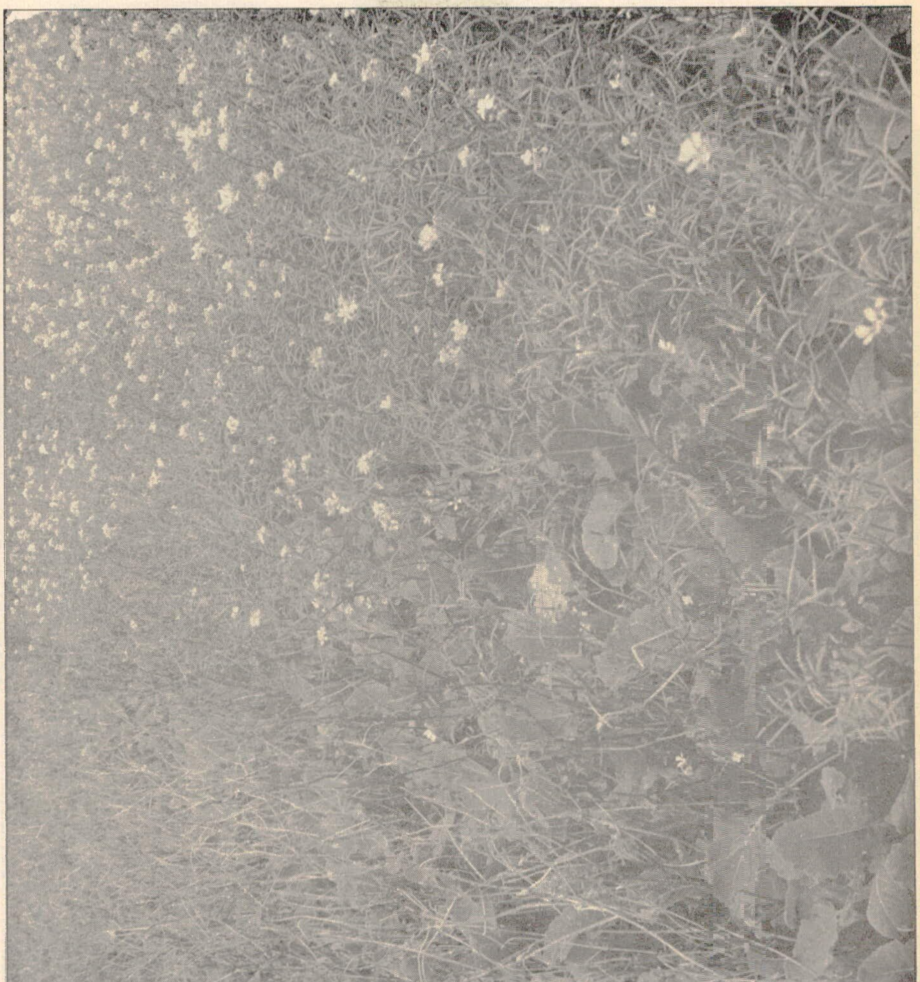


PHOTO C

PHOTO D

(22394-3)10

WEED CONTROL WITH DNC (SODIUM) AND MCPA (SODIUM) IN FIBREFLAX IN DENMARK

P. SONNE FREDERIKSEN
(Dansk Hørforskningsinstitut, Viby J., Denmark)

Summary

A considerable number of trials made in Danish fields of fibre flax showed a particularly good effect from a spray made of a mixture of DNC (sodium) and MCPA (sodium). Against the crop of fibre flax the mixed spray proved to be more lenient than sprays of corresponding weed killing effect but made from only one of the two chemicals, and it is of a more comprehensive effect against the weeds.

The trials show that with spraying equipment corresponding to that used in practical field spraying it is possible in fibre flax to obtain as good an effect with 300 litres liquor per hectare (26.7 galls/acre) and a pressure of 20 atmospheres (294 p.s.i.) as with 1000 litres liquor per hectare (89.0 galls/acre) and a pressure of 3 atmospheres (44 p.s.i.). A reduction in the amount of DNC (sodium) used per hectare is possible with the former method of application.

Introduction

Because of the special use of the straw of flax an abundance of weeds means a much more serious effect on the economical value of fibre flax as compared with grain crops. During the pulling by machine the weeds are to a great extent included in the pulled straw, where they increase the processing costs, thus reducing the value of the crop, and contaminate the fibre products. The latter inconvenience is especially the case in the tow, in which all kinds of vegetable remains can be found, but a few species of weed are found also in the scutched flax. These objectionable species are in Denmark mainly *Chenopodium album* (Fat hen) and *Polygonum* spp., especially *Polygonum convolvulus* (Black bindweed). Both of them contain in their stalks bast or vascular bundles, which withstand the action of the scutching turbine. Remains of their stalks therefore are mingled with the long fibre, where they cause much damage during the later spinning operations and, as a result, they cause the flax fibre to be placed at a comparatively low price level.

I. Investigations from 1939 to 1948

Trials with weed control in fibre flax in Denmark were started by the Government Stations for Experiments and Research in Plant Culture in 1939.

The results from the first 10 years' experiments are briefly as follows:-

(1) That it is possible to control weeds with harrowing along the rows when the flax plants are from 2 to 4 centimetres (2.54 centimetres = 1 inch) of height and provided that the soil is not too loose.

(2) That it is possible to control effectively weeds with inter-row weeding if the flax is sown at a distance of 15 to 18 centimetres between the rows and the weeding is done when the flax plants are not more than 6 centimetres of height.

(3) That chemical weed control is possible also in fibre flax if the right product and the right spraying time are chosen.

The old traditional weed control products: Ferric sulphate, sulphuric acid, sulphate of copper, chloride of copper, and calcium cyanamide were all tested. Nearly all of them caused considerable yield decreases, even when the weed was much dominating. Until recent years, however, sulphate of copper was considered usable and recommended for practical use at a quantity of 18 to 24 kilos per hectare (1.1209 kilos per hectare = 1 lb. per acre), corresponding to 600 - 800 litres spray (100 litres per hectare = 8.9 gallons per acre) at a concentration of 3%.

The sulphate of copper is effective against Sinapis arvensis (Charlock) and Polygonum species, which are common weeds in Danish fields, but is not able to kill effectively Chenopodium species, which are very common too. Against Chenopodium species 50 to 100 kilos of calcium cyanamide therefore was often previously used.

II. Investigations from 1948 to 1954

After the great war, 1939-1945, when the Danish linen industry changed to making linen products of finer quality, the demand for the quality of flax straw increased. The Danish Flax Research Institute, which was established at the end of 1945, therefore nearly from its beginning has considered chemical weed control in flax fields as important work and has carried out field trials and investigations concerning the problem.

The trials were carried out as rows of systematically distributed 10 square metre plots (= 12 square yards) with a distance of 0.5 metres (= 19.7 inches) between the plots. There were 5 replications in each of the trials. Sprayings were done with a hand sprayer (table 1) or a motor sprayer (table 3) equipped with a special sprayboom which was carried over the plot by 2 men. The boom had 5 nozzles placed at a distance of 0.4 metres (= 15.7 inches). The quantity of liquor was measured by means of a stop-watch. The trials were sprayed when the flax plants were 3½ to 6 centimetres (= 1.4 to 2.4 inches) in height and with a temperature range measured between the plants from 14°C to 27°C.

The effect on the weeds was determined from 3 selected species of weeds, Sinapis arvensis (Charlock), Chenopodium album (Fat hen) and Polygonum convolvulus (Black bindweed). The number of these weeds was counted just before spraying and after about 10 days in marked areas in each plot (0.5 or 1 square metre). The other species of weeds were counted collectively.

The crop after harvesting was processed in the plant of the Danish Flax Research Institute through warm water retting in a tank and scutching on a turbine. This processing corresponds to a industrial methods.

The first part of the investigations (table 1) indicates that the new weed control products, DNC (3,5-dinitro-o-cresol), dinoseb (2,4-dinitro-6-sec-butylphenol), and MCPA are - if any of them is used alone - much superior to sulphate of copper and cupric chloride being not only more effective against the weed but less damaging to the fibre flax plants. The additional yield for the treatment should be studied especially with regard to seed and the long fibre. From these columns it appears that the two traditional chemicals, applied at the quantity necessary (30 kilos per hectare = 0.24 cwt per acre) for controlling the weed to a satisfactory degree, only caused an increase of 50 kilo seed per hectare, whereas DNC (sodium), dinoseb (ammonium), and MCPA (sodium) gave rise to additional yields of 127 - 188 kilo seed and 69 - 105 kilo long fibre per hectare, and a mixture of DNC (sodium) and MCPA (sodium) additional yields of 259 kilo seed and 129 kilo long line fibre.

