WEED CONTROL IN FIELD CROPS.

at the AGRONOMY DIVISION of the DEPARTMENT OF SCIENTIFIC
and INDUSTRIAL RESEARCH, LINCOLN.

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The primary purpose of the Agronomy Division is the improvement of field crops. Briefly, this is achieved either by obtaining new varieties from overseas or by breeding varieties more suited to N.Z. conditions from local and imported material. Weed control plays an important part in our cropping programme, and, in common with every farmer, we should like an easy method of doing the job. However, we grow only small areas of each crop variety, and in many cases the seed produced forms the nucleus for certification schemes; so we have to be certain that the weed control treatments produce no harmful effects on the yield, the germinating power, or hereditary character of our seed lines. Trials to check such possibilities take time, and we have concentrated on those crops in which harrowing is likely to cause damage, since in them alternative methods would be invaluable. During this period it has become increasingly apparent that owing to variations attributed to the interaction of climatic conditions, varietal differences, stage of growth of crop, or any other factor that can be thought of our results, are strictly, applicable only to our own farm. They do, however, indicate factors which require investigation and which should be noted in wider scale trials. Complete information on climatic and fertility effects can, in fact, be obtained only by conducting trials in as many localities as possible, and over a number of years. Here it is that the co-operation of farmers and the Dept. of Agriculture is of such great importance. The more trials that are laid down, and the more farmers who experiment on their own behalf, the faster will a complete body of knowledge be built up. This conference will do valuable work if it stimulates interest in the weed problem and speeds the exchange of information gained by research organisations and private individuals.

Before I go on to describe the work of the Agronomy Division there are three points I should like to make clear. Firstly, I shall refer to D.N.O.C. compounds from time to time. These are formed from the yellow dye substance, dinitro ortho cresol thus the D.N.O.C. Unless otherwise stated, I refer to the sodium salt of D.N.O.C., which is obtainable in N.Z. as Sinox or Selectone. Secondly, I shall not refer to all the hormone weedkillers by name. It must be understood that only water-based compounds are referred to. It may be necessary to revise this opinion later, however, now that highly-concentrated oil solutions are being produced, for, with these, there is a much lower amount of oil in the final spray mix. Thirdly, I shall refer to rates of application of the hormones as so many pounds weight per acre. This means pounds acid equivalent per acre. The hormone weedkillers in use at present are made up from an acid and some other substance. The killing power is conferred primarily by the acid portion. Therefore, the important thing to know about any hormone weedkiller is how much of the acid portion per unit it contains. This is the acid equivalent. If this is known, plus the quantity of acid/acre required to kill the weed, then spraying is simplified. For example, if the weedkiller contains 4.8 lb. acid equiv. per gallon and $\frac{1}{2}$ lb/acre will kill the weed, then you need $\frac{5}{6}$ pints/acre and will add this quantity to the volume of water your sprayer will deliver in covering an acre. This concept makes it easier to work out quantities required for spraying, enables compounds to be interchanged, and enables relative costs of material to be

assessed. In fact, we should like to see all commercial hormone weedkillers have their pounds acid equiv. stated clearly on the label. That is, pounds acid equiv./gal in the case of liquids and % acid equiv. by weight in the case of solids.

Turning now to the work of the Agronomy Division. First of all, linen flax and linseed. Weeds are a problem in both these crops. They can seriously reduce yield through competition for living space, and weed impurities reduce the value of the harvested product. But harrowing for weed control is liable to damage young plants, and it is becoming increasingly difficult to find weed-free land or to obtain a clean seed-bed by pre-planting cultivation.

Today, of course, chemical weed control is the obvious answer to the problem.

To obtain good fibre in linen flax, the crop should grow uniformly from emergence to harvest. Any checks in growth are liable to cause weaknesses to appear in the fibre, with consequent losses during processing and probable reduction of fibre strength. Such checks in growth must be watched for, when applying weedkillers. In early trials, Sinox alone at 2 gals/acre and Sinox at 1 gal/acre plus 1 lb. sulphate of ammonia did not appear to check the growth at all. However, when hormones were first applied at 1 lb/acre the flax reacted alarmingly. It bent over and touched its toes, so to speak, and we thought we had lost a valuable crop. However, in about a week it had recovered and was growing in the right direction again. This gave us courage, and we tried $\frac{1}{2}$ lb/acre on other seed-increase areas. The same bending and recovery occurred. Samples at harvest showed that the seed yield had not been affected. It was, in fact, slightly better on the sprayed than the unsprayed. But sample sheaves processed by the Linen Flax Research Station at Washdyke showed up the effect of the check in growth. The % fibre was cut in half, from 8.2% to 3.5%. Furthermore, the sprayed fibre was of much harsher quality than the unsprayed.

