THE CONTROL OF WEEDS ON PASTURE AND PLAYING AREAS

by
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MR. G. S. HARRIS: In introducing a discussion I would like you to realise that it is practically impossible to do much more than touch on the main points of the subject which if I treated it fully, would require a full detailed study. It is fairly obvious that many books have been written on weeds in pasture and on playing areas and the subject in all is an extremely large one. If this paper appears to be somewhat disjointed and to cover a wide range of subjects without dealing with any one point in detail, it will be understood that the necessity for treating much material in the minimum of time is responsible.

Assuming, for the purposes of this discussion, that a "weed" is defined as a plant out of place, or growing where it is not wanted, then our first question must be - "why is this plant growing where it is undesirable?" Unless we have a knowledge of why weeds invade pastures and turfs we cannot formulate control measures to eliminate undesirable plants and retain those which we require. Treating, first of all, the pasture phase, but remembering all the while that what applies here also applies almost exactly to weeds of lawns and playing turfs, our first excursion must be into the realms of ecology and the ecological relationships of the sward.

In any plant population within a climatic zone, competition is the prime factor in deciding the ultimate composition of a community, and in a pasture sward the two prime factors governing competition are light and shade and pasture utilisation. I am speaking now, of course, of an established sward, and neglecting for the moment those weeds which must be taken into account in the establishment phase and later such things as secondary growth, Fern, Gorse, Blackberry, etc.

Light intensity will tend to promote stability in a sward due to the fact that a plant which can keep its canopy in the light assumes and maintains dominance, but the moment it becomes shaded by a more vigorous competitor it loses its dominance and may even in the ultimate be eliminated completely. Plant succession is fundamentally based on this factor of light and shade.

In a pasture sowing the early establishing species may have a marked effect on the slower establishing ones, due to the shading effect, and this applies not only to the sown species but also the weed population which is always present from seed which has been dormant in the soil until cultivation has so moved the seeds that light and moisture have encouraged germination. It is for the above reason that such plants as Spear Thistle, *Erigeron* spp., *Erechtites* spp., and *Solanum nigrum* appear following a primary forest burn. The seeds have probably been present for some considerable period on or in the soil surface, but just as soon as the forest shade is removed, they tend to become the dominants in the new succession.

The principle of weed control by an understanding of the ecology of pasture establishment cannot be overemphasised. Any factor which breaks the turf and allows increased light to reach the soil surface brings about the germination of weed seeds. Winter poaching and trampling by cattle leads to invasion of Pennyroyal, summer drought and opening up of the cover on crests leads to invasion by *Erodium* spp., baring of the soil in stock camps under trees leads to a dense cover of Barley Grass, sheep yards and tracks bared by moving stock are colonised by *Poa annua*, and so on. The examples could be multiplied an hundredfold without departing from the basic principles of light and shade and competition.

So much for these factors per se. What is not so often realised, probably, is that the system of grazing practiced, which is a major factor in the control or spread of weeds, is also based on the principles we have just discussed. Close and continual grazing is a fruitful method of weed encouragement; just as close and continuous mowing of a playing turf will allow establishment and spread of flat and mat weeds.

The common Rush Plant, one of the worst weeds of damp grazing areas, is an example of the effect of light on a plant whose growth form allows spread by tillering from a short underground rootstock. So long as grazing

is close and continuous the rush will continue its steady spread. Ease up the grazing and allow pasture species to shade the crown of the rush and the spread is checked at once.

Time will not permit detailed discussion of many other points which resolve themselves finally to this question of light and shade, but brief mention might be made of creeping and stoloniferous weeds whose spread is checked by shading, annual weeds which are encouraged to germinate by opening up of pasture due to drought in summer, and so on.

The main point to which I am trying to lead is this - any treatment of a sward, be it pasture or turf, which will maintain a dense healthy cover of the desired species all the year round will be the best insurance against the development of a weed flora. This, in itself, opens up a further large field in the study of species and strains, fertilisers and their effect on the growing plant, soil fertility and the appropriate species for best growth at varying fertility standards, grazing management, and a host of others.

