5. WEED CONTROL RESEARCH IN NEW ZEALAND

by

L.J. MATTHEWS*

INTRODUCTION

This paper is based on the review of over 2,000 field experiments largely conducted by the Farm Advisory Division of the Department of Agriculture.

These experiments have given a fairly clear picture of the value of weed killers in New Zealand, but we will never know all the properties of various weed killing chemicals. To date over 600 trials have been conducted with MCPA and 2,4-D and we are still adding to our information on these chemicals.

We have most things Australia has but you have more of it. Our rainfall varies from over 200" per annum to less than 15". Only about two-fifth (43.4 million acres) of the land area of New Zealand is regarded as having an agricultural potential, and only one-third (14.3 million acres) or $\frac{1}{6}$ of total land area of the agricultural land is capable of being cultivated. There are 1,500 odd soil types of agricultural importance and with few exceptions our weeds have all been introduced. Your country is known as the arid continent and ours as the land of running water.

WEED CONTROL IN PASTURES

Most New Zealand agriculturalists used to preach that good farm management would control all weeds. For the low fertility weeds this was true. With pasture improvement the scrub weeds, gorse (Ulex europaeus), manuka (Leptospermum scoparium) and low fertility demanding grasses, Chewings fescue (Festuca rubra var. fallax) and Danthonia spp., gave way to ragwort (Senecio jacobaea), flatweeds, sorrel (Rumex spp.) and high producing grasses and clovers.

---

*New Zealand Department of Agriculture.

With further improvement the weeds of intermediate fertility were replaced by the highly competitive species, docks (Rumex spp.), a mixture of thistles, buttercups (Ranunculus spp.) and barley grass (Hordeum murinum). The spread of these species is aided by the very factors aimed at increasing production. These highly competitive weeds were indeed a challenge to future production, particularly the dairying industry.

Clover is essential to the New Zealand economy. Before the organic cycle is balanced clover is very important and any damage to clover results in pasture depression and usually a significant loss of stock production. For this reason the phenoxybutyrics are the favoured preparations. Seedlings docks, buttercups and most thistles are controlled effectively by these preparations. MCPA and 2,4-D may be employed at two periods without clover damage; in early spring before clover growth commences and again during the summer months. Application of MCPA and 2,4-D at times other than these, results in clover damage, particularly for the autumn period. (Slides 1-5)

Barley grass can almost be eliminated in one season by two applications of dalapon. The seed of this weed does not remain viable for more than one year. An application of 2 lb dalapon per acre in early spring when most seed has germinated followed by a knock-out application when any escaped plants are just beginning to flower, has virtually eliminated barley grass.

The problem weeds of high producing pastures yet to be satisfactorily controlled are mature docks, established Californian thistle (Cirsium arvense) in old pastures and more recently in autumn saved pastures, chickweed (Stellaria media). Also Anthemis cotula is increasing on lighter soils. As yet these species cannot be controlled without clover damage.

NEW PASTURE

Reliance in the past was placed on high seeding rates as a means of controlling weeds in newly sown pastures. The highly competitive effect of ryegrass suppressed most weeds but also associated clover and the slower establishing grasses, such as cocksfoot (Dactylis glomerata) and timothy (Phleum pratense). In the second year, due to nitrogen being a limiting factor, the pasture became clover, weed dominant. Only after several years was a balanced pasture restored.

The phenoxybutyrics have allowed a lighter seeding rate to be employed; imbalance of species does not occur to the same extent and most of the high fertility weeds are controlled, namely, seedlings and root regrowth of docks, Californian thistle and buttercups. Spurrey (Spergula arvensis) is one of the worst weeds in southern pastures that may grow once the competitive effect of susceptible weeds is removed.

CROPS

(a) Lucerne.

2,4-DB and dalapon have gone a long way to giving satisfactory weed control in this crop. The two may be applied separately or in conjunction. At most, lucerne is depressed up to the first cut. Mature docks in old stands and spurrey in newly sown stands are still a problem, paspalum (Paspalum spp.) and Indian doub (Cynodon dactylon) are also a problem, but no other chemicals to date can compete with the efficiency of 2,4-DB and dalapon. With dalapon there is a possibility of renovating old stands by closing a crop for seed, harvesting, and then applying dalapon alone or with 2,4-DB to control weeds present. The dead litter forms a satisfactory seed bed for the germinating lucerne.

