CHEMICALS USED IN WEED CONTROL

by
DR. B. W. DOAK

DR. DOAK: Some very old books on Agriculture recommend the use of salt for control of weeds in agricultural land. Little further progress was made until the early part of the present century when the discovery was made that certain inorganic compounds exerted a selective herbicidal action. The use of salt, if used in herbicidal amounts, killed useful plants as well as weeds.

Arsenicals were likewise almost completely non-selective although the discovery was subsequently made that arsenic pentoxide was considerably more selective in action than arsenic trioxide preparations. This discovery was of some importance in the control of weeds in lawns and playing fields but these compounds were of little use for farm purposes.

The use of solutions of nitrate of soda, of sulphate of ammonia, and of potash salts for the control of Wild Mustard and other greenfield weeds became fairly widespread in Britain and Europe. Some time later dry powdered kainit and calcium cyanide were added to the list of selective weed-killers. The next development was the use of sulphate of iron solutions and also sulphuric acid solutions for control of weeds in wheat. These chemicals have only been used in a minor way in New Zealand. It was not until the introduction of sodium chlorate in the twenties that much use was made of herbicides in this country. Comparatively large quantities of chlorate were used for Ragwort control. A number of other inorganic chemicals have been used overseas, viz. borax, ammonium sulfamate, ammonium thiocyanate, but these have only been used in experimental quantities in New Zealand.

With the war came the necessity for reducing the labour requirements for the control of weeds by hand so the uses of sulphuric acid sprays for onions and kerosene sprays for carrots became comparatively common, but in most cases spraying was confined to a band of 3 or 4 inches along the rows, while between rows mechanical equipment was used to control the weeds.

About 1935 there was a new development in weed control. An organic dyestuff was found to be both highly toxic and fairly selective in action. This chemical, sodium dinitroorthocresylate, known commercially as Sinox, has considerably altered the outlook on selective herbicides. The dye "Victoria Yellow" or dinitroorthocresol is low in solubility and to remedy this it is converted into the sodium salt. As both the original dye and the sodium compound are inflammable and closely related to known explosives, the commercial preparation is a paste containing about 70% of water. It is non-corrosive and relatively non-poisonous. The addition of ammonium sulphate and other acid salts increase the toxicity of Sinox. These "activators" make the solution more acid and this affects the amount and rate of penetration into the tissues. The increased toxicity is accompanied by a decreased selectivity.

The spectacular development has been that of the so-called "hormone" sprays. The story of this development is an interesting one and is a good illustration of the great practical development which can eventuate from researches apparently only of academic interest. Fourteen years or so ago a group of workers isolated from urine three compounds which, in small amounts, exerted a very great effect on plants. From this there came a search for compounds which could be prepared synthetically and which would induce the same effect as the naturally occurring hormones. The first use to which these compounds were put commercially was the preparation of solutions to promote the rooting of cuttings. In this work it was found that very low concentrations were effective and also that different plants reacted differently to others. Some were extremely sensitive and were readily killed if the dosage was a little high. During the war, English workers conceived the idea that derivatives of these compounds might conceivably be used for the destruction of the enemy's crops and a search was made for more toxic compounds. It was early realised that the selective nature of the effects might enable these chemicals to be used positively in the war effort by killing weeds in our crops. The English researches showed that certain chlorine derivatives of phenoxyacetic acid had very desirable properties. With the

entry of the U.S. into the war, this information was given to the U.S. authorities, while research continued in Great Britain. British research developed two very promising chemicals, 2,4 dichlorophenoxyacetic acid and 4 chloro 2 methylphenoxyacetic acid. Though many of the properties of these compounds are similar, some plants react rather differently to the two compounds. For various reasons, chiefly manufacturing, the British concentrated on the 4 chloro 2 methyl compound, which was also somewhat more effective against many weeds. The Americans with better manufacturing resources, worked almost entirely with 2-4 dichlorophenoxyacetic acid. 2,4-D itself is only slightly soluble and various methods were evolved for increasing this solubility. Addition of Carbowax 1400, a polyethylene glycol, made a great improvement, but the cost of this chemical was greater than 2,4-D. Various salts of the acid were also used, chiefly the sodium and ammonium salts, and later the so-called alkanolamine compounds. The latter made possible very concentrated solutions thus easing transportation costs. One of the most significant of the American advances was the development of the ester form of 2,4-D. Esters have certain advantages, chiefly that penetration into the plant tissues appears to be considerably improved. Esters being oily in nature have to be emulsified before they can be used as sprays. They may be dissolved in an oil fraction similar to kerosene which is emulsified with water, or they may be emulsified directly. One advantage oil based sprays have is that they are not readily washed off foliage by rain and consequently rain following the application may not cause any significant reduction of the herbicidal qualities. There is a greater risk of washing off when 2,4-D salts are used. Esters, with or without an oil fraction, can penetrate through the waxy cuticle of some leaves better than the salts can. On the other hand, because of this, the selectivity may be reduced. Ester preparations are more difficult to remove from spray equipment than the salts.