The grazing animal itself may be a factor for either weed introduction or control according to its use and management, through defoliation of the sward and so control of the light factor as well as mechanical breaking of the surface by trampling, camping, and so on. For example, the control of Bidibidi by allow pasture growth (by spelling) to raise the runners of the weed above the ground surface, followed by cattle grazing to break and mechanically injure the plants, is well known.

Such weeds as Manuka, Cassinia, etc., may be controlldd by fire only under conditions where the recovery of grasses and clovers following the burn is sufficiently rapid to prevent establishment of further weeds from the seed supply present in the soil. Even under the best conditions several burns may be necessary before the seed supply is sufficiently depleted to allow the dominance of the pasture species.

Bracken fern can be controlled only by starvation of the underground rhizome, which is too deep to be affected by burning or surface treading. Trampling by cattle to break the young shoots in the curled stage, coupled with fire and the slasher if the fronds mature, are the usual methods, but the question of maintaining a dense pasture cover should by no means be neglected.

Much labour has been wasted in the control of gorse through failure to appreciate the assistance which may be gained through the competitive effect of a dense, healthy pasture sward, and its suppression of re-establishment from seed owing to the dense bottom shade produced; under cattle grazing ragwort can become a serious pest, but under sheep the plant never becomes a serious menace due to the influence of the grazing animal on plant competition.

The control of blackberry, gorse, etc., by goats is another example of the same process as indicated above.

In New Zealand little has been done in the past so far as direct chemical control of pasture weeds is concerned. Sodium chlorate spray or dry chlorate plus lime has been used for ragwort control in dairying country. Arsenic pentoxide is used extensively in lawn and turf work for weed control, and reference to this will be made shortly; sulphate of iron and/or sulphate of ammonia are also much used, and of recent years have been extensively applied to aerodrome surfaces, mainly for the fertiliser value of the ammonia salt, but with good incidental control of weeds. In pasture work care must be exercised with sulphate of ammonia or suppression of clover by contact burn may result.

Biological control, e.g. control of gorse by weevil to prevent viable seed formation, also has a place.

To sum up from the pasture viewpoint, formation of a dense sward of persistent strains of suitable species and the maintenance of these species in their most productive state by discreet use of fertilisers and controlled grazing, is the main essential.

Prevention, as always, is better than cure. Destruction of weeds to leave bare soil exposed is useless unless the seeds of useful species are soon to fill the gaps and prevent re-establishment of the weeds. It so happens that my personal experience has been more intimately concerned with the control of weeds in playing greens and sports turfs, and the following remarks on this aspect of the problem are offered mainly with the idea of stimulating interest and discussion.

Sprays and Fertilisers for Weed Control.

In order to obtain some appreciation of the reasons for the treatments applied it is necessary to review briefly some of the factors which control the competition between weeds and grasses in the playing green surface.

A good turf of grass, dense and healthy, is the surest insurance against weed invasion; but the attainment of this ideal is by no means a simple matter, and it is in the course of the establishment and building up of the final first class turf that weeds become at times a major problem. As stressed before, any treatment or happening which reduces the density of the grass cover, thus causing an opening up of the bottom and increased light on the soil surface, encourages the germination and growth of weeds. Once established, the habit of growth of the common mat weeds and flat weeds with their crowns appressed to the ground and prostrate leaves or stems mostly below mower height, allows them to thrive and spread in spite of regular cutting of the turf.

Not only do the weeds, by occupying much of the ground surface, force the grass leaves to grow erect in order to obtain the necessary light, but the shading and smothering effect of the weed gradually thins out the grasses at the same time. Consequently we have fewer and still fewer grass plants present, due to the shading and smothering, and what grasses do persist are drastically pruned at each cutting since the erect leaves are readily caught by the mower. If no remedial measures are undertaken we are actually encouraging the weeds by a continuation of mowing !