(22394/13)3

Table 1. The effect of chemicals sprayed in a water solution at 1000 liters per hectare (89 gallons per acre) and a pressure of about 3 atmospheres. Hand sprayer.

Number of Trials	Chemical, kilo active matter per hectare (commercial name in brackets)	(1) Unthreshed straw kilos per hectare	(1) Threshed straw kilos per hectare	Seed (1) kilos per hectare	Long Fibre (1) kilos per hectare	Long Fibre grade	Tow (1) kilos per hectare	Tow grade	Proportionates for nett value of yield	(2) Weeds counted per 10 meters² Sinapis arvensis (Charlock)	Chenopodium album (Fat hen)	Polygonum convolvulus (Black bindweed)
7	No treatment	5928	3571	967	641	D-	214	3+	100	146	327	45
7	30.0 sulphate of copper (Blasten)	+ 62	+ 91	+ 53	+ 16	D	+ 29	3+	107	- 120	- 106	- 39
7	2.5 DNC(sodium) (Herbanit)	+ 514	+ 403	+ 174	+ 77	D	+ 1	4-	117	- 140	- 121	- 37
7	0.5 MCPA(sodium) (Herbatox or Dicotox)	+ 448	+ 355	+ 127	+ 69	D-	+ 12	4-	114	- 124	- 203	- 8
5	0.75 dinoseb(ammonium) (Sevtox)	+ 415	+ 376	+ 155	+ 76	D	+ 9	3+	118	- 135	- 134	- 25
5	1.25 DNC(ammonium) (Stirpan)	+ 552	+ 452	+ 188	+ 105	D+	+ 1	3+	123	- 134	- 140	- 21
5	1.25 DNC(sodium) (Herbanit)+ 0.5 MCPA(sodium) (Herbanit or Dicotox)	+ 749	+ 638	+ 259	+ 129	D	+ 24	3+	130	- 140	- 243	- 42
2	30.0 chloride of copper (Raphanit)	+ 52	- 1	+ 46	- 12	D-	- 8	3+	99	-	-	-

469

(1) 125.54 kilos per hectare = 1 cwt. per acre.

(2) Besides the 3 weeds stated there were counted per 10 square metres on an average about 1250 specimens of small or infrequent varieties (especially Polygonum aviculare (Knot grass)). In the same area as a rule 18.000 - 20.000 flax plants are found.

Also from the results stated in table 1, it can be seen that DNC (ammonium) can be used similarly to DNC (sodium) provided that the efficiency of the ammonium salt is duly taken into consideration. In addition, dinoseb (ammonium) caused an excellent yield increase and had a good effect against the weeds. However, after the completion of these trials (table 1) subsequent experiments have been made mainly with DNC (sodium) and MCPA (sodium), either alone or as a mixture, these materials being considered the most suitable for practical spraying operations.

In trials not reported here DNC (ammonium) at a concentration of 0.125% has the same effect as DNC (sodium) at a concentration of 0.25%. In addition, DNC (sodium) does not have its full action against the plants before 12 hours after spraying, whereas DNC (ammonium) develops its effect in a few hours (table 2). The slowly acting chemical is subject to the influence of the day temperature to a considerably lower degree than the quickly acting chemical, and therefore in the hands of the practical spraying man it has the most uniform effect from one field to another and from one day to another.

Dinoseb (ammonium) showed mainly the same way of acting as DNC (ammonium).

Table 2.

The effect of DNC (sodium) and DNC(ammonium) influenced by rainfall a short time after time spraying.

Hours from spraying until rainfall	DNC(sodium), 0.25%		DNC(ammonium), 0.25%	
	Action(1) on flax	Action(2) on weed	Action(1) on flax	Action(2) on weed
3	7	45	40	80
8	7	86	33	96
30	43	100	77	92

(1) Grade of scorching, from 0 to 100.

(2) Percentage of killed Sinapis arvensis(Charlock).

In the years from 1951 to 1954 20 experiments in all were made with each of DNC(sodium) and MCPA(sodium) as well as with mixtures of both.

The results of the trials (14 from 1951-53) already processed are given in table 3.

The figures show that the control of weeds with DNC(sodium) and MCPA(sodium) resulted in additional yields of seed and long fibre of 264 - 319 kilos and 120 - 153 kilos respectively per hectare, or an increase of the nett value of yield by 34 - 44%. If the decrease of the number of weeds is taken into consideration it appears from the trials that 1.0 kilo DNC(sodium) employed in 300 litres at a pressure of 20 atmospheres has nearly the same effect as 2.0 kilos employed in 800 litres at a pressure of 3 atmospheres. Such a difference in efficiency seems not to apply to different methods of spraying MCPA (sodium).

A mixture of DNC (sodium) and MCPA(sodium) gives a more comprehensive control of weeds and seems to have no more ill-effect on the flax plants than that caused by the most effective chemical found in the mixture.

(22394/13)4

Table 3. The effect of DNC(sodium) and MCPA(sodium) respectively or in a mixture. Motor sprayer. 14 trials, 1951–1953.

Chemical, kilo active matter per hectare (commercial name in brackets)	Volume application per hectare and pressure of sprayer (1)	Unthreshed straw(2) kilos per hectare	Threshed straw(2) kilos per hectare	Seed (2) kilos per hectare	Long fibre			Tow	Length of stem (3) centimeters	proportionates for nett value of yield	Weeds counted per 10 square meters (4)		
					(2) kilos per hectare	grade	(2) kilos per hectare	grade			Sinapis arvensis (Charlock)	Chenopodium album (Fat hen)	Polygonum convolvolus (Black bindweed)
No treatment		6254	3433	865	624	D–	248	2+	60	100	849	334	153
2.0 DNC(sodimm) (Herbanit)	800 litres, 3 atm.	+ 896	+ 831	+284	+120	D	+ 10	2+	+ 2	134	–796	–273	–136
1.0 DNC(sodium) (Herbanit)	300 litres, 20 atm.	+ 959	+ 863	+265	+136	D+	+ 1	3–	+ 2	138	–764	–263	–133
0.4 MCPA(sodium) (Hertanit)	800 litres, 3 atm.	+ 746	+ 871	+264	+127	D	+ 12	3–	+ 2	138	–819	–310	– 90
0.4 MCPA(sodium) (Herbatox)	300 litres, 20 atm.	+ 736	+ 896	+266	+122	D+	+ 17	3–	+ 2	140	–807	–320	– 85
0.5 DNC(sodium)+ 0.4 MCPA(sodium)	300 litres, 20 atm.	+1066	+1087	+317	+138	D+	+ 19	3–	+ 3	141	–842	–319	–117
1.0 DNC(sodium)+ 0.2 MCPA(sodium)	300 litres, 20 atm.	+1056	+1053	+319	+153	D+	+ 9	3–	+ 3	144	–843	–322	–132
Sig. diff. (P = 0.05)		331	303	96	62								

(1) 100 litres per hectare = 8.9 gallons per acre.
(2) 125.54 kilos per hectare = 1 cwt. per acre.
(3) 2.54 centimeters = 1 inch.
(4) Besides the 3 weeds stated there were counted per 10 square metres on an average about 600 weeds of small or infrequent species (e.g. Polygonum persicaria, Polygonum aviculare, Raphanus raphanistrum, Anchusa arvensis, Stellaria media, etc.),

The level of yield (table 1 and 2) in the trials is normal for Danish flax fibre production, and the growth of weeds per 10 square metres stated in the tables is also an expression for normal Danish fields of agriculture.

III. Problems for the future experiment work.

The flax plant is of the same type and essentially similar in form to the species of weed to be controlled and to crops such as clover and beets, which are susceptible to many herbicides.

The flax plant is damaged only to a relatively low degree by the scorching type herbicides (DNC and dinoseb) and is rather resistant to MCPA products. The reason for the first is to be found in a much developed wax layer on stem and leaves and the protective placement of the upper leaves round the point of growth. The rather good resistance to growth regulators may be on account of the same circumstances, but further work must be carried out before this can be confirmed.

For future investigations concerning chemical weed control in fibre flax there is a series of problems the solution of which will be of importance:-

(1) Investigations on the quantity of wax on the flax plants and its variation in relation to the height of plant and the climatic conditions.

(2) Determination of the quantity of wax in various varieties of flax and simultaneous investigations on the resistance of the varieties to contact herbicides.

