CHEMICAL WEED CONTROL IN HORTICULTURAL CROPS

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THIS paper will deal principally with chemical weed control trials conducted by officers of the Horticulture Division on vegetable crops last year. Mention will also be made of 2 small fruit trials and one on a cut-flower crop.

VEGETABLES

Chemical weed control is a major step forward in vegetable crop production, since it reduces labour costs and enables weed control under adverse conditions when other methods are not practical. If herbicides can be employed to destroy seedling weed growth before the emergence of the crop, the first cultivation may be delayed until the crop is well through the ground. Post-emergence weed control with herbicides is far more difficult, since the margin between crop tolerance and satisfactory weed control is often very narrow.

We do not want to consider chemical weed control as a substitute for all cultivations, but merely as a supplement to standard cultural practices. Resistant species may increase and dominate if only chemical eradication methods are employed.

Herbicides Already in Use in New Zealand in Vegetable Production

Chemical weed control practices already well established in New Zealand in vegetable production include:—

- (i) Dilute sulphuric acid for onions—both pre- and post-emergence;
- (ii) Dinitro compounds for onions—post-emergence only;
- (iii) Dinitros for peas—both pre- and post-emergence;
- (iv) Power kerosene and similar compounds for carrots and parsnips—at the 2 true-leaf stage only.

These have been discussed fully at previous conferences and therefore will not be elaborated here.

Trials 1952-53:

1. Levin Horticultural Research Station: The trials at Levin were initiated for testing the tolerance of beetroot, carrots, leeks, lettuce, onions, parsnips, silver beet, spinach and turnips to the 8 herbicides listed below on the "Crop Tolerance Chart."

Six blocks, each containing one row of each of the vegetables listed, were sown with a Planet Junior drill on 9 October 1952. The blocks were pegged off into plots 12ft. long by 10ft. wide to give 2 plots for each treatment and in addition approximately 25 per cent. for control plots.

The herbicides were applied at a range of concentrations on 13 and 14 October just before the emergence of the crops, though by the latter date some turnips were appearing. The lettuce and spinach and some beetroot emerged 4 days after the herbicides were applied. Apart from only a patchy strike of the onions and leeks, all the other vegetables were well up 9 days after treatment.

A Graveley tractor was employed to deliver the sprays through 2 32M nozzles fitted to an H1 wand at a pressure of 100lb. per square inch.

Temperatures at the time of application of the sprays were fairly high (60 degrees to 70 degrees F.), but a cold period with a good deal of rain followed and thus those herbicides (TCA and IPC) which are absorbed in the main through the roots were well washed into the root zone. Unfortunately it was not possible to grow the crops on to maturity and thus an assessment of the effect of the herbicides on the yield and quality of the crops was not made.

Below is a summary of the tolerance of the crops to the various herbicides employed. It is not intended that these results should be accepted as final recommendations. It must be realised that the trials have been conducted only in one particular locality for one season and on one particular soil type. In addition, only one variety of each vegetable was tested and there may be a considerable range of tolerance displayed by other varieties, especially to those herbicides which act through the roots and not merely by contact of above-ground parts. This latter point in particular I make in the light of my recent experiments with sodium trichloracetate to which 10 oat varieties showed a marked variation in tolerance.

It is hoped that the suitability of those herbicides showing most promise last season can be confirmed this year.