Fortunately there are treatments which will assist in the maintenance of a weed-free turf, not only by control of the weeds alone, but also by encouraging better grass growth at one and the same time. If, in the course of such treatments, it is found that the excessive or prolonged use of the necessary chemicals (the so-called "toxic" fertilisers) is undesirable, it is then possible to resort to the use of certain other chemicals for weed control. These substances have the effect of a more drastic burning or poisoning effect on the weeds present than they have on the turf grasses, thus removing or reducing weed competition and allowing the grasses better conditions for their development and spread. It is important to stress, however that unless the necessary plant nutrients for healthy grass growth are present (or are supplied in addition) it is useless undertaking chemical weed control measures. The only result is to kill the weeds and leave an open and weak sward in which the grasses have plenty of room to grow but no vigour to take advantage of it.

No matter what job is being undertaken, better results will be obtained if the person doing the work has some knowledge of the principles underlying his efforts. This is particularly true of such operations as spraying with chemical weedicides, since a greenkeeper, e.g., who does not understand the important reasons for adhering strictly to exact quantities and rates of application is likely to depart therefrom, due to lack of interest and carelessness, and so do permanent harm to the turf being treated.

For the above reasons it will not, therefore, be out of place to consider here some of the basic principles which govern the use of the more common chemicals used for weed control purposes. Dealing first with sulphate of ammonia, since this chemical is much used on account of its dual effect as fertiliser and weedicide. When applied dry in a finely crystalline form, particularly when turf is wet with dew, the sulphate of ammonia readily dissolves in the moisture present on the leaves. In the case of turf grass leaves, which are normally erect or semi-erect, not much moisture will be retained on the leaf to hold the sulphate, and the leaf area is so divided that if some leaves do hold moisture and collect fertiliser, others are dry and so are not affected. With broad leaved weeds and clovers however, the leaves are prostrate and of large area, and readily hold moisture and so collect crystals of ammonium sulphate.

This salt, then, is collected by the moisture and forms a very strong solution which reacts with the cell-sap of the leaves in such a way as to kill by contact, and we get our first weed control action - "contact burn". Practically all flatweed leaves are affected, depriving the plant of all leaf area and leading to starvation of the root system. Vigorous root systems may have sufficient reserves to put forth new leaves, but subsequent treatments rapidly reduce the vitality until death occurs. As only comparatively few turf grass leaves are severely burnt the plants do not suffer to more than a minor extent unless the rate of application much exceeds that which would normally be used. Grasses with hairy leaves, such as Sweet Vernal and Yorkshire Fog, naturally hold moisture readily and are often severely burnt, but as these grasses, from a turf point of view, are weeds, the burn is all to the good.

So much for contact burn, but the action of sulphate of ammonia by no means ends here. The vast bulk of the material supplied does not remain on the leaves but falls to the ground. Here it dissolves in the soil moisture and is transferred to lower levels where it becomes available to plant roots.

In common with most other salts, sulphate of ammonia breaks up when in solution in the soil, into what roughly correspond to the ammonia portion of the molecule and also the sulphate portion.

It is a fortunate fact so far as turf maintenance is concerned, that the grass plant is capable of taking up a large part of its nitrogen in the form of ammonia, while most weeds cannot deal with nitrogen in this form and must await its break-down to the nitrate form before they can utilise it. Actually, they can starve in the midst of plenty, when nitrogen in ammonia form is present. Thus the grasses derive the benefit of the fertiliser while weeds do not.

We are left with the sulphate part of the molecule, which forms sulphuric acid in the soil solutions and of necessity increases the acidity of the soil. The fortunate suitability of Browntop and Chewing's Rescue for turf work is again demonstrated, as they can both tolerate moderately acid soils, whereas weeds and clovers both like (with few exceptions) soils which are neutral or slightly alkaline. Again we favour our grasses and deter the weeds.

In all, then, sulphate of ammonia has a three-fold action in weed control - contact burn, nitrogen (as ammonia) available to grasses but not weeds and sulphate to increase soil acidity.

Sulphate of iron, which is often used for weed control together with sulphate of ammonia, is not a fertiliser. It is a means, once again, of getting a contact burn on weeds, the sulphate portion in the soil increases acidity, and the iron tends to lock up some of the soil fertility, which creates conditions detrimental to weed growth but which can be tolerated by the turf grasses. Its effects are a harshness in the foliage of the grass and a dark green colour.

