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COMMERCIAL EXPERIENCE WITH SOIL-INCORPORATED HERBICIDES IN SCOTLAND

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Summary The problems posed by the climate and the soil types of Scotland on the use of soil-acting herbicides are discussed and the techniques evolved to exploit the potential of soil-incorporated materials described. Details are given of machines which apply and incorporate in a single pass. The use of TCA and EPTC for the control of couchgrass and of trifluralin for the control of annual broad-leaved weeds is illustrated in respect of commercial experience, and the problems associated with tank mixtures of TCA and trifluralin discussed.

INTRODUCTION

The Company markets a wide range of herbicides throughout Scotland and operates an extensive contracting service particularly in the arable farming, vegetable and soft fruit growing areas of the eastern part. Over the years it has been apparent that many herbicides, when used in Scotland, give results which vary from those experienced in England. Observations in the field tend to indicate that climatic and soil factors may be largely responsible for this difference.

The two seasons when such differences are most marked are in spring (mid-March to mid-May) and in autumn (September and October). In the spring, when the majority of soil-acting herbicides are applied, there is normally a lack of moisture in the surface levels of the soil and the temperature of the soil is low due to low rainfall and cold, drying winds. In these conditions surface applied residual herbicides often give unsatisfactory results when related to the expected behaviour indicated in manufacturers' data. Two examples from commercial practice are typical: (1) When sugar beet was grown in East Scotland pyrazone often gave a low level of weed control which eventually required expensive post-emergence work; (2) although satisfactory results are sometimes given, the use of lenacil on strawberries is today restricted because of unpredictable control efficiency. On the other hand, it is significant that there are specific herbicides and treatments which consistently perform adequately.

Most of the surface-acting residual herbicides mainly control annual broad-leaved weeds whilst a majority of the current range of soil-incorporated herbicides control grasses in addition to a range of broad-leaved weeds. A suitable comparison exists between propachlor and trifluralin which are both used extensively in brassica crops. In our commercial experience the surface-acting propachlor formulations have not given as consistent results as the incorporated trifluralin, taking into consideration the slight differences in the respective weed susceptibility spectra. It has been concluded that lower soil temperatures in association with drier conditions in the spring period in Scotland tend to make surface-acting herbicides less effective and less consistent than when used in the south. It could be that the higher levels of soil organic matter encountered in Scotland may be adding to this behaviour, but if this were entirely responsible then the soil-incorporated materials would be similarly affected, a fact which is not borne out in practice.

The autumn period presents a different situation in that foliar-acting herbicides (aminotriazole and dalapon) were traditionally involved. These products were used in the 1960's to control perennial grasses, principally Agropyron repens and to a lesser extent Agrostis gigantea and Agrostis stolonifera, after harvest of the cereal crop. The results from spraying couchgrass growth in stubbles without prior cultivation were generally poor; where the stubbles could be cultivated and the regrowth of the grass sprayed, the results were much more satisfactory. Of the cultivation techniques used, that using the rotary cultivator gave the best results. Unfortunately, it was possible only in a few cases to obtain sufficient regrowth after this stubble cultivation to justify spraying, and aminotriazole and dalapon are now used on a very limited scale. The later harvest of cereals in Scotland as compared with the south, coupled with the rapid fall in soil temperatures in the autumn, gives rise to the common situation that especially where stubbles are cultivated there is insufficient time between this operation and the cessation of grass growth to obtain the foliar growth necessary for the uptake of these two translocated herbicides.

For almost the past two decades, perennial grass weeds have been the most serious problem in arable areas, and this has led to research and development of techniques of incorporating residual herbicides into the soil. These incorporation methods have since been used with a number of herbicides and are now in commercial practice on many crops. Most of the development work by the Company has been with TCA, EPTC and trifluralin, but some work has also been conducted with tri-allate and with a cycloate + lenacil mixture.

INCORPORATION MACHINERY

Recommendations by manufacturers for application and incorporation of herbicides normally indicate that spraying is followed by certain cultivations as separate operations. Whilst large acreages are treated in this way, the Company has concentrated on "instant spray and incorporation" whereby herbicide applications and immediate cultivation are carried out by one tractor with one pass over the ground.