Such herbicides as arsenicals or chlorates kill owing to their toxic effect on the plant cells. In other words they are cell poisons. The killing effect with these is rapid. With the hormones type herbicides the effect is quite different. The chemicals in themselves are not poisonous to the cells but they increase the rate of respiration very considerably. This leads to a depletion in the sugar content of the plant and causes the breakdown of starches and other carbohydrates to keep up the sugar supply. Consequently the plant is literally starved to death. At the present time it is not known whether the relative resistance of some plants is due to non-absorption of the chemical, or whether certain plants have the ability to render these chemicals inactive.

It should be emphasized very strongly that the use of these substances, though very promising, is still only in the experimental stage. Much work still remains to be done before all the facts are understood. It is quite likely that even then recommendations suitable for one district may not be satisfactory in another.

The exploitation of 2,4-D and related chemicals is following a pattern which has become all too familiar of recent years. First comes the subdued but natural enthusiasm of the discoverer, followed closely by the extravagant and largely imaginary claims made by the "popular press", in which miraculous results are described. Following this comes a more reasonable but probably overenthusiastic attitude to the new development. Scientifically conducted investigations gradually show the strengths and weaknesses and if the weaknesses overshadow the successes, then the product is on the way to oblivion. With 2,4-D the first two stages are passed, while the third is beginning to pass. We in New Zealand are still in the midst of it but already we have seen the 2,4-D dusts come and go. High volume sprays have had their chance, and have failed to satisfy a need. It remains to be seen whether the new technique of low volume application will do the job but it is still unproven. I do not see any particular reason why it should not be successful, but at the same time we still have a lot of work to do before we can prove the work, and the economics of the large scale use can be put on a more satisfactory basis. At present the cost of the materials appears to be too high and it is to be hoped that a substantial reduction in price will take place at an early date.

DISCUSSION:

DR. YEATES: I feel that what we have got to consider in regard to hormones is the economics of their application, and I do think that we have to investigate the problem fully, and Dr. Doak has indicated how various compounds have come and gone. In all these things it is a matter of costs and returns and I think that what we have got to find out is whether or not the hormone weed-killer is as economical a means of eradicating weeds as other and more well known ones.

MR. WATKINS: As a manufacturer, I thought this would come sooner or later to-day. The matter of costs depends entirely on the way in which you evaluate your costs. Are the farmers able to say the approximate cost per acre for, we will say, seventeen discings, or seventeen cultivations on the ploughing. That would be very high, I should imagine. I believe that with Californian Thistle, taking experimental results as a criterion, 90% of eradication can be brought about at a cost of approximately £2 per acre. Other weeds are more resistant, and the cost will vary. We believe that many pasture weeds that are serious from the point of view of obtaining milk or butter, can be eradicated or severely checked at below £1 per acre. The prices of manufacturing materials vary as a result of increased use of materials. The United States Secretary of Agriculture, Mr. Clinton, actually said that this year they hoped they would be able to treat in the vicinity of 25 million acres in Canada and the United States, which means that the people producing the material to treat those acres have increased production at decreased overhead and can sell their production at a lower rate. That can apply in New Zealand. Naturally, as the turnover of the active ingredient increases, so will the price fall. I would like some expression of opinion from the farming group as to what it does cost approximately to control some of the fairly important weeds on present day farm practice.

MR. MACHIN: The question of relative cost is very important. No cost is too high if you can get it covered by your returns.

MR. L. B. SCOTT (Federated Farmers): I did try to farm in a good manner, and that means that you fallow the land for your weeds. You cannot say what it costs because you depend on the season. In a dry season it is much more cheaper than a wet season. Then on your own farm, different paddocks vary and I could imagine there is quite £2 difference in two different seasons. I should also like to point out that having cleaned the paddock thoroughly at a cost of £8 an acre, that is not the end of the story. You put down the land in valuable seeds, and along your hedges you have a home for all the weeds imaginable. Sometimes you may see some of those hedges white with the seed of Californian Thistle. Having cleaned your land you still have the wind blown seed which is often the cause of the trouble. We would like to know how to handle that, where we get it coming along from everywhere and anywhere. You could cut a tall gorse hedge down but you have not got the wire to make another fence.