Ferrous ammonium sulphate has also been used to combine the effect of both the preceding substances, but unfortunately it contains ammonia and iron in unbalanced proportions from a turf viewpoint, and while acidifying and giving contact burn, has insufficient nitrogen to promote vigorous growth.

The next type of chemical used for weed control is exemplified rather well by arsenic pentoxide. This class of substance acts by a contact burn similar to sulphate of ammonia, and probably also by leaving a poisonous residue which is absorbed by the leaves before death and passed on to other parts of the plant.

All who have had occasion to use arsenic pentoxide will no doubt have remarked the general and obvious leaf burn which occurs within a short time of spraying, both grasses and weeds being equally affected. Following favourable weather, however, the grass is again greening up in about a week, whereas most of the weeds are dead, or only slowly recovering. It is this differential rate of recovery which makes such a spray so valuable, since we can use a solution of such a strength as to severely burn weeds but still allow the grass, after a check, to recover.

An important factor in this recovery is one which is seldom realised.

The leaf of a weed, even in a juvenile state, is normally very similar in shape to the fully grown adult leaf, and increases in size by growth in all directions outwards. The grass leaf, however, although the shape is similar in juvenile and adult, grows from the base of the leaf; and this is the secret of the rapid recovery. Burn off a weed leaf, all the growing area is destroyed, and the plant must put forth a new leaf to replace that which was lost, a process which takes time. Burn off a grass leaf, and growth continues from the base, replacing in a comparatively short time that part of the blade which was lost. Provided plant foods are available, the grasses can colonise the areas previously occupied by weeds before the weeds can regain enough vigour to withstand the competition.

Spray substances such as sodium chlorate and allied materials are not to be recommended for use on turf, since their action is drastic on weed and grass alike.

Of recent years sweeping overseas claims have been made for a class of substances known as "hormone" weed-killers, usually containing a substance referred to for convenience as 2,4-D (2,4 dichlorophenoxy acetic acid) or one of its derivatives. Experimental work so far carried out indicates promising results with careful handling, particularly on weeds such as Dandelion and Pearlwort, which are hard to kill with arsenic pentoxide.

DISCUSSION:

MR. D. WATKINS: This matter of control of weeds in grass areas is one of particular interest to us at the moment. It is rather interesting to inquire what are the serious weeds infesting our pasture lands generally. As a result of a trip to Australia it was ascertained that 70% of Australia's worst weeds are infesting their pastures to the loss of sheep, cattle, and various agricultural products. I feel this conference should be able to decide what loss of production there is to the country through loss of production through weeds, by competition, starving out the useful grasses. I would like to state that as a result of two years' work in this last winter season, we have treated controlled areas of about 250 acres as trials. We have a very definite feeling that actual acres of production can be increased by the reduction of flat and other pasture inhibiting weeds. We have evidence from overseas that cattle can increase in weight after areas had been sprayed with growth regulating hormones because of two reasons: a possible increase in the actual grass, and also from the actual control of weeds itself. I do not think that any work has been done other than possibly, England and America on that particular sphere of work. There has been a little done in Australia and New Zealand. It is fairly new with a lot of difficult points to be answered yet, but I do feel that with careful application followed by good pasture management, such as oversowing areas denuded of weeds and by good manuring practice it may be possible to carry more sheep or cattle on a primary producer's farm; and they may produce more meat or more milk. In the U.S.A. the possible increase has been estimated as 50 million pounds of milk in one season from one state. There have been extraordinary reports from the cattle states of Texas where two or three extra cows could be carried on a given area of land. I feel that if it is such an important subject that we should devolve ways and means of investigating and laying down some structural work for future years and see if such things can be carried out in New Zealand. If weeds are as important as we believe they are, then I feel sure that the greatest publicity should be given to the fact that those weeds cost money through the lack of production. They keep out of production areas that can be better occupied by useful species.