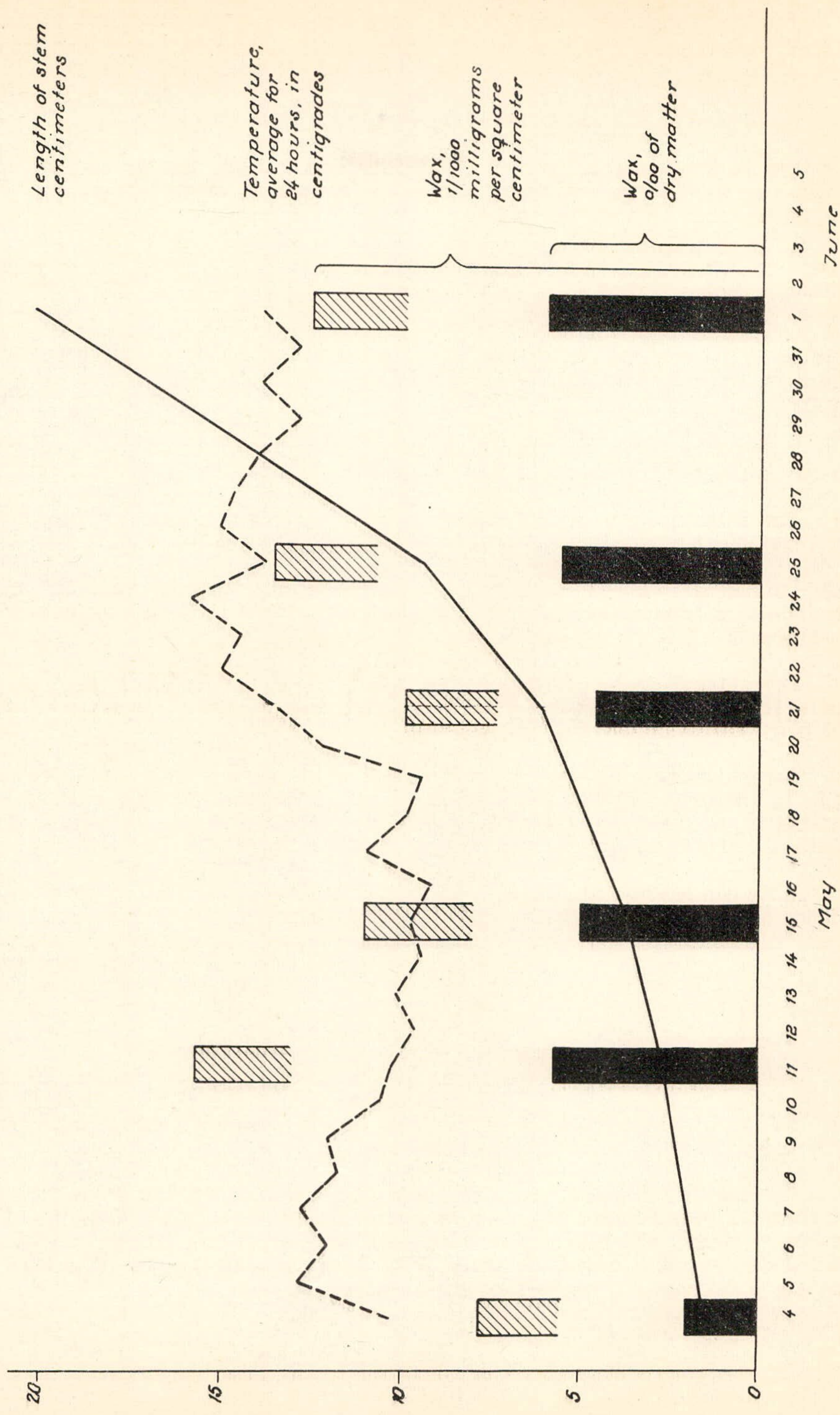
(3) Investigations on spraying at an earlier stage of growth of the flax as there is a large quantity of wax in the flax plants at the stage when they are 2-3 centimetres high (see fig. 1).

Investigations in progress from which results for 9 crops are given in fig. 1, indicate that the quantity of wax per unit area differs in relation to the height of plant, to the temperature and perhaps also to other climatic conditions. It is hoped that studies on these problems will be continued.

MCPA can cause buckling of the plants if sprayed too late. Even if the plants do not buckle they can, however, be checked by MCPA. Especially in a summer deficient in rainfall, the roots are damaged and the growth delayed for some time. When this check is overcome the growth regulator has apparently an accelerating effect on the growth and involves a vigorous branching together with formation of the so-called 'clerical' bands. (collars of leaves), which have a damaging effect on the contruction of fibre.

Investigations on spraying time (height of plants) and quantity of chemical with regard to the smallest possible disturbance of growth and avoidance of clerical bands are of great importance in relation to a possible extension and a more profitable use of MCPA in fibre flax.

For the Danish cultivation of fibre flax the last 10 years' development of chemical weed control has been of extraordinary importance. In the last few years nearly all flax fields have been sprayed. Only if the flax has been undersown with clover or grass or if it is absolutely free from weed are there motives for neglecting weed control.



Length of stem centimeters
Temperature, average for 24 hours, in centigrades
Wax, 1/1000 milligrams per square centimeter
Wax, 0/00 of dry matter
20
15
10
5
0
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5
May
June

SURVEY OF SWEDISH EXPERIENCES OF CHEMICAL WEED-KILLERS USED IN FIBRE FLAX DURING THE YEARS 1940-1953

KÅRE FRÖIER, D.Sc., A.L.M., Head of Dept. of barley and fibre plants & Flax laboratory, and
HENRYK ZIENKIEWICZ, M.Sc.Agr., First Assistant

The Swedish Seed Association, Svalöf

Summary

Weed-killing in fibre flax by aid of chemicals is complicated owing to the great sensitivity of the flax towards practically all preparations hitherto devised and tested. The fibre quality, chiefly the percentage of long-fibre, is even at relatively low concentrations of the herbicide spray perceptibly reduced, causing considerable economic losses.

If very low, and for the flax fibre harmless concentrations are used, the weed-killing effect wished for is on the other hand not achieved. The action of the chemicals on the weed flora must hence always be carefully weighed against the quality damages of the flax.

The authors report the chief features of Swedish field and laboratory research work 1940-1953 on this general problem (see also list of references) and suggest at the end of the paper the use and further development of combination preparations (DNC + MCPA) as a convenient way of chemical weed control. They also, however, stress the great importance of prophylactic soil treatment by various cultivation measures. The flax should be given an optimal place in crop rotation, so that an as weed-free seed-bed as possible is given from the start of flax vegetative growth.

The selective action of DNC and MCPA types on the weed flora is discussed and exemplified. It seems, according to the present writers' results very probable that by using combination preparations of the "KOC" type a much wider range of Swedish fibre flax weeds can be successfully combated.

Introduction

Weed killing in fibre flax by aid of chemicals started in Sweden during the years 1940-1943 shortly after the revival of flax growing in connection with World War II. From the very beginning it was clearly understood that flax growing and its future progress in Sweden would to a very great extent depend on the growers' efforts to keep the flax acreage free from weeds. The high labour costs (contrary to such countries as for instance the Netherlands and Belgium) exclude any manual weed cleaning. Hence the Swedish flax growers from the very first asked for chemical weed killers as chief complement to the usual prophylactic agricultural soil treatments.

Plans for field trials with different chemicals were devised by The National Agricultural Research Centre (Statens Lantbruksförsök) at Uppsala, in the first instance directed towards determining the effects on annual weeds.

The field research work with flax is in our country conducted in close cooperation between 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 top organization of the Swedish flax factories.

The harvest from all local fibre flax trials is entrusted to the Svalöf Flax laboratory for determination of seed and straw yield, processing and final quality grading. This has consequently also been the case with the trials concerning effects of weed killers. At The Royal Agricultural High School, Uppsala, comprehensive and very valuable work has been carried out on effects of weed killers on different plants, among them also fibre flax; some of these investigations have not been included in the common collaboration programme. Finally, the Flax laboratory has carried out certain investigations on weed killing chemicals on its own behalf since the laboratory has to advise and help a number of Scanian flax growers, contracted in order to secure a sufficient and economic production of fibre (the laboratory is run as a small-scale factory besides its function as a quality research centre).