Now English work indicated that sodium D.N.O.C. compounds could be used with reasonable safety on flax, but that the hormones and sodium D.N.O.C. plus sulphate of ammonia were liable to wreck the fibre yield while not affecting the straw yield. Accordingly, last season we laid down a trial to check these findings under our conditions. Sinox alone at 2 gal/acre, at 1 gal/acre plus 1 lb. sulphate of ammonia, and three hormone weedkillers were applied to Liral Crown Linen flax. Unfortunately, weather conditions prevented treatment at the correct time and an excess of material was applied. The Sinox did not affect the growth of the flax, but the hormones produced a greater effect than in any previous trial. This left a permanent bend in the straw, which would have made it extremely difficult to harvest the crop for fibre. Omitting reference to one of the hormone treatments which suffered more severely from the overdose, the following points emerged:

1. All treatments gave a greater bulk of crop than the control.
2. All treatments reduced the % of fibre, but in the case of Sinox the increase in bulk of crop largely offset this, with the result that the yield of fibre/acre was only slightly reduced.
3. The seed yield of Sinox-treated plots was greatly increased, while that of the hormone treatment that approached closest to the intended rate of application was only slightly less than the control.

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4. The other two hormone treatments gave very much reduced seed and fibre yields, emphasizing the need for great care as to quantities and evenness of application when treating these crops.

5. The control and 2 gal. Sinox plots produced the best quality fibre, followed by the 1 gal. Sinox-plus 1 lb. sulphate of ammonia. The hormone-treated plots produced harsh poor-quality fibre.

As can be seen, there are two possible effects of the sprays. (1) A Reduction in the fibre % and (2) a reduction in quality. When the hormone-treated flax was examined it was found that the fibre bundles were deformed at a level corresponding approximately to the height of the plants at spraying. When it was pulled it tended to break at this point and considerable loss must have occurred during scutching, through this defect. Now, if the reduction in fibre extracted is due to this cause alone, it follows that the earlier the crop is sprayed the lower the break will occur, and the smaller the losses. This would have the further advantage that all weeds are more susceptible in the seedling stages. Sodium D.N.O.C. cannot be applied until the flax is 3" - 4" high, and we had applied this rule to the hormones also. However, last season we applied $\frac{1}{2}$ lb., 1 lb. and 2 lb. of Agroxone to duplicate plots when the flax had less than half an inch of stem above the seed leaves. The flax did not react and the weeds did; so a week later, when the flax had two true leaves expanded, we sprayed the whole two acres at $\frac{1}{2}$ lb/acre. Again the flax did not react, and a good kill of fathen, chickweed and spurrey was obtained. Things looked promising. Sample sheaves showed that the seed yield had been doubled and the deseeded straw weight increased by about a third. But again it was found that the fibre % was reduced, this time from 14.2% to 8.4%. We are going to conduct a further time-of-application trial in the coming season in an attempt to finalise the matter. At present, hormone weedkillers should not be used on linen flax. If weed control is necessary, use sodium D.N.O.C. compounds.

So much for linen flax. How about linseed?

As I have indicated, seed yields of linen flax can be considerably increased if due care is taken as to quantities/acre and evenness of application. We have sprayed Rio, Golden Viking, Cheyenne, Koto and Victory of the linseed varieties without obvious ill-effect. On the basis of this experience we can recommend the use of the hormone weedkillers for linseed at up to $\frac{3}{4}$ lb/acre when the crop is from 2" - 8" high. The upper limit of size is determined by the fact that the crop will be damaged if sprayed at or after the time that the flower buds can be found at the tips of the stems. Since weeds are most susceptible in the seedling stage, it follows that early spraying will give best results. D.N.O.C. compounds can also be used.

All clear, eh? Sorry - there's another "but". This time, the quality of the oil produced from the seed. A recent report from America states that hormone treatments reduced both the oil % and its quality or drying power. On the other hand, English workers have reported no reduction of oil content. The matter seems to be tied up with the differential reaction of varieties.

This effect on quality is of considerable general importance. We have not done any work relating to the effect of the hormone weedkillers and oil quality of linseed, but we have other evidence to show that the hormone weedkillers can markedly affect the chemical composition of plant products, or, in other words, the quality. For instance, in a trial at the Agronomy Division, using Agroxone on Research barley, the chemical composition of the seed was altered, up to 20% increase in nitrogen content

being recorded. This could be a serious drawback since Malsters & Brewers prefer low-nitrogen grain. It gives higher malt yields and "paler ale". Actually, in this instance, there was a compensatory effect which offset the nitrogen increase, and the quantity of malt obtained would not have been reduced. A report from America indicates that the protein content of wheat is increased by spraying, a beneficial effect. Along the same lines is the temporary increase in sugar content of sprayed plants. For instance, we have found that Californian thistles sprayed in the rosette stage will be grazed right out by sheep after spraying, and there are many other reports of similar increased palatability. This increased palatability may have practical possibilities, enabling better use to be made of old pastures, tussocks and weeds.