I think another point is that the methods of applying these materials were inefficient. They were uneconomical and I do believe that with the advent of the new low volume methods of application of solution, an economical method of applying weed-killers has been evolved, and one that should be investigated very very fully from now on.

MR. MACHIN: Have you had any experience of animals thriving better after the areas have been sprayed with hormones, Mr. Harris?

MR. HARRIS: I personally have had no experience in that work in New Zealand. We have carried out over the last two or three years, quite extensive control and I know of no experiments that have been carried out on a large scale and certainly have not heard of any increase in the weight of animals due to the hormone spray. I could imagine the case where the animals were

just getting sufficient nourishment to maintain them, where spraying the weeds would just give them that little bit more to put on weight although I must confess to being rather skeptical as to having a great effect on the beasts themselves.

DR. YEATES: I would like to mention one point there, although I probably shall draw a lot of criticism. I think that at this stage of the development of weed-killers for pasture work, there can be very grave dangers if there is any general impression given to farmers (and after all, grass is our most important crop) that the weed-killer as such is going to bring about much improvement in his pasture. We shall be doing a disservice to the very cause we are trying to serve, and the disappointments that would ensue would put back the use of such weed-killers a great deal. I know from many letters I get from time to time from farmers, that it is no use using a weed-killer if you do not manage your pasture properly. It is far better to manage your pasture and do without the weed-killer. I am not in any sense belittling the importance of these killers but I do think the economics of the weed-killers for general pasture work and their practicability from the average point of view are still very much in the experimental stages. That fact should be very definitely emphasised lest farmers try to replace weed-killing for pasture management and disappoint themselves. They may not then regain their faith in them. One aspect of weeds and pasture is the question of those weeds that cause damage to wool. The burr weeds hang on to the wool and reduce its value. At the present time wool prices are very high. If wool becomes a bit easier in price there will then become apparent to the farmer a very big difference in price between clean and seedy wool. I have been talking to a number of wool buyers and brokers and they maintain that New Zealand wools are increasing very very greatly in seed content. They distinguished between seed which can easily be removed and burr, which is more difficult to remove. One thing that is causing them a great deal of worry is Storksbill seed. Manufacturers are gradually coming to the point of view that wools containing these are not worth buying. The suggestion submitted by the woolbuyers was that it won't be very long before J.O. gets all the weed wools and the manufacturers have all the clean wools, if wool goes down in price. I was interested in Mr. Harris's talk because I feel he has hit the nail on the head, and that is the elimination of these weeds from the pastures so that they do not cause trouble is a matter of pasture management and one of the factors is super. I think possibly the restriction of the subsidy on super is more important than the applying of hormones. I would like to tell Mr. Harris that I was interested in the distribution of hormone weed-killers by air. Does he think that that has any future for the control of burr weeds? Or whether it is just going to remove the clover rather than the burr weeds?

MR. HARRIS: As far as the distribution of these hormone weed-killers from the air is concerned, it has not been investigated here at all. I believe one of the largest difficulties is that if a liquid solution of the hormone is used, the difficulty is to get the liquid down on the ground surface from an aircraft. The aircraft is flying at such a speed that the droplets may vaporise before they hit the ground. Where a solid material is used the difficulty is that it may spread as much as four or five miles; that is all right if you have an area of some thousands of acres. If the man next door has a very nice garden and some of your 2,4D hormone happens to get on that garden there are going to be a few claims for compensation, and I very much doubt whether it is practicable with the knowledge that we have at present.

DR. B. M. DOAK: There has been a certain amount of evidence that 2-4D compound does not absolutely kill the clover entirely but it does enter into it, and it does not need much injury to the clover to perhaps push it out altogether so that it cannot stand competition. I think it is a very real point, and people should watch that before applying hormones to pastures. It is a different proposition where you do not want a clover, but in pasture you certainly do. There is a real risk involved there. I am interested in the land both from the pasture point of view and for another section of the community, those who cannot live without "playing the game". It is turf that I am specially interested in to-day. I understand applications of 2-4D have been made to playing areas quite successfully and have eradicated this weed that some people call "Storksbill". There is the point that possibly a whole lot of experiments will have to be made on farm pasture lands with these hormones before they are universally used, but I am personally interested in playing areas, and I think that we can use 2-4D on this land because I believe it will get rid of Storksbill, which is one of the worst weeds we have.