As a start, before the more modern compounds were known, Swedish field research work concentrated upon the effects of calcium cyanamide (still used by the farmers to a certain extent) and also of common salt alone or mixed with copper salts (e.g. $CuSO_4$). Later on, the various nitro-cresol compounds appeared on the market. In the course of development different types of hormone derivatives entered into the picture and had to be carefully studied and tested. Finally, during the last few years, the effect of mixtures of hormone derivatives chiefly of the 4K-2M - type and nitrocresol compounds - DNC-type - has been studied. Fibre flax is, as well-known, very sensitive to chemical treatment, and the fibre quality is unfortunately very easily damaged. On the other hand the demand for weed-free flax straw is pressing; hence the main interest now centers upon chemical compounds which eradicate as many of the usual weed species and genera as possible without producing too great damage to the fibres; a certain damage must practically always still be counted with.

A list of literature (1 - 17) at the end of this communication may serve the reader as a practically complete tabulation of Swedish research work on weed-killers in fibre flax up to now. We regret that not all of the publications enlistened have been furnished with summaries in English or other foreign language. The especially interested reader must kindly be referred to direct translation.

Below, the reader will find some comments on the practically more interesting results so far gained.

Results from earlier years

In a trial series 1941-1942 the following chemicals were tested: sulphuric acid 3.5 per cent solution, 2 per cent $CuSO_4$ + 2 per cent NaCl, 1.5 per cent "Disulit" ($CuSO_4$ chiefly), 0.75 per cent "Sinox" (nitrocresol), 0.75 per cent "Sinox" + 0.2 per cent "Actisinox" (nitrocresol), and, finally, calcium cyanamide, not oily, in a dose of 150 kgs/hectare. All the former compounds were given in doses of 800 litres/hectare. On the whole the straw and seed yield was raised by the treatment. The fibre quality differences did not, however, significantly differ in this series (10).

Continued field trials 1943-1945 (11) confirmed the positive effect on straw and seed yield and simultaneously pointed to a definite superiority for the different nitrocresol compounds. The rather weak action of the sulphuric acid upon the weeds combined with its obviously great damage on fibre quality was clearly demonstrated. Thus, in 1944 ten trials average showed a marked reduction of the long-fibre yield - from 0.7 to 2.0 per cent which means a considerable damage, the total long-fibre percentage varying at that time from 13 to 15 per cent on the average.

From fibre quality point of view a treatment with 1 per cent solution of "Ewosid" (a paste with 19.3 per cent DNC of Swedish industrial experimental production) in these series showed the least damage. The weed-killing effect was, however, somewhat unsatisfactory. As average of 25 trials 1944-1945 sulphuric acid diminished the long-fibre by 1.8 per cent (i.e. about 80 kgs/hectare, meaning a loss of about 20 guineas' worth per hectare), the copper-compound "Disulit" (24.6 per cent Cu and 5.8 per cent Cl) by 1.1 per cent, and the "Ewosid" by 0.9 per cent (12).

In 1946 the first hormone compound entered into field research trials, "Agroxon" (4 per cent solution = about 3.2 kgs/hectare of MCPA). Besides, the two DNC-preparations "Extar Sandoz" (2 per cent solution = about 3.3 kgs DNC/hectare) and "Am-Stirpan" (1 per cent solution = about 2.1 kgs/DNC/hectare) were tested. Sulphuric acid was also included in these trial plans - somewhat unnecessary perhaps. The two DNC-preparations on an average augmented the straw yield by 12 per cent and the seed yield by 20 per cent compared with untreated flax. The long-fibre percentage diminished with sulphuric acid 2.1 per cent and with the DNOC-preparates 1.5 and 1.3 per cent respectively. A remarkably strong effect of the "Agroxon" was noted, especially upon fat hen (Chenopodium album), creeping thistle (Cirsium arvense) and other weeds which had earlier proved practically resistant towards DNC-treatments, that is, in doses below the optimum for not getting serious fibre damage. Shortly after the spraying it was found that the dosages of "Agroxon" employed were by far too heavy, causing the very characteristic "bends" (S-curvatures) of the culms (cf. Figures 1 and 2).

The same year two large accessory trials were therefore laid out in which the effects of "Agroxon" in 1, 2 and 4 per cent solution (0.8, 1.6 and 3.2 kgs active substance per hectare) were carefully studied. These trials gave the result that even so low concentrations as 1 per cent "Agroxon" sprayed in 1000 litres/hectare caused quite considerable fibre damage. The reduction of long-fibre was thus no less than 1.6 per cent in comparison with untreated flax. Hence the 1946 results served to point out the great sensitivity of fibre flax to "Agroxon" and indicated a further reduction of the dosage of this preparation as necessary.

Table 1. Effect of spraying against weeds in fibre flax in the counties of Halland, Kronoberg and Uppsala in 1947. Average from 7 trials.

	Yield of straw		Yield of seed		Long fibre %	Tow %	Total fibre %
	Kgs/hectare	Rel. figures	Kgs/hectare	Rel. figures			
Untreated	2570	100	520	100	11.5	4.9	16.4
1000 litres of sulph. acid 3 per cent	2920	114	620	119	10.4	5.8	16.2
1000 litres of "Extar Sandoz" (DNC) 1.2 per cent	3330	130	670	129	10.2	5.2	15.4
1000 litres of "Stirpan" (DNC) 1.2 per cent	3220	125	710	137	10.0	5.5	15.5
1000 litres of "Agroxon" (MCPA) 0.5 per cent (8% act.subst. in market produce)	3370	131	760	146	9.4	6.1	15.5

In 1947 (cf. Table 1 above) the trials were concentrated to the then most active districts of Southern and Central Sweden, namely the counties of Halland, Kronoberg and Uppsala. The "Agroxon" (MCPA) concentration was reduced to only 0.5 per cent (about 0.4 kgs active substance per hectare; the market product used contained 8 per cent active substance). 1000 litres per hectare were sprayed. In spite of this very low concentration an average of 7 trials gave the disappointing result that the long-fibre percentage sank by 2.1 per cent - a greater reduction than by the DNOC- preparations and even by the sulphuric acid, as seen by Table 1. The result is disappointing also if we calculate the total fibre yield per hectare, because the quality gradings of the quality gradings of the "Agroxon" - treated flax gave low figures (not included in the tabulation here).

Morphological effects of weed-killing substances on flax

The action of fibre flax and on its more common Swedish weeds of a great number of chemical preparations (among which the hormones dominated) was in 1946 subjected to a closer morphological study by Denward and Aberg (1) at The Royal Agricultural High School, Uppsala. The flax straw from these trials was sent down to the Svalöf Flax laboratory to be processed and tested as to quality of fibre.

The authors have studied the typical morphological and anatomical deformations and aberrations of the flax straw. The report on the fibre quality from these experiments is found in a paper by Granhall and Zienkiewicz (14). Summing up the results from papers 1 and 14, practically all chemicals tested in low, medium and strong concentrations caused perceptible alterations of the straw morphology and fibre quality.

The total length of the culm was thus in most cases somewhat shortened. A still greater reduction befell the so-called "technical length" of the culm (= the distance from the upper part of the root to the first point of ramification). In brief, the spraying has caused more numerous and deeper ramifications. The shortest and most richly branched straw was procured after spraying with 2,4-D acid. On the whole the flax straw from plots treated with 2,4-D acid or its sodium salt was less favourable in appearance. The plants were as a rule dwarfed, weak, and displayed abnormally thick and swollen spongy roots (cf. 2 in Figure 3).

Figures 1 and 4 illustrate various anomalies of ramification (untreated flax to the left). Figure 1 shows different straw development as function of increasing dosages of 2,4-D acid (1 - untreated). Note the strongly misshapen culms in 5, 6 and 7. Those abnormities were, however, clearly indicated even at the lowest dosage in 2, hardly to be seen in the photograph here; in 3 the beginning abnormal "S-bends" are quite visible.

The larger number of deep ramifications is no doubt the cause of the (sometimes quite considerably) raised seed yield in flax after sprayings with weed killers (1). The present authors have been able to verify this amply in several subsequent experiments. Apart from this positive spraying effect which has, however, practical relevancy only in growing oil flax, the anomalous stem branching in fibre flax represents a decided deterioration of fibre quality. Least quality damages have been found in spraying with low dosages of "Stirpan" and "Extar Sandoz" (both DNC types).

Microscopic examination has shown that only at such parts of the straw where morphologically observable defects are found (sharp bends, gnarls &c) definite abnormalities in fibre cell distribution and structure arise. These aberrations consist chiefly in fewer cells - as seen in transverse sections - and on the whole a most heterogeneous distribution with "empty" areas where, normally, well-developed fibre bundles should be seen.

When scutched on the large, fast-running turbines the fibre bundles must inevitably break off at such damaged points. The result is an augmentation of tow percentage at the expense of the much more valuable long-fibre (14).