(b) Field brassicas.

Only two chemicals have shown merit and neither satisfies all situations. Chlorpropham gives adequate control of spurrey in southern crops but fails to control fathen (Chenopodium album) at lower rates (1 lb/ac.) that crops will tolerate. Flatweeds, thistles and buttercups are also resistant.

MCA (monochloracetate) in the north gives adequate control of Amaranthus spp., black nightshade (Solanum nigrum) and Polygonum spp., but fails to control fathen. Rape, chou moellier, swedes and turnips may be treated with the above chemicals, but MCA cannot be used with safety on turnips until the 6-leaf stage.

(c) Cereals.

Weed control is so effective in cereals that these crops are regarded as cleaning crops for weeds.

MCPA is the most widely used preparation if fathen, wild turnip (Brassicas spp.) thistles and spurrey are the

dominant weeds. The amine salt of 2,4-D, if Amaranthus spp. and black nightshade dominate, and if members of the Polygonaceae dominate 2,4-DB should be used at an early growth stage. Cleavers (Galium spp.) are seldom a problem but mecoprop could be employed, particularly if chickweeds (Stellaria media and Cerastium spp.) are also present.

Anthemis cotula is seldom a weed, but, if present, may be controlled with MCPA/TBA preparations. The use of MCA is still doubtful. Yield depressions have followed its use; wild oats are not a New Zealand problem but carbyne appears very promising for this weed.

(d) Potatoes.

Potatoes seldom require weeding, but if they do no chemical can be recommended with confidence. TCA as a pre-emergence application under the correct set of moisture conditions controls grass weeds, fathen and Amaranthus spp. Dinoseb or dinoseb-dinosam mixtures are also a stop-gap pre-emergence treatment, but there is not a reliable post-emergence treatment.

If MCPA or 2,4-D or the phenoxybutyrics are to be employed, the weeds must cause more damage if not controlled than the above preparations before their use is warranted.

(e) Peas.

No single weed killer has proved satisfactory. Dinoseb is still the best weed killer when applied singly but its undesirable properties are well known. Also its lack of control of species arising from rhizomes, grass weeds, etc. MCPB is satisfactory under warm temperatures, but does sufficient damage to peas not to warrant its use unless the weeds would cause more damage than MCPB; it also fails to give adequate control of Amaranthus spp. and black nightshade. MCPB/dinoseb mixtures are not satisfactory, but MCA/MCPB mixtures with the exception of grass weeds have proved very reliable and widened considerably the spectrum of weeds control. A suitable mixture is 10 lb MCA $\frac{3}{4}$ lb MCPB per acre. MCA gives highly satisfactory control of Amaranthus spp., Polygonum spp. and black nightshade, and MCPB controls fathen, Californian thistle, etc. (Slides 6)

(f) Onions and Carrots.

Weed killers are helpful but must be supplemented by hand-weeding to some extent. On heavy soils, CDAA is satisfactory on onions, but does not give a wide enough

spectrum of control. Grass weeds, Amaranthus spp., Portulaca (Portulaca oleraceae) are removed but fathen, etc., survive. Chlorpropham applied at post-emergence in granular form is satisfactory except for thistles, flatweeds, legumes, buttercups and all members of the Cruciferae. The addition of CDEC or EPTC has not improved the range of weed control either with Chlorpropham or CDAA. Amiben has given outstanding control of weeds in carrots, controlling flatweeds and Amaranthus spp., Polygonum spp., Chenopodium spp., sorrel and Portulaca, but failed to control grasses. Chlorpropham controls grasses, spurrey, etc., so that the two chemicals appear complementary in their actions and are the most promising mixtures tested to date for carrots, winter lettuce, and possibly onions and brassicas, such as cabbages and cauliflowers.