MR. MACHIN: We thought it desirable that perhaps the four subjects that have been discussed to-day should be thrown open so that anyone who has a point and would like to speak to it may do so. If that pleases you we shall follow that course.

MR. L. CHAPMAN (High Country Committee): I am only deputising Mr. McLeod. The Committee was elected by high country farmers and represents what we call the high country. I am referring to country up to about 8,000 feet; the district we represent does not take in such country as Banks Peninsula. I might outline the general position with us. The high country is particularly vulnerable to weed invasion. In that part of the country machinery is out of the question. It is very inaccessible, and the vegetative cover being pretty sparse, leaves the country open for the germination of seed. Almost any weed seed, so long as it can compete with the climate, has its opportunities there. It is very difficult to combat, especially as it is very inaccessible, and it so happens that you might only be near a given point once or twice a year. The average musterer is not very interested in weeds, so that infestation of that sort has every chance to get well going before it is reported to the owners. Then another factor that occurs to me is the question of stocking. With a lot of country as good as Banks Peninsula you may vary your stocking quite a bit. Our stocking is entirely governed by the feed from season to season. Therefore you are pretty well limited in the number of sheep and in some cases cattle, that you can carry and you have not much chance of varying things in that direction. If you do vary it you have overstocking, and then

a fairly quick deterioration in the better type of grasses; or you may understock. In understocking, particularly on the heavier growth country, where you get a southerly rainfall or nor'west rains, you will get a heavy growth of tussock and unpalatable grass, and in no time you find the only resort is burning. We as runholders have practiced it. I regard that as a necessary evil however - we do not burn when we can help it. The other factor - economy - as I said before, high country farming has not been a sound investment for a good many years, ever since the slump of about 1930. Throughout the war years fine wool was penalised to the extent that it only reached the prices of coarse wools. The biggest question of all is the labour question. As you know, labour is difficult to get on all farming country now. There is a most peculiar position in the back country with its isolation. They have to do unattractive work, grubbing and that sort of thing. One other factor is the psychological factor - that owing to the difficulty in the back country over the last 10 or 20 years there is generally a sense of insecurity amongst the people in this country and the chances are that your son won't be there, and that is a very potent factor as to whether a man is going to look after his country or not. Theoretically, we should look after it whether we are going to be here the next year or not - the idea does not work out in practise. I was hoping to hear to-day from the experts and scientific men. Poison seemed to me to be our only hope. It could be done by the few women and men left in the back country. I think the main weeds are gorse and broom. I am leaving out Nassella, which seems to trouble the better class of hill country. Gorse and broom and briar are definitely our worst problems. Californian Thistle is all through the back country. Some people say that Browntop is a weed. That is a very doubtful question with the hill country. It is a difficult grass to control, still it has a very good binding effect in many cases. There are a number of other grasses which come into the same category. Another weed appears a lot on my place, and that is King Devil weed, I think. It is a little low-growing weed which takes complete possession as far as I can see. Nothing can come through and compete with it. It is a very real threat to country in Canterbury anywhere. Then there are the native Veronicas. One native that could be dealt with or eradicated is common Matagouri. It has spread, and it is gradually spreading all the time under the present type of running of the country. Matagouri occupies a tremendous amount of the best country. From the point of view of a layman the question of dealing with these weeds seems to be almost entirely a question of management unless, as I say, a poison has been evolved. There are two or three courses open to us, the one of grubbing and then the general question of management for that class of country. I was interested in the light and shade and its effect on weeds. I do not know whether the amount of burning of the protective tussock covering has any effect. I think it should certainly come under control, but that is very questionable, whether most of the country could carry on understocking without burning. I think research is required into all these things and there is apparently little research being carried on through I saw in the paper a few months ago a report that a certain amount of research is being done on Molesworth. It seems to me that all this research should be concentrated on the one station. I think if it is broken up amongst the Conservation Council, Department of Scientific Research, Department of Agriculture etc., efficiency is lost. I think the amount of money granted to go into research into the back country will be limited, and some of us have discussed it and are inclined to advocate that all money should go into one station under a capable man, which we think would be more effective. I am sorry I have not been more constructive.