Action of chemicals on the weed flora weighed against the quality damage of the flax fibre

Our practical advice to the fibre flax growers has during the last years been this: Spray against weeds only when you would otherwise be risking a considerable frequency and development of the weed flora! Remember that spraying does practically always cause a reduction of the fibre value!

This advice, however, presupposes that the grower does really know how to handle his soils carefully. It also presupposes that he is interested in doing this. He must keep the weeds away by carefully selecting the best place for the fibre flax in his crop rotation and by taking various cultivation measures. He should not rely solely upon chemicals.

We are well aware of these presuppositions being but haltingly fulfilled among the farmers nowadays. Fibre flax is, however, quite rightly at present considered as a specialized and rather difficult crop to grow. Hence it does in Sweden now chiefly attract the interest of the more advanced and skilled farmers in the South. Most of these growers do now quite well understand the great necessity of arranging a seed-bed for fibre flax, as free from weeds as possible already from the start of the growing season.

Even the best grower may, however, with bad luck in cold, wet spring seasons get considerable weeds in his fibre flax. What advice should then be given? This intricate question prompted us to study in Svalöf the selective action of the chemicals upon the weed flora more thoroughly, above all the action of the now mostly used commercial preparations of the DNC and MCPA types.

Selective action upon the weed flora

We have found that DNC types as "Stirpan", "Extar-Sandoz" and "Trifobloc" on one side, and MCPA types as "Agroxon" and "P 46" on the other, used in concentrations practically harmless for the fibre quality, constitute two groups clearly separated as to specific weed-killing range. The DNC types thus kill certain species but leave others quite unaffected. The MCPA types likewise display an obvious selective effect. The activity ranges of the two groups do not cover each other to any great extent.

It is true that when the concentration is raised both types of preparations display a wider range of weed-killing. This has, however, now to be carefully weighed against the simultaneously increasing devastating effect on the flax fibre.

Some examples of selective action could be given. We thus found that "Agroxon" supplied at suitably early stages of plant development (3 - 4 litres of 8 per cent market product per hectare) is practically harmless to the flax fibre but highly effective against the worst flax enemy, the fat hen (Chenopodium album). The same dosage has, on the contrary, far too limited effect on the nearly equally troublesome willow weed (Polygonum persicaria), as likewise on the cornflower (Centaurea cyanus), the black bindweed (Polygonum convolvulus) and the different Galeopsis species (hempnettles).

The last-mentioned weed group, in the first instance the willow-weed and the black bindweed can easily be combated by DNC-preparations according to our experiences best by "Stirpan". This preparation has, however, little or no effect on the fat hen.

Experiments with mixing the DNC and MCPA types

Observations on the selective effect mentiond above, collected from our own field experiments and from large-scale growing led us to try mixtures of the DNC and MCPA types. We used various combinations and concentrations in preparatory experiments in Halland on suitably weed-invaded flax fields, and then devised a rather comprehensive field trial plan to be realized at Svalöf and at the Flax Factory in Laholm, Halland, in 1950 and 1951.

In these 1950 and 1951 trials the effect on the various weed species was studied. Likewise, the effect on fibre quality was carefully detemined. Below, the results from each year are recorded separately.

Results from trials with mixed preparations in 1950

Following trial plan was used:

1. No treatment.
2. "Agroxon" (MCPA), 400 grs/hectare of active substance.
3. "Stirpan" (DNC), 1600 " " " " "
4. Preparation A: 8 litres/hectare (= 272 grs MCPA + 1040 grs DNC)
5. " ": 12 " " (= 408 " " + 1560 " ")
6. Preparation B: 8 litres/hectare (= 216 " " + 1120 " ")
7. " ": 12 " " (= 324 " " + 1680 " ")

Sprayed quantity was 500 litres/hectare. Spraying pressure was kept at 7 - 8 atmospheres. The spraying was carried out at 10 cm length of the flax plants.

3 field trials (2 at Svalöf, 1 at Laholm) with 4 replications each were laid out this year. Plot size was 25 sq metres, (assessed area 20 sq metres). Plots randomized as usual. The results (average from all 3 trials) are found in Table 2 below.

As seen from Table 2, all preparations had a certain yield-increasing effect, in the first instance on seed yield but also in most cases on straw yield. The best results have been achieved with the mixed preparations. The action of spraying upon long-fibre percentage was somewhat unfavourable - note the correspondingly raised tow percentage in all cases but one ("Stirpan"). The total fibre yield per hectare has on the whole even a marked tendency (no statistical significance) of being slightly raised for both preparations A and B.

The weed-killing effect was very good at the higher concentrations of preparations A and B (see 5 and 7 above).

Table 2. Results from spraying trials in fibre flax 1950 in Svalöf (2 trials) and Laholm (1 trial). Average from all trials.

Treatment	Straw kg/ha	Seed kg/ha	Long-fibre %	Long-fibre class	Tow %	Long-fibre kg/ha	Tow kg/ha	Total fibre kg/ha	Frequency of weeds+) before spraying	after spraying	at pulling
1. No treatment	5160	1037	14.1	II-	4.2	761	197	958	5.0	5.0	4.7
2. "Agroxon" 400 g/ha	5170	1143	13.6	III+	4.2	713	212	925	5.0	2.3	2.3
3. "Stirpan" 1600 g/ha	5211	1123	13.8	II-	4.0	737	214	951	5.0	3.2	3.2
4. Prep. A: 8 l/ha	5333	1157	13.7	III+	4.5	746	227	973	5.0	3.0	3.7
5. Prep. A: 12 l/ha	5286	1173	13.4	III+	4.4	724	221	945	5.0	1.7	1.7
6. Prep. B: 8 l/ha	5376	1130	14.0	III+	4.4	770	229	999	5.0	2.8	2.7
7. Prep. B: 12 l/ha	5316	1136	13.2	III	5.0	708	255	963	5.0	1.8	1.5

+) 1 = practically weed-free
5 = top frequency of weeds

Results from trials with mixed preparations in 1951

This year a much enlarged field trial plan was used:

A. No treatment.
B. Preparation "2": 8 l/ha (= 336 g MCPA + 880 g DNC)
C. " "4": 12 " (= 424 " +1408 ")
D. " "6": 12 " (= 384 " +1562 ")
E. " "7": 8 " (= 192 " +1166 ")
F. " "8": 8 " (= 256 " +1166 ")
G. "Stirpan", 4 kg/ha (= about 880 g DNC)
H. " , 5.3 " (= " 1166 ")
I. " , 6.4 " (= " 1408 ")
J. " , 7.1 " (= " 1562 ")
K. "Agroxon", 2.4 l/ha (= about 192 g MCPA)
L. " , 3.2 " (= " 256 g ")
M. " , 4.2 " (= " 336 g ")
N. " , 5.3 " (= " 424 g ")

Plot size and number of replications as in 1950 (above). Sprayed quantity 500 litres/hectare, pressure 7 - 8 atmospheres.

The trial was carried out at Scalöfsgården, Svalöf, in a flax field with a rich weed flora, representing practically all of the more troublesome flax weed species. Thus a considerable frequency of Polygonum persicaria, Chenopodium album and Galeopsis species occurred, homogeneously distributed in the chosen part of this field.

Table 3. Spraying trial in fibre flax 1951 at Svalöfsgården, Svalöf.

The flax straw pulled together with weeds.

Treatment	Deseeded straw Kgs/ha	Seed kgs/ hectare	Long-fibre per cent	class	Tow per cent	Long-fibre kg/hectare	Tow kg/hectare	Total fibre (long-fibre + tow) kg/hectare
A. No treatment	5510	460	2.2	IV	8.3	121	457	578
B. Preparation "2" 8 l/ha	6020	1150	9.0	III	8.9	542	536	1078
C. Preparation "4" 12 l/ha	7060	1340	9.1	III+	6.3	642	445	1087
D. Preparation "6" 12 l/ha	6940	1400	9.7	III	7.3	673	507	1180
E. Preparation "7" 8 l/ha	6630	1200	10.1	III+	6.6	670	438	1108
F. Preparation "8" 8 l/ha	6560	1200	7.1	III	6.6	466	433	899
G. "Stirpan" 4.0 kg/ha	5800	500	3.0	III	7.8	174	452	626
H. "Stirpan" 5.3 kg/ha	6450	870	8.3	III	6.7	535	432	967
I. "Stirpan" 6.4 kg/ha	6410	730	5.7	III	7.4	365	474	839
J. "Stirpan" 7.1 kg/ha	6480	760	7.1	III+	6.9	460	447	907
K. "Agroxon" 2.4 l/ha	5850	930	7.9	III	5.6	462	328	790
L. "Agroxon" 3.2 l/ha	5790	750	7.2	III+	7.1	417	411	828
M. "Agroxon" 4.2 l/ha	5680	910	9.0	III+	6.6	511	375	886
N. "Agroxon" 5.3 l/ha	6020	1100	8.9	III	6.4	536	385	921

The flax was sprayed on the 4th of June at a plant length of 8 cm, very few plants having then reached 10 – 12 cm length. After the spraying dry and warm weather persisted during twenty whole days. Hence the action of the different preparations must be supposed to have been the maximum possible. In order to ascertain the effect of the weeds in processing the straw the following measures were taken.