Propazine and trietazine give poorer weed control generally than amiben, while simazine and strazine appear too toxic on onions and carrots. Zytron is still to be tested.

(g) Maize.

The outstanding chemicals are simazine, strazine or a mixture of these two. At rates of 4 lb/ac. they give luxury weed control except for members of the Paniceae. (Paspalum spp.), crab grass (Digitaria sanguinalis), witch grasses (Panicum spp.), barnyard grass (Echinochloa crusgalli) etc.) However, these weeds come when the crop is established as they are all summer germinaters and do not appear to depress the yield. Maize, like all other crops, suffers the most severe effects from weeds in the early establishing stages. (Slide 7)

CROP DESICCATION

Diquat in initial work is the most promising chemical for potato haulm destruction. This material and cacodylic acid are worthy of further testing. In the past the most effective preparation for potatoes, in spite of undesirable properties, were the arsenicals. In lucerne chlorates, MCA wetting agent and dinoseb/dinosam mixtures in diesel fuel oil are satisfactory but diquat is still to be tested. In red and white clover dinoseb/dinosam mixtures are the recommended materials, but diquat and even MCA look promising. Dinoseb/dinosam mixtures are efficient materials but possess disagreeable properties.

CHEMICAL PLOUGHING

This term is used for the establishment of crops and pastures without cultivation. Essentially cultivation removes existing inter-plant competition and prepares a seed bed. For chemical ploughing, chemicals remove existing inter-plant competition and the dead litter forms the seed bed or the seed may be drilled directly into the dead litter.

I consider this is the most promising use for weed killing chemicals yet developed.

Some of the advantages are:

1. Inferior grasses reduce yields of pastures normally more than do broad-leaved weeds.

2. Inferior grasses such as Danthonia spp., ratstail (Sporobolus capensis), browntop (Agrostis tenuis), Chewings fescue, Poa spp., (P.pratensis, P.annua and P.trivialis), Yorkshire fog (Holcus lanatus) and annual grasses, barley grass, goose grass (Bromus mollis) etc., may be removed with little or no damage to the rye grasses (Lolium spp.), cocksfoot and clover. If sufficient high producing grasses remain the area need not be oversown.

3. The method is applicable particularly to New Zealand as only one-third of the so-called agricultural land is capable of being cultivated.

4. The normal cropping weeds are not troublesome.

5. Erosion, wind-blow, rain-wash, etc., are not a problem and brassica crops have been grown where it is normally too dry to grow crops by conventional methods.

6. Pastures and brassica crops equal to that obtained by conventional methods have been grown. (Slides 8-20)

7. For pastures and some crops the method may be done aerially.

8. The method is applicable to such troublesome species as Nassella tussock - your serrated tussock - (Nassella trichotoma). (Slides 21-25)

One of the biggest limiting factors to its adoption in New Zealand is the lack of suitable chemicals. Dalapon and

amitrol both have a short residual life in the soil particularly if they reach the soil. For safety a time lag of up to two weeks must elapse between spraying and oversowing and this factor reduces the efficiency of the method. The ultimate would be a grass killer as efficient as dalapon but with no residual effects in the soil. Also a broad-leaved weed killer with the same properties.

TOTAL CONTROL OF WEEDS

In the initial knock-down of weeds specifics are more efficient than long term soil sterilents.

Dalapon and amitrol in the ratio of 5 lb to 1 lb supplemented, if necessary, with 2,4-D at 2 lb/ac. is sufficient to control most vegetation in nearly all areas when applied in the autumn-early winter period. A repeat application of this mixture can be made in spring or one of the soil sterilents monuron, diuron and simazine with amitrol in a ratio of 5 : 1 may be applied as an alternative. Soil sterilents would be more popular in New Zealand if heavy rates of 40 lb or so to the acre would give adequate weed control of all species, or if a mixture of two species would control all species. Unfortunately diuron, monuron, simazine and strazine all appear to control the same range of weeds. Members of the Paniceae flatweeds, Medicago spp., etc., are resistant to even high rates of application.