CROP TOLERANCE CHART

Herbicide Common abbrev. in brackets.	Rate per acre.	Beetroot	Carrots	Leeks	Lettuce	Onions	Parsnips	Silver Beet	Spinach	Turnip
4,6-dinitro ortho secondary butyl phenol (DNBP)*—										
	2 qts.	T	T	T	T	T	T	T	M	X
	4 qts.	X	M	M	M	X	T	T	X	X
	8 qts.	X	X	X	X	X	T	M	X	X
4,6-dinitro ortho cresol (DNOC)*—										
	2 qts.	T	M	T	T	M	T	T	M	X
	4 qts.	X	X	M	M	X	M	M	X	X
	8 qts.	X	X	X	X	X	X	X	X	X
sodium trichloracetate (TCA)—										
	5lb.	T	T	T	T	T	T	T	T	T
	10lb.	T	T	M	T	M	T	T	M	T
	20lb.	T	T	X	T	X	T	T	X	M
	30lb.	T	T	X	T	X	T	T	X	X
isopropyl-N-phenyl carbamate (emulsion) (IPC)—										
	2lb.	T	T	T	T	T	T	T	X	M
	4lb.	T	T	T	T	T	T	T	X	X
	8lb.	M	T	T	M	T	T	M	X	X
sodium cyanate—										
	5lb.	T	T	T	T	T	T	T	X	M
	10lb.	T	T	T	T	T	T	T	X	M
	20lb.	T	T	T	T	T	T	T	X	M
	30lb.	T	T	T	X	T	T	T	X	M
disodium 3,6-endoxohexahydrophthalate (Endothal)—										
	3lb.	T	T	T	T	T	T	T	M	M
	6lb.	T	T	T	T	T	T	T	M	M
	12lb.	T	M	M	T	M	T	T	M	M
sodium isopropyl xanthate (NIX)—										
	2lb.	T	T	T	T	T	T	T	X	T
	4lb.	T	T	T	T	T	T	T	X	T
	8lb.	T	T	T	T	T	T	T	X	T
	12lb.	T	T	T	T	T	T	T	X	T
sodium 2,4-dichlorophenoxyethyl sulphate (Crag Herbicide 1)—										
	1lb.	T	M	T	T	T	X	T	X	T
	2lb.	T	M	T	T	T	X	M	X	T
	4lb.	T	X	T	T	T	X	M	X	M
	6lb.	X	X	T	X	T	X	X	X	X

T equals Tolerant. M equals Moderately tolerant. X equals Intolerant

* Plus dieselene—15 gallons per acre.

Weed Control:

The annual weed population was made up approximately as follows:—

Spurrey (*Spergula arvensis*), 50 per cent.
Redshank (*Polygonium persicaria*), 40 per cent.
Black nightshade (*Solanum nigrum*), 10 per cent.

It was possible to arrive at definite conclusions in respect to the herbicidal value of some of the chemicals employed, though the density of weed growth varied so much from plot to plot that a fair comparison was not possible. In subsequent trials a protected control area is included in each plot to enable a fair assessment to be made.

DNBP and DNOC at 8qts. per acre completely denuded the plots of annual weeds and an 80 per cent. control was obtained at half this rate. Two quarts was not considered efficient, though the measure of control appeared greater than even the strongest concentrations of all the other chemicals, with the exception of **IPC**, which gave an excellent control of spurrey at all rates and some control of redshank and black nightshade at the 4lb. and 8lb. rates. **Sodium cyanate** also gave some degree of control at the 10lb. rate and heavier.

Endothal, NIX and TCA did not appear to give any significant control of annual weed seedlings (12lb. rate for Endothal excepted).

Crag Herbicide 1, which was included mainly to determine its herbicidal value, gave no suppression of weed growth even at the 6lb. rate. Trials with this herbicide have been conducted at several places in New Zealand and in only one instance (at Katikati, of which mention will be made later) has any indication of weed control been reported. Some malformation of redshank and parsnip seedlings was apparent, but both plants soon outgrew this.

Conclusions

Observations have shown the phenolic sprays to be the most satisfactory herbicides for pre-emergence weed control in the trials conducted. Onions and leeks were extremely sensitive to such sprays applied before germination. These plants should therefore not be treated until they have reached the 2 to 3-leaf stage.

It is possible that the phenols alone, without the addition of dieselene, might not be as residual in effect and therefore less toxic to the germinating crop. Of the vegetables tested carrots and parsnips were the most tolerant to the phenol-dieselene spray mixture. It may have been that they were only more tolerant to the dieselene and not the phenols.

Weed Control in Asparagus

Weed control in a perennial crop such as asparagus can be a real problem. Trials were initiated at Hastings and Katikati to determine the tolerance of this crop to several herbicides and also to assess the measure of weed control obtained from the application of these at various rates.

Herbicides Tested

- (i) **Pre-emergence**—DNBP at 1, 2, and 4 qts., plus 15 gals. dieselene per acre.
Sodium cyanate at 2, 4, and 8lb. per acre.
IPC (emulsion) at 1, 2, and 4lb. per acre.
TCA at 5, 10, and 20lb. per acre.
- (ii) **Post-emergence**—Sodium cyanate at 2, 4, and 8lb. per acre.
IPC (wetttable powder) at 1, 2, and 4lb. per acre.
Crag Herbicide 1 at 1, 2, and 4lb. per acre.

(iii) **Post-harvest**—TCA at 25, 50, and 100lb. per acre.

MCP sodium salt at 0.5, 1.0, and 2.0lb. of acid equivalent per acre.

MCP butyl ester at 0.5, 1.0, and 2.0lb. of acid equivalent per acre.

Results and Conclusions

(a) Asparagus Tolerance

The asparagus was tolerant to all the herbicides used for the pre- and post-emergence treatments at all rates of application.