The following systems have been evolved:

(1) The 'Rota-Sprayer': This method was initiated by the Edinburgh School of Agriculture and consists of a 'Rotavator' on the tractor three point linkage, with the rear flap raised and a spray-bar covering the same width as the Rotavator mounted to spray towards the rotor and into the curtain of soil thrown rearwards from the machine. A modification to suit certain herbicides has the rear flap lowered and the spray-bar mid or front-mounted on the tractor. The diluted chemical is carried in saddle tanks mounted on each side of the tractor bonnet and the pump is driven by hydraulic motor or a small independent petrol engine.
(2) The 'Roterra-Sprayer': 'The Roterra' power harrow with rotating crumbler is carried on the three-point linkage, and the spray-bar is either front or mid-mounted on the tractor. The tank and pump system is as described above.
(3) The 'Triple-K Sprayer': A standard 'Triple-K' spring-tine cultivator with single rotating crumbler at the rear is mounted on the three-point linkage. A spray-bar covering the same width as the cultivator can be mounted on any of three positions; on the leading edge of the cultivator, mid - or front-mounted on the tractor. Again the liquid supply system is as described.

It will be seen that changing from one system to another simply involves a change of cultivator; there is no need to alter any of the chemical supply arrangements other than to couple-up to the required spray-bar.

COMMERCIAL RESULTS

TCA: The Company adopted the 'Rota-Sprayer' system in its early stages and in close co-operation with the Edinburgh School of Agriculture, carried out trials, commencing commercial applications in 1968. The results from autumn applications were good and undoubtedly superior to other chemicals and systems (e.g. aminotriazole, dalapon, TCA in split dose with at least four cultivations) but it became evident that the application of an easily-leached chemical to a rhizome system rapidly becoming dormant and incapable of absorbing the chemical had serious drawbacks. Attention was thus directed to spring application prior to a smother crop such as turnips, swedes, kale or rape. These brassicas are more tolerant of residues of TCA than other agricultural crops, and experience has shown that they can be safely sown from 1 to 4 weeks after treatment, the interval depending to a large extent on the dosage of TCA used. Even at the maximum period of 4 weeks, applications can be made from late March onwards, when soils are in general workable.

Results have been excellent with consistently over 90% of the couch infestation being eradicated. This level of control is superior to that resulting from autumn application.

The 'Rota-Sprayer' has proved the best single-pass machine. For cereal farmers who do not grow brassicas and therefore must use TCA in the autumn, this machine has produced better and more reliable control of couch in one pass, than have separate spraying and incorporation methods which require a greater duration of good weather.

Spring application of TCA (prior to brassicas) has been found to be less critical and other systems can match the 'Rota-Sprayer' in efficiency. Both the 'Triple-K Sprayer' and the 'Roterra-Sprayer' techniques have been successful commercially, but it is usually necessary to advise a further cross cultivation to ensure optimum incorporation. Good results have also been recorded from a normal spray application which is then incorporated by Rotavation. The choice of the system to be used depends on individual preference, on soil type and condition, and on the availability of labour in the spring period.

EPTC: In Scotland this herbicide finds extensive use for couch control and for limited broad-leaved weed control prior to planting the potato crop. The 'Rota-Sprayer' has proved the ideal tool since it removes the problem of having the chemical incorporated within the time limit of 15 minutes, after which loss by evaporation becomes significant. When applying EPTC, the spray-bar is either mid- or front-mounted on the tractor. Over the 4 years in which this technique has been in commercial practice, results have been of a very high standard. However, difficulties have been encountered in rather wet soil conditions or where the couch rhizomes have been buried deeply by previous ploughing and are thus not accessible to the herbicide on incorporation.

With the agreement of the Stauffer Chemical Company, the 'Triple-K Sprayer' was first tested in 1972, principally to afford a greater work rate. It was found that if this treatment was followed within 24 hours by a Rotavation at right angles to the original pass, excellent results ensued. Discs have been used for the second pass but with inferior results.

Trifluralin: The 'Rota-Sprayer' was first employed with this herbicide in 1968. In this case the back flap is lowered and the spray-bar mounted on the tractor. Although giving very efficient weed control, the output per unit was limited to 8 to 11 acres per day and this was considered inadequate at what is generally a particularly busy period of the year. Overseas recommendations for this herbicide suggested that a Rotavator was not essential to obtain the desired incorporation. In some soil conditions in Scotland it can also be difficult to maintain the required shallow incorporation needed for maximum efficiency. In 1971, with the co-operation of Elanco Ltd., and the Murphy Chemical Company Ltd., the 'Triple-K Sprayer' was introduced on a limited acreage and compared with other means of

incorporation. It was found that when working on a reasonably good soil tilth at forward speeds of 5 to 7 m.p.h. a single pass of this machine gave similar results in weed control to the 'Rota-Sprayer' and to methods involving 2 passes at right angles of discs or other recommended tools. With the 'Triple-K Sprayer' careful depth setting and a high forward speed was essential and it was also found that the addition of the 'Rotacrat' rotary crumbler was necessary to complete the incorporat--ion. This last implement had the advantage of leaving a firm finish suitable for ridging or for sowing. Demand for this technique has risen considerably since its introduction and the success rate has been high.