MR. MACHIN: The opinion has been expressed that many of these theories are best tested by the practical farmer, and I should say in reply to one or two of the points raised, that men like yourselves should take up the question of a test in conjunction with the gentlemen who are interested in the scientific side and work them out practically. I make that suggestion less diffidently now than I could have a year ago because I feel that the price of stock etc. will be that good, farmers will be able to afford to consider these little experiments to add to the sum of knowledge. There is the question of Mr. Harris and the machines he has invented for cleaning drains. Would it be any help to you if it were advertised through the press the places, locations, and times when these machines would be actually at work cleaning drains?

MR. M. CARPENTER: I think it would be an excellent idea, judging from the results in our county. I think the farmers have learned more of the value and the results from drainage and the absolute impossibility of doing it by hand and the great advances that the machinery of the Catchment Board has given.

With the big Fernside swamp, the problem has been to get the springs cleaned out. The job having been done, the effect on the farmers is that they have been able to produce and work the land to such an advantage that those who did not go about much and were not acquainted with what was being done - to them it is a revelation.

MR. D. W. GREY (Federated Farmers): Several of our worst weeds have hardly been mentioned; probably the most serious in the country is one that has only been mentioned twice and that is Manuka. In the North Island there is a tremendous area going back often into Manuka scrub. The reason is largely economic and lack of labour. If the Manuka is taken off it may be capable of running a sheep and a half to the acre which with the addition of topdressing can be brought up to a much higher figure, to within three or four ewes to the acre. I have farmed that type of country for the last 20 years and it is largely a question of control in improving the pasture. If one's pasture is thick enough the weeds do not trouble you. It goes back to the price of super and lime. Also there is the question of Manuka blight which has been so striking in Canterbury. There will be times to burn, but I find it is a far larger question. Personally I am inclined to think that is a greater evil than it is a benefit to-day. Research should be taken up by the appropriate body and pushed forward to see if anything could be done with the Manuka blight. Another very bad weed is variegated Thistle. It covers a tremendous area, more particularly on coastal areas. The old method was to chip and grub it. Once a year is not enough. You have to go over the same area two or three times in the Spring. I had a property with no variegated Thistle until about fifteen years ago, and I have always been trying to get rid of it. Another pest is gorse, particularly on hill country. It can be eradicated by continual grubbing. Farmers in a lot of cases have been to blame for allowing it to spread. After all, if the farmer can look out and grub plants before they seed, there is no doubt he can prevent it spreading, but it is largely a question of the labour available. There is just one question with regard to the hormone weedkillers. I have seen it mentioned in various articles that the question of temperature had to be considered. When you apply the hormone spray, does a hot or a cold day have any effect?

MR. HARRIS: Generally speaking, the higher your temperatures the more effective the results and if applied under cold temperatures the results are not so effective or are considerably delayed.

MR. WATKINS: I agree with Mr. Harris on one point that the effect may be delayed. I cannot agree with the results over a considerable period that the eventual kill is affected at all by temperature especially as it affects the growing conditions of the plants. I think the plants themselves, if they are in an active state of growth, then the material will have the same effect, except some materials evaporate very quickly in high temperatures.

MR. GRANT (Parks & Reserves Wellington): We have whole hillsides of gorse in Wellington and there is another weed, that is, Fennell. I have come down seeking information as to just how effective these hormones are to clean up the city. What we are doing at the moment is that we have cut the gorse within three inches of the ground one chain wide. I now want to find out whether you can use the spray and spray those roots and kill that gorse. For the footpaths, I think there is a possibility of applying the hormones to those roots and carrying that poison down into the roots, but there are other problems besides cutting it down. I would like to hear what Mr. Harris has to say about spraying the footpaths. I feel the job is only partly done by cutting down and burning the gorse etc. We are concerned too with spray drift.

MR. HARRIS: The last speaker has raised two important points, one of which I am quite prepared to answer, and the other I would very much prefer someone with more experience to answer. He raised the question of hormone control of gorse. We have been more concerned with flat weeds and so on and for that reason I do not feel myself competent to advise you on the control of gorse with hormone sprays. To come to the second point concerning drift when spraying. That is a serious problem, particularly with hormone sprays. There are a number of plants, particularly garden plants, which are very sensitive to the hormone indeed, and there is going to be drifting spray when spraying in the wind and I do know that quite a number of things are affected by a very slight drift of spray and the only solution that I know of is to do that on a calm day.

