PROBLEM OF MIXED WEED POPULATIONS IN CROPS

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SUMMARY

THE possible consequences of the selective action of post-emergence weed control chemicals on the mixture of weeds found in cereal and pea crops are discussed.

Trouble from broad-leaved weeds is unlikely in cereals provided currently available chemicals are used correctly and due regard is paid to the encouragement of crop vigour.

A real danger is seen in the large-scale swing to MCPB for weed control in peas. The virtues of dinoseb should not be forgotten and more use should be made of this chemical, especially in districts where a pea crop is grown two or more times in the rotation.

Complete suppression of seeding is recommended as the minimum standard of weed control.

Weed grasses are not discussed.

Crop production methods have now reached a high state of mechanisation from which there can be no retreat without a considerable reduction in our living standard. It is fair to say that the introduction of chemical methods of weed control over the past 15 years has done much to facilitate this change. This is particularly the case with mechanised harvesting and processing of crops. We know the troubles encountered in heading weedy crops and the blame placed on headers for increasing this weediness by returning weed seeds to the ground. We also know that pea growing for processing would not have been possible on the present scale, if chemical weed control had not paved the way for intensive mechanisation of the industry. Equally important is the fact that it has been possible to maintain and increase crop yields with this reliable and less labour consuming method of controlling weeds. The fact that chemicals now play an essential part in the maintenance of yield, facilitation of harvesting, and insurance of crop quality in the present-day system of farming is well exemplified in the case of garden pea growing in North Canterbury, where excellent yields of both green and seed peas are now regularly obtained from land which in the early 1940's had gone out of pea production because of fat-hen (*Chenopodium album*), wild turnip (*Brassica campestris*), and Californian thistle (*Cirsium arvense*). We need, however, more knowledge of the best way to fit this method of weed control into farm practice, if the advantage we have gained is to be maintained and further progress made. The implication of weed resistance to the post-emergence application of selective weedkillers is a case in point.

Chemical weeding of crops depends on the fact that different species of plants react differently to a given dosage of chemical. If the difference is sufficiently great, the more susceptible can be controlled in the presence of the more resistant. However, the factors responsible for tolerance are not peculiar to our crop plants. Thus when a crop containing a mixture of weed species is sprayed any resistant weeds as well as the crop will benefit from the removal of the competition from susceptible weeds. This will result in a change in composition of the weed population. The consequences may be immediate as was the case at the Crop Research Division when MCPA was first used on linseed. Fat-hen had made it almost impossible to grow the crop. MCPA at $\frac{3}{4}$ lb. acid equivalent per acre fixed that, but

wireweed (*Polygonum aviculare*) came away after an initial check and presented a new and even more difficult problem. In this case the wireweed seed content of the soil was already high enough for the wireweed to cause trouble as soon as the repressing effect of the fat-hen was removed. Normally the build-up of resistant weeds will be slower. They will seed more freely and subsequent generations will only have to compete with susceptible weeds arising from dormant seeds instead of these plus a large strike of "new" seed. Ultimately, resistant weeds may predominate and thus make the current range of weedkillers of little value.

Another way in which this differential effect of our weedkillers can increase weed resistance is by the selection of resistant varieties from slightly resistant species. This was fully discussed by J. L. Harper at the third British weed control conference. Wild populations are normally very variable and there is every reason to expect differences in reaction within species due to variation in physiological, morphological and phenological characters. For example a variety of fat-hen may exist which has only weak β oxidase activity and would therefore be resistant to MCPB and 2,4-DB. Another fat-hen could have the surface conditions conferring "dry weather" resistance to dinoseb even under moist conditions while yet another with slow germinating characters could avoid early spray treatment.

The speed at which the resistant weed population builds up will be determined to a large degree by the intensity of cropping, frequency and efficiency of weed control operations, and size of the resistant weed population at the time of introducing chemical weed control methods. If all the weeds are killed there is (by definition) no specific resistance and no varietal resistance can arise. If some survive, the greater the number and the more frequent the treatment the sooner is resistance likely to prove troublesome. Several years will be required for a weed to build up from infrequent occurrence to dominance, assuming that factors other than competition from chemical susceptible weeds are favourable for its increase.