The 'Roterra-Sprayer' has also performed well with trifluralin, and whilst slower than the 'Triple-K Sprayer' it has the advantage of being able to work directly on the weathered plough furrow, without prior cultivation, giving a final seed-bed in one pass.

It has been noted that weed control with trifluralin is usually superior and longer-lasting where the crop is grown on the flat rather than on the ridge. Ridges demand greater depth when working in, and the herbicide is consequently at a greater dilution.

TCA + trifluralin mixtures: Since both TCA and trifluralin are used as incorporated pre-sowing treatments for brassicas, it was natural that mixtures would be attempted. Full dose rates of each as a tank mix have yielded excellent results in control of grasses and broad-leaved weeds. Lower rates of each product are less satisfactory and have only the merit of reducing the cost. Experience has shown that weed control can be compromised to the extent that neither sufficient reduction in the couch is obtained nor is the control of broad-leaved weeds satisfactory. Many combinations of the two herbicides have been tested using all the application systems described, but results have been inconsistent. It is considered that the two chemicals demand different conditions for optimum results; TCA requires deep and thorough mixing and a time interval before sowing the crop, trifluralin needs a shallow incorporation immediately before sowing.

The current practice of the Company is thus to treat the main weed problem with the full rate of the appropriate product, with only a slight reduction in the dose rate of the other.

CONCLUSIONS

There is no doubt that soil-incorporated herbicides perform well under Scottish conditions; their commercial success is ample evidence. Compared with surface-acting equivalents, the resulting weed control is more reliable especially under drier conditions in the spring. The ability of these incorporated materials to withstand a limited amount of soil disturbance, such as is produced by light cultivations, may be an important criterion and can be utilised as a means of increasing the duration of weed control.

The facility of the one-pass system, in which application and incorporation can be conducted at the same time by one man, means that there is less dependence on prolonged spells of suitable weather and leads to the more efficient use of labour and machinery as well as ensuring proper incorporation of the herbicide. There is also the not insignificant saving in fuel afforded by single-pass operations.

Discussion on Session IV

Mr. McKelvie wondered whether the differences in the prevalence of various weeds which Miss Carnegie had shown to be associated for example with light soils were attributable mainly to differences between districts, between farms, or between fields on a farm. If the differential associations occurred within a farm, this would more certainly be attributable to soil characters than if the differences were essentially between districts when other factors like climate might be involved. Miss Carnegie replied that she felt this was largely a district effect. For instance, Morayshire had a very distinct flora due in part to the prevalence of light soils and in part to differences in climate and management practice acting in combination.

Mr. McKelvie in further questions asked Dr. Forbes with regard to his survey of ragwort in Orkney whether the correlations which he had recorded between surface wetness, age of the pasture and sheep stocking rate with the prevalence of ragwort would allow him to predict expected levels of infestation. Dr. Forbes replied that since nearly all the variation in ragwort levels was attributable to these three factors, that within fairly wide limits it should be possible to indicate the potential for infestation of particular parts of Orkney. He hoped that this might be accomplished with greater precision when the full analysis of his results was completed.

Mr. Waterson asked Mr. Hill whether he felt the drilling of swedes on a ridge was a necessary and integral part of their culture. Mr. Hill stated that virtually all the trials reported had been grown on the flat, and that the use of a ridge, and the variation in the height of this, presented real problems to the use of soil-incorporated herbicides which required further research. He thought that in the East of Scotland there was little reason for not growing them on the flat. Mr. Waterson concurred that at the West of Scotland College he no longer grew the crop on the ridge.

In response to the suggestion which Mr. Attwood had made in his summary with regard to the possible use of ULV spraying equipment for the application of asulam to bracken, Mr. Pink said that in the course of development May & Baker had tested a wide range of spraying systems for this purpose. The problem with hand-held ULV sprayers was associated with access to and application in dense stands where uniform coverage became increasingly difficult. Mr. Attwood indicated that he had been speculating more particularly about the possible use of tractor-mounted ULV units although the cost of such equipment limited their wider adoption at present.

At this point the Chairman closed the discussion on the papers presented in Session IV and a general discussion on the proceedings as a whole was commenced.