We have tried all sorts of things but without success, and are hoping we will be successful with the application of 2-4D. Whether I applied that solution or not, on a playing field I would have no hesitation in saying to anyone who is interested to use it, but on pasture land I would want to know something more about it.

MR. HARRIS: I would like to make some further comments concerning weeds, particularly on turf, which are not affected by the 2-4D type of hormone spray. I have here some findings which were being made in connection with a report on green-keeping research and these extracts are taken from the notes. I will give you some indication of the results we have had up to the present in rather limited scale experiments connected with weeds on turf. It may be well if I went right back to the start of our work. In 1946 we obtained several samples of the new weed-killers and in order to conduct comparative tests I obtained from overseas, some six or eight different proprietary brands, all being weed control substances containing 2-4D. These were tried out and they were used at both the minimum and maximum rates recommended by the manufacturers and the plots were sprayed on the same day, the weather being fine and warm. The air temperature was 76 degrees and there was a slight breeze. Included in the same series were three control plots, two plots sprayed with arsenic pentoxide - one being sprayed with 1 lb. to 8 and the other with 1 lb. to 10 gallons and also a plot on which fertiliser treatment was given - 3 parts phosphate to one part of sulphate of ammonia. There is sufficient sulphate of ammonia in that mixture to have a certain amount of weed control where it is used over a fairly long period. In three days there was a good even burn; all weeds were affected and the more severe affects being with the greater strength of arsenic pentoxide. No effect could be seen with any 2-4D except with Catsear and a few young dock plants. Five days after treatment, burn was evident on both the arsenic plots; no effect was visible on the plot which had been treated with ammonia and superphosphate. With 2-4D rib-grass showed recurving of the leaves, and the leafstems were brown. The ordinary field daisy showed severe distortion on flower stems, turning back of the petals and the foliage was starting to wrinkle and go yellow. In two cases the flower stems of the ordinary field daisy had actually tied themselves in a knot, so great was the distortion. Mouse-ear and Chickweed leaves were yellow but not distorted. Various flat weeds which were fairly closely pressed to the surface of the ground showed a certain amount of yellowing but were not very severely affected. It is possible that the grass protected the leaves. A fortnight after the treatment was commenced the symptoms were exactly the same but the leaf curl and distortion, particularly on Yarrow, was very much more marked as was the purplish discolouration. These effects, generally speaking, were persistent and there was an effect which I noticed some fortnight after spraying. We noticed it again the next year and I have seen it again in one or two other instances. In every case where we have used 2-4D we have also noticed that the turf grass and particularly Browntop, has suffered a check in growth. To sum up, among the plants that were killed was ordinary Plantain, Catsear, Field Daisy, Star Thistle, Sorrel, Buttercup, Hawkbit, Hawkweed, in some cases clovers; in one case mint was severely affected. That I think, just about covers the list of plants killed. Quite a few other young weeds were severely affected, but recovered, and there were very few plants, most of them not young, which were not severely affected by the 2-4D. That was our first preliminary experiment with this 2-4D preparation. The next year, another experiment was made and that has actually been kept going since with regular spraying. There are one or two other points which I might mention. The Manawatu Golf Club carried out an experimental test with 2-4D. The object was mainly to control the flowering of the field daisy. On one fairway the daisies were so thick that it was difficult to see a gold ball lying on the grass. Several squares of that fairway were treated with the dust. The results, so far as the suppression of the flowering of the daisy was concerned, were striking. The flower stems showed severe distortion. Although the daisy plants were not one hundred per cent killed, there was really effective control. Incidentally, a rather complete control was obtained with the one dusting. Even now you can still pick that area out walking along the fairway. Pennyroyal is generally immune to dusting, and there has been a definite suppression of Browntop growth. Someone has mentioned Buttercup. I have used it going round the concrete foundation of my own garage and in that case the Creeping Buttercup was right in underneath the edge of the concrete where it would have been very difficult to deal with other than by spraying. The only trouble since is the growth of one or two seedling plants. They are quite easily controlled with one treatment. I treated several of the docks experimentally and with one treatment they are also killed. We have obtained quite good control of flat

weeds. I know that we had white clover very severely affected but it recovers fairly rapidly providing adequate fertiliser is applied. In fact, the effect may be overcome by liberal doses of fertiliser.