MR. LYNCH: From fifteen trials with hormone weedkillers, in no case was any effect secured on gorse. I think you can wash it out from the point of view

of spray applications. There is the possibility of mixing hormones with kerosene or oil. Briar was mentioned, and unfortunately here again it is not one of those plants that are readily controlled with hormones. We did six trials and obtained a satisfactory reaction in some cases. Broom is generally damaged quite severely and in some cases killed completely, particularly if the application is made in warmer weather, but I personally, in all the weed shrubs doubt very much the value of the hormone weedkillers. For one thing, they are terribly difficult to apply, for the weed is waist high, and if you kill one group of seedlings you soon get another and so on. If you killed off gorse with a hormone spray, that won't stop a crop of seedlings coming up. The ground underneath old gorse is just full of seedlings. I think that with gorse the answer is that you have either got to grub it out or pull it out. In a farm you have got to use your stock. There is with all these things a tendency to think that once you have killed the mother plant you have solved your problem, but you definitely have not by any means. Fennel is not susceptible.

MR. E. KENSINGTON: I cannot offer anything very definite in the way of costs regarding two of the specific weeds quoted, the gorse and broom, but I do offer experience and results. We have obtained eighteen months' experience on a very limited scale in connection with gorse and broom control on the irrigation works in Canterbury. For the reason that gorse seeds lie dormant for many years, we have had a very big problem in Canterbury here where we have some three to four hundred miles of irrigation races up to 20 or 30 feet wide. When they were constructed, either along road lines or inside the fences, in the majority of cases the gorse fences, the seeds were lying dormant; the races were constructed and within the last few years we have had this big problem. Approximately eighteen months ago we obtained supplies of a hormone weed-killer for experimental purposes. The first application was made in February 1947 out of a knapsack sprayer. We had other experimental plots located and they were given that spraying. Again in the late Spring or early Summer and the same year a second application was made about last October. Those results have been carefully tabulated but I have not them in a form to present them to the meeting. In the second spraying we tried mixtures of kerosene as well as Weedone and water. Those results are very encouraging, particularly as far as the broom was concerned. To date, or during the last eight months we have been attempting to deal with the control or maintenance of this race by using cutters, which keeps the gorse very low, but we need a gang of men to clear up afterwards. The results we have had using the hormone weed-killers have been sufficiently encouraging for us to decide that providing we can get suitable mechanical equipment and hormone weed-killer this coming Spring, we are going to start expanding that and using mechanical equipment. We have four or five hundred miles of races in Canterbury but we do not think it is going to be as expensive as using hand labour. As far as gorse is concerned, at least it is keeping the growth down. We have not had a 100% kill but there are classes to it. But we think we can keep this under control by spraying and although it will be expensive it will be cheaper in the long run than by the combination of power cutting and the hand cleaning up afterwards. Regarding the other weeds, some have been successfully treated and others not successfully. Our primary problem has been gorse and broom control and we are quite optimistic about getting control and eradication.

MR. BLACK: What mixture did you find best?

MR. KENSINGTON: We did not vary the different proportions but we used 60 to 1.

MR. D. McCULLOUGH (Catchment Boards): The South Canterbury Catchment Board has also carried out experiments using Weedone and kerosene, Weedone and Deiselene to both broom and gorse with very much the same results as Mr. Kensington. Several areas of broom in the river beds have been sprayed with a 60% kill and it is considered that a second spraying would get rid of the broom 100%. With the gorse, we have only given it one spraying and that has made the gorse look very sick ever since but it has definitely not died and whether it is dying I would not be prepared to say. As regards the costs of spraying areas of broom and gorse, we have not sprayed large enough areas to be able to take out a proper cost, but I would say that as far as broom is concerned, with the average broom up to 4'6" you should be able to give it one spraying by using a mechanical sprayer at a cost of somewhere about three to four pounds an acre using Weedone and water; but as regards gorse, more applications would have to be made. We have not actually taken out any costs to be able to tell exactly what it would be.

MR. J. F. BROWN: It should cost not more than about £10 an acre for one application. I think that where it is impossible to cultivate gorse it is a fair enough method. Where implements can get it would be out of the question. I think kerosene and Weedone are worth considering.

MR. KENSINGTON: In the second lot of spraying, we did use a kerosene mixture with Weedone. There was an initial effect which appeared to be far more effective than the Weedone and water application but at the end of a few months' time the effect was dissipated entirely and the Weedone and water mixture appeared to be far more effective than the Weedone and kerosene.

MR. BROWN: I would like to endorse those remarks. We put down trials on various groups and in each case we used either Weedone and kerosene or deiselene and on returning to those plots it was quite obvious that Weedone and water had a far more lasting effect on the willows. I think from quite a lot of research work I have read on 2-4D it is essential that you must get a thorough coverage of the surface. When these trials were carried out, it was done with a knapsack sprayer. I am quite certain you must have a power spray unit in second growth willows.