Dr. Waister recalled how during the course of the day a number of factors like soil organic matter, low temperature and low transpiration had been presented as being of importance in influencing herbicide uptake and activity. In particular, he wondered if there was any concrete evidence for the importance of transpiration in relation to uptake of herbicides from the soil and also for the way in which the type of organic matter might influence activity.

Dr. Caseley was of the opinion that transpiration rate was of some significance in that work at Letcombe Laboratories had shown that the rate of uptake and accumulation of a soil-applied herbicide to be related to the transpiration of the plant. In the north, lower temperatures, higher rainfall and higher humidities could all be expected to influence herbicide uptake.

Summing-up of the Symposium - J.G. Elliott

I think I have probably got the most difficult job of all to try and draw out some threads from what we have heard today. This morning Dr Gloyne was telling us about the differences in the climates of north and south; north of York versus south of York particularly in relation to the east of the country. He drew attention to cumulative effects of small differences causing a very markedly different soil water balance and to differences in the general level of summer rainfall and also the differences in spring growing conditions; the north being slower than the south. I thought it a pity that we were not supplied with soil temperature data which provide a cumulative measure of what the plant is going to find in the physical environment in which it grows. Dr Batey did not draw out many points about differences between north and south but he did say that, on the whole, soils in the north were lighter and a bit more acid. He also indicated that there are a greater number of Montmorillonite clay soils in the north with perhaps a greater tendency to absorb chemicals compared with other soils with a lesser quantity of this particular mineral. He also mentioned that there is rather more leaching in the north than there is in the south. If we put all the soil and climatic data together it seems to indicate that as far as plants are concerned we have in the north a much more vegetative climate than one which is given to the hot dry ripening. And of course the very crops that grow best in Scotland and in the North of England are vegetative crops, such as grass and potatoes.

I think that it is important to bear in mind that weeds are plants just like wheat and potatoes, the only difference between weeds and crop plants is that weeds have to make their way in the world so it is clear that differences in climate, differences in soil, differences in past cropping history and differences in cultivation all will affect the weed flora. A flora in a particular field is largely a consequence of the cumulative past history of all these things so we must just accept that our weed flora is going to be different when all these things combine to ensure that the environment over the years in the past has been different. I thought that the paper by Lawson and his colleagues in those two fields with different past histories typified the effect of past environment.

One of the interesting points was the reference to possible ecotypes of weeds: I am sure that there are ecotypes and feel that we are rather lacking in information about them.

Turning to the herbicides. Mr Stovell pointed to the effect of rapidity of transpiration on the safety of certain chemicals in relation to the visible symptoms of damage that occur, he also mentioned that there could be different and sometimes longer safe periods for spraying in the north compared with the south. Mr Waterson mentioned the difficulty of applying wild oat herbicides during the safe stage. If the growing environment is slower in spring then it is not just the weeds that grow slower, the crops do also and therefore the safe stage must be longer. Other things being equal it should be easier to spray when the crop is growing slower but of course that leaves out the weather. Unless you equate the weather pattern to the rapidity of the growth of the crop and to the duration of the safe stage it is impossible to work out whether application is likely to be difficult or not. I hope that we shall see a great deal of attention paid to detail of this sort in the future.

Much is known about the environment of the north to the extent that if all the information were put together many useful predictions could be made about how weeds would grow in certain cropping situations and how chemicals would perform; but I did pick out three aspects which are important and about which we probably

do not know enough:-

The first is soil temperature in relation to air temperature: We are good at measuring the aerial environment and we have many records but we do not have equivalent information about soil temperature and this seems to me to be the thing that plants respond to in spring.

The second point is that there is a need for more study of the significances of soil organic matter in relation to herbicide performance particularly with soil-acting herbicides.

Thirdly, ecotypes: This subject is important; it is predictable not only that there will be ecotypes but that herbicides will perform differently on them.

Finally, I will pose the question, "Is the Northern Environment different to the Southern Environment?" It seems to me from the evidence which we have heard today that the answer must be firmly "YES". If we then go on from there and say "Is there such a thing as a Northern Environment?" then I am afraid the answer must be "NO". People in Fife would regard their environment as different to that in Ayr and probably people in Aberdeenshire will feel different again to Fife. The answer really is that every local environment, perhaps every field, is special; it is compounded of its own local climate in that year, of the soil type, of the past cropping history and so on. Therefore I hope there will be more interest on the part of the chemical companies in accepting this point that they try to cater more for local differences in their recommendations.

The whole day has emphasised to me the need for a great deal more "agronomic weed ecology". That is the study of how weeds grow and survive within the encironment of modern crop production systems.

Symposium on "Weed Control in the Northern Environment"

16th January 1974

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