Exactly half of each plot was hand-pulled, deseeded and processed with all its weeds kept. At pulling, all weeds were thus here included in the bundles. The other half of each plot was pulled without the weeds. A careful assorting work had consequently here to be done on the field, incidentally and luckely favoured by good weather. The results of this large and rather laborious trial are found in Tables 3 and 4.

On those parts of the plots from which the flax was pulled without the weeds, the latter were gathered up after the pulling, air-dried and weighed so that the exact dry-weight of weeds per hectare after spraying with different preparations could be ascertained (Table 4).

The effect of the different preparations and concentrations upon straw and seed yield of the flax is best seen in Table 4 (the flax pulled without weeds). When the flax was untreated or when the sprayings had less effect against the weeds, the straw and seed yields have been quite considerably lowered.

The highest straw and seed yield was procured from plots sprayed with preparations "4" and "6" at dosages of 12 litres per hectare where the weed quantity was at the same time the lowest.

A general judgment of the total spraying effect in fibre flax should comprise straw and seed yield, long-fibre yield and quality, percentage and range of killed weeds and observations of flax plant development during the vegetative period. In passing such a judgment we have found that the combination preparation "6" at a dosage of 12 litres/hectare has on the whole given the most promising results. At lower weed frequency on the flax fields and when using larger, tractor-driven high-pressure sprayers we recommend, however, a somewhat lower dosage of preparation "6", namely 8 to 9 litres pro hectare.

This preparation was shortly afterwards brought on the Swedish market and named "KOC", now well-known among the fibre flax growers and getting more and more used. The renowned firm Bönnelyche & Thuröe Ltd., Malmö, supplied us with the necessary mixtures according to our wish, for which we have been much obliged. We would also like to express our gratitude to The Swedish Flax & Hemp Federation, Stockholm, which organization has given considerable economic support for the field research work in its total extension from 1950 onwards.

As seen from Tables 3 and 4, the results from plots sprayed solely with "Agroxon" and solely with "Stirpan" were considerably less favourable. In spraying solely with "Agroxon" about 57 percent of the weeds were killed at the highest concentration (5.3 litres/hectare) but only about 40 percent at the lowest, for the flax practically harmless concentration (2.4 litres/hectare).

The sprayings with solely "Stirpan" produced still less satisfactory results.

Table 4. Spraying trial in fibre flax 1951 at Svalöfsgården, Svalöf.

The flax straw pulled without weeds

Treatment	Deseeded straw kgs/ha	Seed kgs/hectare	Long-fibre per-cent	Long-fibre class	Tow per-centage	Long-fibre kg/ha	Tow kg/ha	Total fibre kg/ha	Weeds+) kg/ha	Weeds, relative figures	Weed percen-tage ++)
A. No treatment	2990	390	13.8	III	6.7	413	200	613	3250	100.0	108.7
B. Preparation "2" 8 l/ha	5770	1160	14.8	III+	4.7	854	271	1125	1200	36.9	20.8
C. Preparation "4" 12 l/ha	6150	1230	12.6	III+	5.6	775	344	1119	1020	31.4	16.6
D. Preparation "6" 12 l/ha	6000	1300	14.0	III+	5.8	840	348	1188	800	24.6	13.3
E. Preparation "7" 8 l/ha	5640	1130	14.8	III+	4.7	835	265	1100	1610	49.5	28.5
F. Preparation "8" 8 l/ha	5680	1190	14.2	III+	6.1	807	346	1153	1230	37.8	21.7
G. "Stirpan" 4.0 kg/ha	3680	480	14.0	III	6.0	515	221	736	3090	95.1	84.0
H. "Stirpan" 5.3 kg/ha	4520	750	14.3	III+	5.5	646	249	895	2000	61.5	44.2
I. "Stirpan" 6.4 kg/ha	4280	510	14.4	III+	6.8	616	291	907	2660	81.8	62.1
J. "Stirpan" 7.1 kg/ha	4590	740	13.8	III+	4.4	633	202	835	2190	67.4	47.7
K. "Agroxon" 2.4 l/ha	4080	710	15.3	III+	5.6	624	228	852	1930	59.4	47.3
L. "Agroxon" 3.2 l/ha	4760	890	15.4	III+	5.0	733	238	971	1410	43.4	29.6
M. "Agroxon" 4.2 l/ha	4240	730	15.2	III+	5.6	644	237	881	1590	48.9	37.5
N. "Agroxon" 5.3 l/ha	4800	920	15.7	III+	5.6	754	269	1023	1380	42.5	28.8

+) Weight of air-dried quantity
++) In percent of harvested and deseeded straw from the different treatments

In the processing of the flax straw pulled together with the weeds (Table 3) the economical output was considerably less, especially when the weed quantities in the straw bundles were large. The long-fibre percentage and also the total fibre production per hectare (long-fibre + tow) were heavily reduced. The establishing of these considerable weed losses is valuable. They clearly demonstrate for the practical growers the disastrous weed action upon fibre yield and quality, if the weeds are not effectively combated.

Our experiences from the 1950 and 1951 field trials together with continued observations these last years have indicated that the combination preparations of the "KOC" type need dry weather at least for 1 - 2 days after the spraying to display their full action.

Experiments with sprayings at different stages of plant development, with different water quantities and different pressures

During the years 1950-1953 in trials at Svalöf and at Tönnersa (Halland) we tried sprayings at different developmental stages of the flax plants, different water quantities at spraying and, finally, different spraying pressures. Earlier found results have on the whole been confirmed, and they could in summary form be put down as follows:

I. The optimal spraying time in fibre flax is at a plant height of about 5 - 6 cm if "Agroxon" or combination preparations are used. In spraying with "Stirpan" and other DNC compounds the plant height can vary from 5 to 15 cm without any appreciable quality damages, granted appropriate concentrations.

II. The water quantity should in fibre flax vary between 350 and 450 litres/hectare. Lower quantities should decidedly be avoided. The earlier prevailing tendency - quite understandable - in the technical development of the high-pressure sprayers to diminish the water quantities as much as possible (in some cases even down to 40-60 litres/hectare) seems fortunately enough to have been checked. It has been found that when spraying for instance quantities of 200 l/ha in flax, the hitherto designed sprayers do as a rule but unsatisfactorily atomize the water solution with the result that the weeds are not uniformly affected and the flax on the other hand partially damaged as to fibre quality. To employ larger water quantities than 400-450 litres seems wholly unnecessary according to our experiences.

III. The working pressure of the sprayer can vary from 3 to 12 atmospheres without any harm being done to the flax. As a rule, however, we recommend pressures of 7 to 8 atmospheres. The higher pressures (15 to 35 atmospheres) should not be applied to flax which is a very sensitive plant. Granted a less satisfactory atomization of the sprayed solution - which seems, unfortunately, to be the case in most sprayers hitherto devised - the solution is ejected in particles with such force that direct damages on leaves and straw arise. It must be reminded that even very small hailstones considerably affect young flax, causing the well-known and typical "hail gnarls" of the stem.

IV. Finally, the flax grower should always be recommended to control the preparation of the spraying solution carefully. Furthermore, he should attentively follow the weed development on the fields from the very sprouting of the flax to the optimal stages for a weed campaign. As a rule a disquietingly sudden and rich weed development is in most cases noted and reported too late to the trained advisers and servicemen at the Swedish flax factories. It is then very often merely a question of keeping the weeds back at any price, without considering the flax fibre quality, which is most regrettable.

References

1. DENNARD, T. and ÅBERG, E. Hormone Derivatives against Weeds. III. Introductory Studies and Spraying and Dusting Experiments. Växtodling (Plant Husbandry), 2, Uppsala 1947.

2. FREDERIKSEN, P.SONNE and JACOBSEN, H. Forsøg med kemisk Ukrudtbekaempelse i Spindhør. – Lin. Dansk-Svensk Hørtidskrift, nr 3, 1947.