MR. F. BARRAUD (Ivor Watkin & Co.): The conference might be interested to hear the results of possibly the first large scale application of 2-4D to be put down in New Zealand. By that I mean something over fifty acres. This was tried in April of this year when the whole of the New Plymouth golf course was treated with 2-4D using a low volume application. The whole course was a mass of weeds, including Dandelions, Catsear, and a few others. So I advised Dr. Quillan and the club decided to treat the whole area including rough, fairways, and even the bunkers. We realised that it was quite impossible to treat an area of that size with knapsack sprays. We had read quite a lot of American applications of 2-4D with a low volume applicator and also English where it is possible to apply as low as a gallon of the material over an acre of the green. So we manufactured a machine with twelve nozzles standing a pressure of up to 80 pounds. There was a beam with 12 nozzles to apply a given amount of material in a given time. We went out and started work on the grass. This was in April of this year. There was a tremendous amount of interest created in this first application. However, we got going and we applied the material. We had 12 nozzles and we worked out a chart where the tractor had to drive at a certain given speed at all times. We covered approximately eight to nine acres per hour and delivered between two and three gallons to the acre of the material. We were applying it at about two to three pounds to the acre. On the second day it was raining. Also, three weeks after being completely finished there was heavy rain for I would say, ten days. I would like to point out here, that the first day we sprayed about 22 acres altogether. We had a lot of stoppages with the machine. After about a fortnight we went out to the course and it was quite obvious that all the weeds we had would be affected. They were showing the curving effects and the brown tinge in the leaf. Now, five to six months after that application, that course was almost completely weed free. It is just grass and clover. If anyone likes to look at that course we can show him a lot more clover than there was before. Whether it is the type of clover required for pasture I cannot say. Yarrow is growing very strongly and it got a very severe knock-back, when we sprayed. It is back now just as good as before. Mr. Harris also made mention of Browntop being severely affected by 2-4D. To my knowledge, most of our greens are predominantly Browntop and our greenkeeper has been using 2-4D for some time. I have never heard him mention that the Browntop has been affected.

DR. DOAK: Mentioning Browntop, I think those who follow the American work will remember that the Americans mention that the bent grasses are much more sensitive to 2-4D than the other grasses. I have no doubt that the effect that Mr. Harris has seen in Palmerston North can be seen elsewhere. It has certainly been recurring in the States. The other point about clover being more prevalent in the golf course does not necessarily mean that the clover is being stimulated. To my mind it means only that we have removed the competition of the weeds and given the clover a chance to grow.

MR. SUMNER (Taranaki): As regards the controversy of clover, I would like to say that some months ago my firm was treating a school playing area. The area was very badly infested with clover. Clover of course, will come through any asphalt surfaces. We thought we would give the hormone weed-killers a try. We knew absolutely nothing about them and used them from a purely amateur view. We sprayed it very heavily all over the area and on our return some time later, we were amazed to find that there was a growth of clover that was remarkable. I know nothing about the quantities that we used.

DR. DOAK: We had a case in Palmerston North where various preparations were tried on Californian Thistle in pasture. In some cases there were two and three applications and no 2-4D was put on last year and yet we can still see a reduction of clover that was persistent for something over eighteen months.

MR. LYNCH (Department of Agriculture): I feel that the meeting will end up in having different expressions of opinion simply because the conditions under which these various results happened, vary. I have in mind our own series of experiments where we had 188 trials on pasture. In plenty of these cases there has been definite suppression of clover. In the remainder there was no suppression at all but it is suggested that there are circumstances under which suppression is possible. If therefore, a pasture is weakened, I would say do not spray the hormone weed-killers under any circumstances.