The importance of the problem will depend on the characteristics of the resistant weeds. The consequences of resistant varieties of currently susceptible weeds, such as fat-hen and Californian thistle, need no elaboration, while resistant species will be of little account, unless they already possess undesirable characters which will be accentuated by increase in numbers. Cleavers (*Galium aparine*), for example, could seriously interfere with harvesting. Curnow's curse (*Calandrinia caulescens*) could choke seedling cereals, peas and grasses, but an increase in parsley piert (*Alchemilla arvensis*) is unlikely to cause much concern. However, all weeds are potential competitors and more work is required on the economics of control of every species.

Turning now to our crop weed problem we find that as far as cereal crops are concerned the present hormone weedkillers are giving satisfactory results because the majority of economically important weeds can be controlled with MCPA and 2,4-D. Exceptions are spurrey (*Spergula arvensis*) and the chickweeds (*Stellaria media* and *Cerastium glomeratum*) and of course wild oats (*Avena fatua*) and barnyard grass (*Echinochloa crusgalli*). But if we look at the list of weeds already naturalised in New Zealand and check it for phenoxyacetic resistant weeds of importance overseas we find the following:

Cleavers: "Very common in hedgerows", but only very occasionally troublesome in crop.

Corn marigold (*Chrysanthemum segetum*): "Well established about Wellington", and distributed over the whole country as a garden plant.

Mayweeds (*Anthemis* spp. and *Matricaria* spp.): Common as weeds of roadside and disturbed land, but only very occasionally troublesome in crop.

The possibility that they may break out to fill the niche left by the susceptible weeds should be watched.

In the case of peas, the only other crop sprayed to any extent, dinoseb has served very well, except for grass weeds, spurrey, Prince of Wales Feathers (*Amaranthus* sp.), and Californian thistle. In the last 2 years there has been a swing to MCPB, which is pleasant to handle and can be applied under a wider range of crop and weather conditions than dinoseb. This has given the answer to Prince of Wales Feathers and Californian thistle, but poses a problem with respect to the following MCPB resistant weeds found in some or all pea growing areas.

Catchfly (*Silene gallica*), Curnow's curse (two species are present in Marlborough, one of which also extends to Nelson and the other to Canterbury), dwarf mallow (*Malva rotundifolia*), field madder (*Sherardia arvensis*), henbit (*Lamium amplexicaule*), red dead nettle (*Lamium purpureum*), speedwell (*Veronica agrestis*), wild turnip (*Brassica campestris*), and willow weed (*Polygonum persicaria*). In addition control of fumitory (*Fumaria muralis*) is erratic, and cornbind (*Polygonum convolvulus*) and wireweed frequently recover and seed. Here then we seem to have the ideal set-up for the rapid development of dominance of MCPB resistant species and the selection of resistant varieties from moderately susceptible species.

Suggestions as to ways of delaying or preventing the build-up of varietal resistance are made by Harper, while A. L. Abel (Proceedings of second British weed control conference) deals with both varietal and specific resistance. Both suggest the use of several weedkillers with widely divergent modes of action. Harper advocates on genetical grounds applying such chemicals in pairs simultaneously, while Abel suggests a "rotation of weed-killers" combined with crop rotation and based on sets of three dissimilar herbicides for each weed. Harper also recommends that rapid acting weedicides be used to prevent the risk of seed being formed before the plant dies.

The problem of specific resistance necessitates increasing the number of weeds killed by a treatment, while varietal resistance requires the duplication of such treatment with dissimilar chemicals. A constant search is in progress for new chemicals and "wide range of toxicity" is always one of the objectives. The same objective can be achieved by mixing two or more chemicals to build up a product toxic to a wide range of weeds. Dissimilar sets of mixtures would be required to prevent varietal resistance developing.

In the case of cereals several new weedkillers including CMPP and a mixture of 2,3,6-TBA and MCPA capable of dealing with the resistant weeds have become available. The TBA checks the growth of MCPA resistant weeds and they remain stunted and eventually die. Wireweed, willow weed, and cornbind were satisfactorily controlled with it and no abnormalities in growth or yield were noted. Clovers, however, were severely checked and it thus cannot be used for undersown crops. As these new products are somewhat expensive they are unlikely to find general favour until the MCPA resistant weeds have become troublesome.