3. FRÖIER, K. and DANELL, N. Cultivation and processing Trials in Fibre Plants 1947. – Meddelande nr 27 från Jordbruksförsöksanstalten, Norrtälje 1948. (English Summary pages 34–36).

4. FRÖIER, K., DANELL, N. och ZIENKIEWICZ, H. Odlings- och beredningsförsök med spånadslin under år 1948 och 1949. Meddelande från Statens Jordbruksförsök och Sveriges Utsädesförenings linlaboratorium 1950. (Only accessible as stencil edition at Svalöf).

5. FRÖIER, K., DANELL, N. och ZIENKIEWICZ, H. Odlings- och beredningsförsök med spånadslin under år 1950. – Meddelande fran Statens Jordbruksförsök och Sveriges Utsädesförenings linlaboratorium 1951. – (Only accessible as stencil edition at Svalöf).

6. FROIER, K., DANELL, N. och ZIENKIEWICZ, H. Odlingsförsök med spånadslin under år 1951. – Meddelande från Statens Jordbruksförsök och Sveriges Utsädesförenings linlaboratorium 1952. – (Only accessible as stencil edition at Svalöf).

7. FRÖIER, K., DANELL, N. och ZIENKIEWICZ, H. Odlingsförsok med spånadslin under år 1952. – Meddelande fran Statens Jordbruksförsök och Sveriges Utsädesförenings linlaboratorium 1953. – (Only accessible as stencil edition at Svalöf).

8. FRÖIER, K. och ZIENKIEWICZ, H. Kemisk ogräsbekämpning i spånadslin. En överblick på det aktuella läget med särskild hänsyn till fiberkvalitetssynpunkterna. – Lin, Dansk-Svensk Hørtidskrift, nr 3, 1951. (English Summary).

9. FRÖIER, K. and ZIENKIEWICZ, H. Results from continued experiments with weed-killing chemicals in fibre flax, conducted at The Flax Laboratory in Svalöf and at The Flax Factory in Laholm. – Lin, Dansk-Svensk Hørtidsskrift, nr 6, 1952 (English Summary).

10. GRANHALL, I. Fem års försöksverksamhet med spånadsväxter. – Sveriges Utsädesförenings Tidskrift (The Journal of The Swedish Seed Association), 1944 (English Summary).

11. GRANHALL, I. och LARSSON, N. G. Odlings- och beredningsförsök med spånadsväxter under aren 1943 och 1944. – Jordbruksförsöksanstaltens meddelande nr 14. Malmö 1945. (German Summary pages 64–68).

12. GRANHALL, I. och LARSSON, N. G. Odlings- och beredningsförsök med spånadsvaxter under 1945. – Jordbruksförsöksanstaltens meddelande nr 16. – Malmö 1946 (English Summary pages 614–616).

13. GRANHALL, I. och LARSSON, N. G. Odlings- och beredningsförsök med spånadsväxter under år 1946. - Jordbruksförsöksanstaltens meddelande nr 22. - Stockholm 1948 (English Summary pages 45-47).

14. GRANHALL, I. and ZIENKIEWICZ, H. Effect of different Weed Control substances upon Quantity and Quality of Flax Yield. - In "Nya framsteg i kampen mot ogräset", Växtodling (Plant Husbandry), 3, Uppsala 1948.

15. HAGSAND, E. The chemical weed control in fibre flax. - Lin, Dansk-Svensk Hørtidskrift, nr 2, 1953 (English Summary).

16. ÅBERG, E. Ogräskampen i spånadslin. - Lin, Dansk-Svensk Hørtidskrift, nr 9, 1948 (English Summary).

17. ÅBERG, E. Nyare erfarenheter rörande ogräskampen i spånadslin. - Lin, Dansk-Svensk Hørtidskrift, nr 3, 1951 (English Summary).

With the Editor's agreement, this paper is numbered and published as "Communications from The Swedish Seed Association, No. 86".

Four figures follow, figures 1 - 3 reproduced from 14 above, figure 4 not before published.

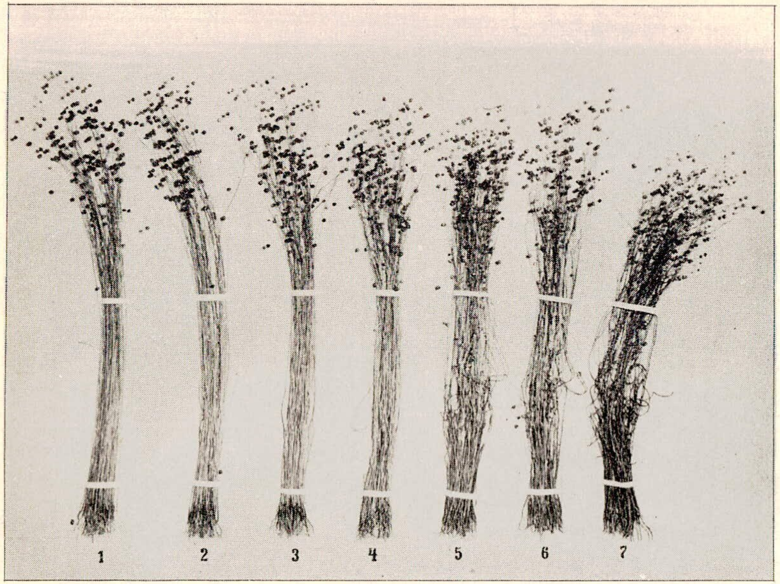


Fig. 1. Flax straw after spraying with "Weedone" solutions of different concentrations. 1. Untreated. 2. 0.1 percent. 3. 0.3 percent. 4. 0.5 pereent. 5. 0.7 percent. 6. 0.9 percent. 7. 1.5 percent. Note the decrease in length and the increasing abnormality of straw. The quantity sprayed was 1000 litres/hectare. "Weedone" contains in the market product 2,4-D acid to 9.6 percent according to the declaration of the producer.

From GRANHALL & ZIENKIEWICZ, 14.

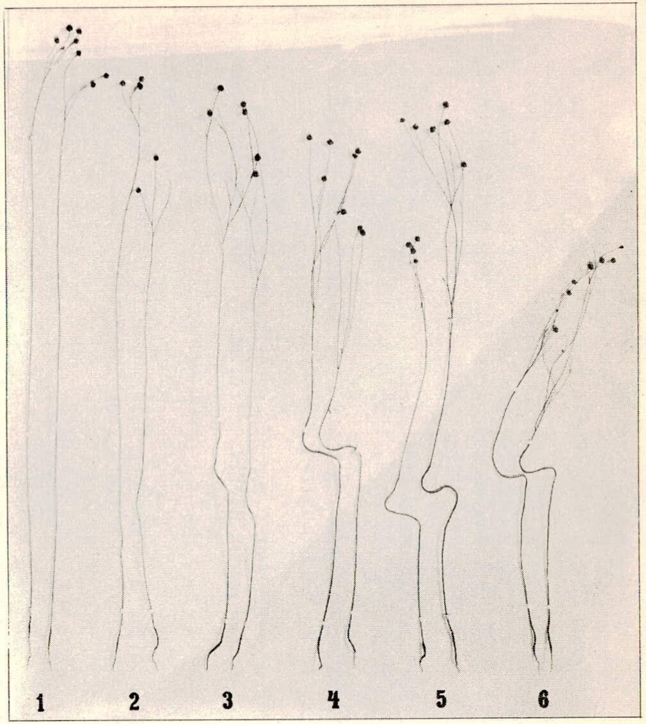
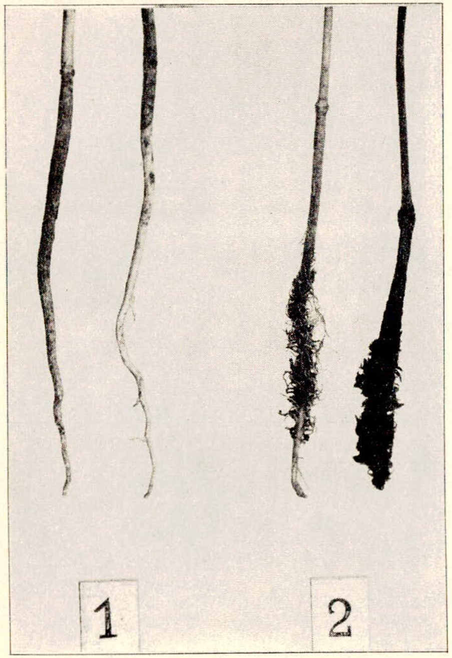


Fig. 2. Flax straw after spraying with "Weedone (2,4-D acid) solutions of different concentrations. 1. Untreated. 2. 0.3 percent. 3. 0.5 percent. 4. 0.7 percent. 5. 0.9 percent. 6. 1.5 percent. 1000 litres/hectare sprayed.