With regard to these opinions, it does seem to me that it is just an indication that we do not know very much about the substances we are talking about. We have not nailed down the conditions under which we are likely to get these results.

MR. M. CARPENTER: From a farmer's point of view I am interested, and I think the conference may be, in the different weeds that we are discussing. It would appear that some weeds are valuable, and it comes down to how to differentiate between good and bad weeds because some of the weeds we are killing are being used as medicines and homeopathic remedies and corrections and are a medicine to our sheep. We have spoken of yarrow, and we know that the yarrow is for the sheep exceedingly nutritious, and Hogweed fattens the lambs very well. My point is just to show that farmers should not be led astray and get the ideas that there is no nutriment in weeds.

MR. M. BLACK (Agronomy Division): I was wondering how much the effects of Browntop may be due to the different time of application of the material. In the Agronomy Division we have used Weedone and although I cannot say there has been no reduction in growth, there is no visible effect on Browntop. We have found there that spraying material in the Spring, you have to use up to 50% more to get the same effect you get spraying in the Autumn and I am wondering just how many of these different effects may be due to the time of applications. Would Mr. Harris be good enough to tell us both the time of application and the quantity?

MR. HARRIS: In the case of the first trial I mentioned, we used some six proprietary brands and it was carried out in October 1946 and its effect on the Browntop was definitely visible in that case and the rates varied from 12 ozs. of actual 2-4D per acre to 19½ ozs. in the heaviest application and it was certainly on the heavier applications that we noticed the effect on the Browntop. I do not think I have the data of the trial carried out by the golf club on the fairway, but just from memory that was also a Spring trial, somewhere about September.

MR. Y. T. SHAND (Canterbury Progress League): In regard to the last query about the time of application, I may say that I had a very long struggle for three or four years trying to get rid of Hawthorn. I used sodium chlorate. I found that the application in the Spring burned the plant and withered it up and you can burn it off, but the plant was absolutely alive in the root and re-established itself. I then tried it in the Autumn, exactly at the time that the sap was running back to the root; that is to say, I cut the Hawthorn one to two inches above the ground and put a little on the severed top. I found that at the end of May and June there was an absolutely successful kill. It seems to me that in order to kill the plant it is essential to have the sap carrying that poison down from where you place it, into the vital parts of the plant. I have extended it to briar and gorse. It seems to have worked, but I cannot say very much about that.

MR. BEVIN: This discussion on weeds more or less divides itself into two categories; that of the playing area and that of the grazing pasture. I think that as far as the playing areas go, we are probably as well informed in New Zealand as any other country on the effect of the various weed-killers. One has only to go over our golf courses to appreciate that our greenkeepers' work shows a pretty high state of efficiency. Now, I think Mr. Harris has raised a main point in introducing his subject of pastures, and that is that the types of plants growing in any turf depend upon the setup obtaining at that time. That is, in terms of shading, fertility, the rainfall, the district and so on. I would say that in the main our thoughts on weed control in pastures should lie largely in terms of management. If we control the pasture by good management with the correct maintenance and grazing all the way through, our weed problem will not be exceedingly great. There are times when management runs away from us as in the North Island and parts of the South Island where we have the problem of the reverted country, and there there may be a chance for the application of something more than management, which may mean the use of weed-killers to try and reduce the weeds in that area. It may be wise to leave that country alone and let it go back to its forest. There are times when we may have need for weed-killers and I am thinking of the sort of thing that happens on farms when after a severe drought you get a big invasion of weeds. I have seen in Auckland after a severe drought, hundreds of acres of Buttercup. Again, you get the condition of run-down fertility on a farm. You may have 100 or 150 acres of

grass, that is pasture gone back to inferior weeds. You can plough and renew only a portion at a time - some measure of weed control on the remainder may warrant consideration. I would think that weeds on our pastures are in the main within the province of management, whereas weeds in our playing areas are controlled almost essentially by the use of weed-killers and fertilisers and the use of the mower.