With peas the outlook is not so bright. The new weedkiller MCPB has solved some problems and created a number of new ones. Take for example wild turnip and the combination of this weed with Californian thistle. In the cool spring weather the sodium salt of MCPB will only check the turnip, which soon recovers and has been known to choke the crop. November spraying kills many of the turnips, but others flower and seed, though the crop doesn't seem to be affected by their presence. Recovery is less the more vigorous the crop. Late in the season (December) rates of 1½ lb. acid equivalent per acre will kill the majority of the turnips and few if any will survive to set seed. Early spraying with dinoseb will deal with the turnip but not the thistle. In the past the sodium salt of MCPA at 0.4 lb. acid equivalent per acre has given adequate control of both weeds, though the margin of tolerance is not great. Mixtures of mixed sodium and potassium salts of MCPA at 0.16 lb. acid equivalent and sodium MCPB at 0.93 acid equivalent per acre have proved satisfactory in the past two

seasons, but critical yield evaluation is necessary to determine whether the mixture has an economic advantage over the MCPA treatment. The mixture is of no advantage in the control of other pea weeds.

It would seem then that specific resistance of broad-leaved weeds is not a problem in cereals because of the availability of "wide range" chemicals, but because only hormone type chemicals are in use, there is some possibility of varietal resistance developing. In peas both types of resistance could be avoided by judicious alternation of contact type dinoseb and hormone type MCPB and MCPA. There would seem to be a risk of loss of effectiveness of MCPB through build-up of resistance if this course is not adopted.

The problem of wild turnip control outlined above indicates some steps which can be taken to reduce the rate of build-up of resistance and points to the possible danger of current thought on standards of weed control.

Recovery of weeds after spraying is always greatest in thin or poorly growing crops, a fact which is especially noticeable when the thinning is due to patches of disease in an otherwise vigorous crop. Normal good farm practice, thorough seedbed preparation, timely sowing of high testing dusted seed, and adequate use of fertiliser together with timely application of weedkiller will, as is well-known, ensure successful weed control and optimum yields. In addition seeding of resistant species or varieties will be reduced to a minimum.

The survival of some of the wild turnip after mid season spraying raises the question of acceptable standards of weed control. Cropping is carried out for profit and all crop production operations must therefore be judged in the light of their effect on net return to the farmer, provided due regard is paid to the maintenance of the overall fertility of the farm. It has been shown fairly conclusively that the maximum benefit in terms of yield response is obtained by preventing weed competition in the early stages of development of the crop.

As a corollary of this a complete kill of weeds is not as important as control over the vital period, provided the crop can be harvested and the quality is not impaired. This leads to the view that provided careful attention is paid to timing, application costs could be reduced by reducing rates of chemical and lowering the standard of weed control. There is little doubt that from this point of view the mid season control of wild turnip by MCPB is highly satisfactory. I believe, however, that in this and other cases dosage rates should be designed to give 100 per cent. non-seeding of weed species as a long-term insurance against the build-up of resistance. Where this is not possible (tares (*Vicia* spp.) in peas for example) the crop rotation could be designed to include a crop in which control of the particular weed or, preferably, complete weed control is practicable. Spring-sown barley is a valuable crop in this respect in many of our cropping districts. Fortunately, the fact that the farmer tends to judge results on the presence or absence of weeds at harvest has resulted in a high standard of weed control in the past and will tend to maintain standards in the future.

DISCUSSION

Q.—Do erratic results with control of fumitory apply only to MCPB?

A.—Dinoseb gives excellent results on fumitory, and MCPB is erratic.

Q.—Has the speaker any experience with mixtures of dinoseb and MCPB? If so, in what ratio?

A.—Nothing recently, because dinoseb prevents translocation of MCPB. Some trial strips have been laid down in the past, with $\frac{1}{2}$ lb. per acre of

dinoseb equivalent plus $\frac{1}{4}$ lb. acid equivalent per acre of MCPA, also $\frac{1}{4}$ lb. per acre of dinoseb equivalent plus $\frac{1}{2}$ lb. acid equivalent MCPB, but no benefit was obtained concerning the control of Californian thistle in peas.

Q.—What are the shortcomings of low volume application of dinoseb?

A.—Inexplicable results sometimes obtained can only be attributed to low volume application. U.K. experiments show that volume rates need to be much higher than those commonly used in New Zealand.

Q.—What merit is there in mixtures of MCPB and MCPA?

A.—In practice we find that a more critical application of MCPA alone is desired.

Q.—What weeds normally appear when a long-term pasture is ploughed up for peas?

A.—In Canterbury fat-hen and wild turnip.

Q.—Has MCPB any effect on the genetical make-up of fat-hen?

A.—This has not been noticed as yet. The possibility seems remote. Sometimes a combination of MCPB and climate can produce phenotypic alterations.