From GRANHALL & ZIENKIEWICZ, 14.



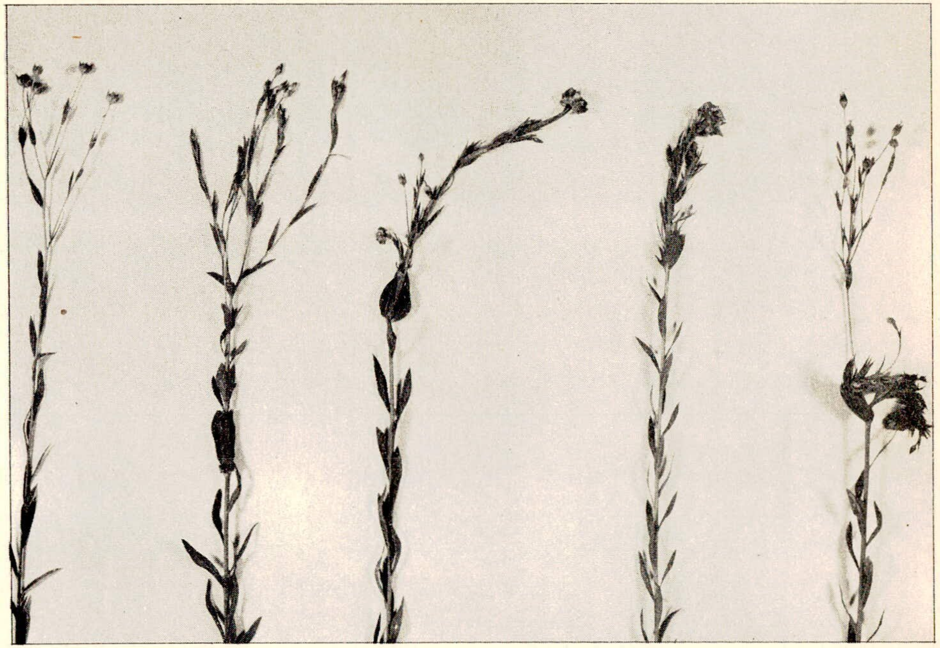


Fig. 3. Flax roots: 1. Untreated. 2. Sprayed plants: Solutions of 0.9 percent "Weedone" (= about 0.86 kg/hectare 2,4-D acid) to the left, and of 0.1 percent 2,4-D acid (= 1.0 kg/hectare 2,4-D acid) to the right. 1000 litres/hectare sprayed.

From GRANHALL & ZIENKIEWICZ, 14.

Fig. 4. Leftmost: untreated, normally developed flax straw. The other plants show various abnormalities, following treatments with "Weedone" (2,4-D acid) at plant heights from 3 to 5 cm. Photo: H. ZIENKIEWICZ, Svalof.

DISCUSSION ON FIVE PREVIOUS RESEARCH REPORTS

Mr. B. G. Hart: With reference to sulphuric acid for the control of weeds in brassicas: in the absence of experimental evidence I wonder if I might make one or two observations from a contractor's point of view, based on the experience of about 400 acres of acid spraying this year, mainly on kale. First of all, we obtained generally satisfactory results. I think the main problem is not so much risking a kill of the kale but of eliminating the weeds with a minimum check to the kale plants, also spraying at an early stage to get rid of the smother effect of the weeds as soon as possible. In that respect the canopy effect of weeds is very important in protecting the kale; I think in Mr. Connold's paper he has given the impression that where a good cover of weeds exists the time of spraying is not important. I suggest that it is still extremely important to get the spraying done early, and in the case of charlock before flower buds begin to form. The canopy effect is rapidly lost as flowers form and extra damage results to the kale from later spraying. The final point: it does seem that humidity and temperature at the time of spraying are rather important, more so than we thought originally and perhaps of equal importance to the weather that immediately follows spraying.

Mr. J. L. Hunt: I should like to comment very briefly on some of Mr. Parker's results with sugar beet.

The organisation to which I belong has been conducting trials with P.C.P. on sugar beet for about four years, using a miscible oil preparation. The results obtained from our trials have been much better than those obtained in Mr. Parker's trials, and I think that a possible explanation is that we have timed our applications differently. He has been using P.C.P. as a residual pre-emergence spray, whereas we have concentrated more on pre-emergence contact sprays, applying the weedkiller almost immediately before emergence of the sugar beet crop. In other words, we delay spraying for as long as possible. By this means we obtain a very much higher level of weed control than Mr. Parker has reported, and also greater selectivity.

Sugar beet is probably less susceptible to damage just before it emerges than when the spray is applied at an early stage in the germination of the crop.

The final point concerns the falling off in performance we have found by reducing volumes below 25 gallons per acre. We have found that application at the rate of 3½-6 lbs. of P.C.P. as a miscible oil in about 50 gallons of water, gives the best results.

Mr. C. D. Price: The feasibility of using sulphuric acid as a weedicide in crucifer crops is of real interest in the North of England where during the last few years several farmers have been using acid on both broadcast and row crops. This season therefore the N.A.A.S. decided to carry out a little investigational work on this problem. Two observation trials (among others) were carried out on well grown kale crops. In one case the kale was heavily infested with chickweed and in the other instance with redshank. The land was in a high state of fertility and crops and weeds, both growing vigorously, were about 9 - 10" high. Spraying with 10 per cent B.O.V. at 100 gallons per acre was done on 28th June with apparently most satisfactory results, as within a day or so the weed foliage appeared to have been almost entirely destroyed. About three weeks afterwards, however, it was noticed that the weeds in each instance had recovered considerably and the position in the sprayed plots was only a little better that that of the unsprayed crop. It was therefore decided to treat another equally vigorous crop (15" - 18" high) of kale and redshank on a different farm and this was done, again with 10 per cent B.O.V. towards the end of July. In this instance, the results were more satisfactory as the kale grew away from the redshank which within a week or two had almost entirely disappeared.

Mr. G. E. Furse: We do fully appreciate Mr. Hart's point about tackling the kale crops in the young stage and we are particularly interested in the work being done now by Professor Sanders at Reading. In the south-west we, too, find, like Mr. Price in the Northern Province, that redshank is one of our major weeds, the other two are fathen and charlock.

Dr. Warren C. Shaw: I would like to ask Mr. Parker if TCA and dichlorylurea were not included in his present trials because of the lack of effectiveness in previous investigations. From a quick glance at some of the figures Mr. Parker has presented I see that at the New Buckenham site where he sprayed on March 22nd and planted on April 7th (16 days interval) he obtained a 72 per cent control of wild oats and records no injury for sugar beets. At Ingham, the treatment was applied on April 7th and drilled on April 22nd and controlled 93 per cent of wild oats, causing only 6 per cent damage to the sugar beets. I think that is really a remarkably encouraging pre-planting treatment for the control of a very difficult weed. I have two suggestions that might be helpful, first, normal propyl N-3-methyl phenyl carbamate has proved superior in some work that we have done to either IPC or CIPC and second isopropyl N-3-methylphenyl carbamate, which is more volatile, can be used to narrow the period of time between pre-treatment and planting without lessening the effect on wild oats.

Mr. C. Parker: We did get extremely good control of wild oat at Ingham and we were very pleased. The discouragement was at Paston where we did damage the sugar beets with doses of 3 lb. IPC per acre. We were very satisfied with the weed control but the toxic effect of the chemical on the crop was rather discouraging. I was very interested to hear about the newer carbamates that you have tested Dr. Shaw, and I am hoping to be able to try them out next year. We did try TCA and dichlorylurea last year and found no useful control of the dicotyledonous weeds in which we were interested. The annual grasses which these chemicals are likely to control are not important in our sugar beet areas.

I would like to apologise for the cursory treatment I gave PCP. In my experiments it was used as a residual treatment. When used as a contact pre-emergence treatment I have no doubt of its value. Unfortunately, the conditions under which a contact pre-emergence treatment can be used with success are not the usual conditions in a sugar beet crop. Farmers in general do not favour leaving a 'stale' seed-bed and when this technique is not used weeds tend to come up with the sugar beet rather than before. In the Fens contact pre-emergence treatment probably has its value but it will have to be timed very carefully, and therefore is not quite as easy a treatment to apply as a truly selective residual treatment would be.