AQUATIC WEED CONTROL

With the exception of Paspalum distichum there are no difficulties in controlling emergent aquatic weeds in New Zealand with dalapon, amitrol, 2,4-D mixture. Dalapon, amitrol mixture is adequate except where buttercups, water cress (Nasturtium officinale) the musks (Mimulus spp.), water plantain (Alisma plantago aquatica) etc., are present. This mixture has revolutionised aquatic weed control. Drains may be weeded for as low as 3d. per chain with distinct advantages over mechanical weeding.

Floating aquatics such as the duck weeds (a mixture of Lemna minor, Wolffia arrhizia, Spirodella oligorrhizia), Callitriche verna and the waterfern (Azolla filiculoides var. rubra) are usually controlled once the emergent weeds are killed except in near to still water. In this latter case the best control is obtained with a surface spraying of chlorinated aromatics or 2,4,5-TP at a rate of 2 parts per million. 2,4,5-TP does not however control waterfern.

The best control of submerged aquatics has been obtained with 2,4,5-TP applied either as granules or as a liquid. It has proved superior to fenac and 2,4-D. It is also highly safe to fish. A concentration of 50 parts per million had no effect on trout and further the fish vacated the area thus minimizing any chance of being poisoned. To date no work has been done with acrolein but this material has many of the drawbacks of chlorinated aromatics. Apart from its toxicity, it checks the top growth of perennials which soon regrow.

NEW CHEMICALS NOT MENTIONED PREVIOUSLY

(a) 2,3,6-TBA.

This material has given control of several weeds not satisfactorily controlled by other chemicals. Alligator weed (Telanthera philoxeroides), a deep-rooted perennial, Russian knapweed (Centaurea repens), Asiatic knotweed (Polygonum cuspidatum) and woody vines such as Lonicera nitida. It also shows promise for convolvulus (Convolvulus arvensis) and sweet briar (Rosa eglanteria as a basal application. Although it has a long residual life in the soil it is relatively non-toxic to grasses.

(b) Fenac.

As yet it is difficult to find an opening for this chemical. It is lethal to some broad-leaved species such as clover. It appears to have little effect on established grasses, but does have a long residual effect if applied to bare ground. At low rates it controls Portulaca and spurrey but there is no latitude between the control of these weeds and its lethal effect on crops so far tested. It may prove complementary to monuron, diuron and simazine.

(c) SMDC and DMTT.

The first relative safe chemical to give satisfactory control of oxalis species is SMDC (Vapam). It is not as good as methyl bromide but superior to DMTT (mylone). The same chemical has given adequate control of nut grass (Cyperus spp.). The rate of 1 lb. per 100 sq. ft is not adequate for either SMDC or DMTT. The rate of 2 lb. is necessary under most conditions. Their main use is for high valued seed beds such as tomatoes.

(d) 4-CPA.

This is not a new chemical but it has been commercialised recently in New Zealand. It is undoubtedly the most toxic chemical available for bracken fern control (Pteridium esculentum). If the area is cultivated, 4-CPA at 3 to 4 lb. acid equivalent per acre controls newly developed fronds. If the fern is burnt not all fronds develop at the same period and a single application of 4-CPA does no more than thin a percentage of the fronds. This thinning is usually sufficient to allow pasture establishment. The chief drawback to 4-CPA is its toxicity to subterranean clover (Trifolium subterranean). Also under proper stocking fern is not a problem.

DISCUSSION

Some of the salient developments of weed research in New Zealand have been discussed. Each new chemical of merit that is developed usually limits the value of a chemical already in use. 2,4-D has lost its place to simazine for weed control in maize and TCA has almost been completely replaced by dalapon. It is true we are developing more and more chemicals to do less and less. There are still large numbers of weeds and problems to be solved even in a small area like New Zealand. Members of the Paniceae and Pennisetum spp. are not satisfactorily controlled by most chemicals except CDAA controls the members of the Paniceae as germinating seedlings. There is no positive control for sweet briar. The family Umbelliferae is unusually resistant to hormone preparations, to name but a few of the problems.

I am sure I will take home from this conference many new developments of value to New Zealand's agriculture.