Reports also tell of reduced germination of seed and of undesirable effects carrying over into the seedlings that is to say, of effects on seed quality. So far we have no evidence of this. Flax, linseed, and barley have all germinated well and plants grown from the seed have not shown any abnormalities. From these remarks it can be seen that there is much work to be done in checking the physiological reactions of all varieties of all crops and determining what the consequence of such changes are likely to be.

Turning now to the matter of application of weedkillers. There is no doubt whatever that low-volume spraying methods have put chemical weed control on the map as a practical proposition for the farmer, and before long a low-volume spray rig will probably be a standard piece of farm equipment. Prior to its introduction we felt that dusts would be most satisfactory for farm use, since they could be applied with a manure distributor. Of course, this still holds good, but results with dusts have been disappointing. At least twice as much active material per acre was required than for sprays, and even then results were likely to be erratic. A number of factors are responsible for this. Firstly, it is difficult to get an even cover with dusts, and secondly, wind can blow the dust off the plants, or rain wash it off, before it has been absorbed. Best results were obtained when the plants were damp, as then the dust stuck to them and was probably more rapidly absorbed. In general, dusts cannot be recommended, though there may be possibilities if they are incorporated with lime or manure and the weed control regarded as a secondary function of the treatment.

When low-volume spraying was first introduced, the doubt was expressed that the very fine particles produced by the low-volume nozzles might not have sufficient force behind them to penetrate dense crops as well as the larger high-volume particles. However, trials this year have shown that weed control in crops is as efficient at 5 - 6 gallons/acre as at 50 gallons/acre. The eddying of the finer low-volume spray particles seems to overcome any lack of momentum.

The importance of the low-volume spraying in popularizing chemical weed control is well illustrated by reference to the D.N.O.C. compounds. It has been known for at least ten years that they can be used to good effect for weed control in cereals, linseed, linen flax and peas, and yet they have never become popular, chiefly because they had to be applied in 50 - 100 gallons of water to get good coverage. Last season therefore, we laid down a trial to investigate, amongst other things, the possibility of applying Sinox low-volume to peas. Fathen is our chief weed in this crop, and 10 lb. of Sinox plus sulphate of ammonia the best rate to use for its control. The question was: what is the minimum quantity of water in which this amount of material will dissolve?

The 1 gal. of Sinox, or, I should say, sodium D.N.O.C., will dissolve in 4 to 5 gallons of water, but when sulphate of ammonia is added a cloudy precipitate soon forms. By increasing the water to 9 gallons we were able to add $\frac{3}{4}$ lb. of sulphate of ammonia before a precipitate started to form. The resulting 10 gallons of liquid was still a considerable saving on the 50 formerly used, so we chose 10 and 50 gallons as our two rates of application. Both rates burnt the peas a little but they recovered, and there was no difference in final yield between either treatment or the control. The weed control was excellent in both cases. The obvious question here, of course, is why waste money on sprays if you are not going to be compensated by a yield increase? The answer to this lies in the season. The peas were planted at the end of October and the surface of the soil was bone-dry until about the time the peas came through, with the result that scarcely any weeds germinated.

Then we had rain and the fathen came up thickly; we sprayed and got an excellent kill, but there was no more rain until the peas had set, and the weeds made scarcely any growth. After this more rain brought the fathen on and at harvest it was very thick and 1' to 2' high on the controls. In most years, with no cultivation, the peas would have been smothered by fathen 3' high and the yield markedly decreased. Even so, the late crop of fathen this year would have made harvesting difficult. The result demonstrates two things: that a considerable reduction in the volume of D.N.O.C. sprays is possible and that increases in yield are likely only when the weed growth is sufficient to compete with the peas - or, putting it another way, there is no gain attributable directly to the sodium D.N.O.C. plus sulphate of ammonia. This is of interest because 1 gal. of sodium D.N.O.C. contains nitrogen equivalent to 1.8 lb. of sulphate of ammonia. Taken with the $\frac{3}{4}$ lb. added to the mixture as an activator, this means that nitrogen equivalent to $2\frac{1}{2}$ lb. of sulphate of ammonia/acre was applied. A stimulating effect has been attributed to this nitrogenous dressing by some workers.

It should be remembered that these are the results of only one season's trials. They are sufficiently encouraging to warrant further investigation and cautious trial by private operators. Of course, every care must be taken to apply the correct quantities per acre, to avoid overlap, to avoid spraying when drift is likely to be serious, and to follow the makers' instructions as to time to spray.

Further work will show whether lower volumes are possible. To some extent this will depend on the weeds concerned. Wild turnip may require less D.N.O.C., and therefore less water, while there is a possibility that the quantity of ammonium sulphate used as an activator can be still further reduced, again enabling a reduction of water. Another point to investigate is whether the pea varieties differ in reaction.

Low-volume D.N.O.C. can be applied quite safely to linseed and linen flax and is worth trying on onions. Extending the low-volume principle still further, overseas work indicates that sulphuric acid can be applied low-volume.

Another matter that has engaged our attention is the question of pre-emergence versus post-emergence application of the materials. Pre-emergence means planting the crop and treating for weed control before the crop comes through the ground, while post-emergence treatment is too unreliable for practical application. This is due to the fact that efficient action of the hormones is dependent on the presence of a definite amount of water at the surface of the soil. On one occasion a dry spell followed our pre-emergence treatment and the material hung fire until

a rain occurred, when an excellent kill of weeds was accompanied by serious damage to the emerging crop. In another trial heavy rain occurred after application and the weedkiller was washed down to the level of the crop seed, again causing serious damage. Finally, on a third occasion, through dry conditions following sowing, weed control was almost nil. Much better results have attended pre-emergence treatment of autumn-sown cereals, because a moist soil-surface can usually be obtained at this time. Furthermore, heavy dews and poor drying conditions tend to keep it moist. Spurrey, Slender chickweed, and mouse-eared chickweed can be killed by this autumn treatment, but information as to the value of killing these weeds in terms of crop yield still has to be obtained.

We have carried out trials with hormone weedkillers on a number of different weeds, chief of which is Californian thistle. In cereals and other resistant crops these thistles can be controlled for the season, provided the thistles are through the ground before the crop becomes too dense for the spray to penetrate. On the other hand, we have had no success in killing thistles on land that is continuously cropped. Better results have attended spraying thistles in grasslands. Spectacular kills should not be expected with the materials available at present. Disappointments can be avoided if the spray rig is regarded as a "differential grubber", or, if you like, a "hormone grubber", rather than a fairy wand.

Its action, if properly used, is to cut the thistles of 3" or more below the surface without disturbing the turf, and if the treatment is repeated when regrowth occurs the thistles will be gradually starved out, just as they would be if diligently grubbed. The advantages of the "hormone grubber" are that it is easy to wield and takes only a fraction of the time of ordinary grubbing, a couple of "grubbings" a year should suffice instead of half a dozen or more, it does not disturb the turf, and you can "grub" gorse hedges. Added to all this is the fact that you may strike it lucky and get good penetration of the hormone into the roots, with a resultant good kill.

GENERAL DISCUSSION.

Mr. J.R. Johnston (Canterbury Seed Company) - This address is probably of most interest to Canterbury. Would Mr. Allen say, as a result of control with D.N.O.C. on garden peas, whether sufficient experience has been gained for farmers to try spraying at least portion of their pea crops for fathen.

A. - It is difficult to say on one season's trial. Results last year are sufficiently promising to warrant further trial, and I would like to exhort as many people as possible to try it out. The factor would be the number of weeds and how serious the problem really is. The pea crop we used was closely allied to Greenfeast, and I don't see why other varieties should not be tried.

Mr. T.S. Thompson (Soil Conservation Council) - I am interested in the chemical stability of some of these substances. At the Science Conference one Canadian expressed concern at the ultimate effects of applying hormones.

A. - The effect on the soil may possibly be cumulative. We have done no work on this, but overseas workers see no effect, as the substances are broken down easily. Where the soil surface was dry there was no break-down and the effect lasted several weeks. The break-down is fairly rapid. Extending over perhaps three weeks.

Q. - In your pre-emergence spraying, what did you use? M.C.P.A. or 2,4-d?

A. - Both. Weedone and Agroxone.

Mr. C. E. Iversen - You said that you did not see any advantage in five gallons or fifty gallons? On warm ground I had experience that five gallons was sufficient.

A. - We use five or six gallons at the fifty-gallon rate to control the fathen. Conditions at the time were warm, ideal for weed control.

Mr. M. A. Black - In dry weather it was thought that ten gallons would be better than five, because of the evaporation. Mr. Allen was spraying Californian thistle, using a low-volume nozzle with a knapsack spray. It was a rough day and the round nozzle gave too fine a mist. We should have used one of the bigger nozzles.

Mr. A. Brodie - There is much in what Mr. Black says. With a weed like Californian thistle one of the fine conical sprays would not necessarily be the best. Material which gets on the stem may be of more consequence than that on the leaves.

Dr. J.S. Yeates - Have you considered whether an oil-based spray is less subject to drying out? From U.S.A. I have gathered that oil-emulsion is used to prevent evaporation before the spray reaches the ground.

A. - We did not use the oil-based sprays because of their lesser tolerance. The general impression is that oil-base is ester and volatile. We cannot use esters on crops.