The post-harvest sprays were applied at the end of the cutting season just before emergence of the spears, which were left to develop into fern. One or 2 spears which were intentionally left in each plot became very twisted as a result of the MCP treatments and some badly stunted by TCA, but those spears which emerged subsequent to spraying developed normally and produced strong fern. It is intended to observe the post-harvest plots again this season to determine whether there is any delayed harmful effects to the asparagus from any of the compounds.

(b) Weed Control

(1) **Pre-emergence:** At Katikati the pre-emergence sprays were applied the day after a last cultivation was given and no weed seedlings had emerged. DNBP and sodium cyanate did not give any apparent weed suppression of seedlings which emerged between 1 and 2 weeks after the cultivation. IPC at the 2lb. rate gave a fair kill of redshank and almost complete control at the 4lb. rate. TCA did not give any significant reduction of dicotyledon seedlings, and neither did it prevent the germination of summer grass (*Panicum sanguinale*) which emerged 2 weeks after the application of the sprays.

At Hastings good control of dicotyledon seedlings was obtained with DNBP at the 4qts. rate of application. No measure of weed control was obtained with the other pre-emergence sprays.

(2) **Post-emergence:** In all, three post-emergence spray applications were made at Katikati, but only one at Hastings. At Katikati plots treated with Crag Herbicide 1 at the 2 and 4lb. rates of application remained completely free of summer grass. In addition there was a noticeable reduction in the density of redshank, spurrey, cress (*Coronopus didymus*), and cudweed (*Gnaphalium luteo-album*). This is the only instance of which I have heard of any weed control being obtained with Crag Herbicide 1 in New Zealand. Vlites and Carrol, both of the Boyce Thompson Institute for Plant Research, New York, have shown that environmental factors are very important in the activation of Crag Herbicide 1. Hydrolysis of this herbicide to its active form is apparently brought about by the secretion of bacterial or fungal acids, and these latter are more numerous at high soil temperatures. This is possibly the reason for the good results at Katikati. Acid soils also favour its activation and this may also have been a factor involved.

Annuals had reached a height of 2in. at the time of application of the post-emergence sprays at Hastings. No weed control was obtained with either Crag Herbicide 1 or IPC.

At Katikati IPC gave no control of summer grass, but it did suppress quite markedly several species of dicotyledons, including redshank, spurrey, cress, and cudweed. Sodium cyanate at 4lb. per acre gave a fair control of the dicotyledon seedlings mentioned above. Double this rate gave almost complete control and in addition summer grass seedlings were suppressed.

(3) **Post-harvest:** On the property where this trial was conducted at Hastings couch (*Agropyron repens*), yarrow (*Achillea millifolium*), and Californian thistle (*Cirsium arvense*) were troublesome. TCA was applied at heavy rates in an attempt to kill the couch and hormones were used against the other weeds.

TCA gave a complete kill of top growth of couch at all rates of application, but its effect was less marked at the 25lb. rate. Inspection of the roots showed approximately 70 per cent. to be dead at the 100lb. rate and about half at the 50lb. rate.

TCA at both the 50lb. and 100lb. rates of application produced a marked stunting of all weed growth and in one plot Californian thistles were killed. A further assessment of the degree of couch control will be made this spring.

Both of the MCP preparations caused much distortion of the annual weed growth, which was about 6in. high at the time of application. However, most recovered and seeded. Some control of Californian thistle was obtained, but not good control. The yarrow was temporarily burnt and distorted, but later outgrew this and developed to maturity.

Weed Control in Onions at Hastings

A. Pre-emergence:

DNBP 2 qts. and 4 qts.; NIX 4lb. and 8lb.; TCA 5lb. and 10lb.; IPC (emulsion) 4lb. and 8lb.; and sodium cyanate at 10lb. per acre were applied as pre-emergence sprays 14 days after the onions were sown. Spraying was delayed probably a little too long, for some of the onions were just emerging.

(1) **Crop Tolerance:** The onions were tolerant to all sprays except DNBP, though all produced a tip burn of varying degrees. In no case was the burning of any permanent consequence. All the onions were killed in the DNBP treated plots.

(2) **Weed Control:** The weed seedlings present in descending order of density were:—

Amaranthus—(*Amaranthus retroflexus*).
Cotula—(*Cotula australis*).
Fat-hen—(*Chenopodium album*).
Veronica—(*Veronica agrestis*).
Mouse-eared chickweed—(*Cerastium glomeratum*).
Winter grass—(*Poa annua*).

DNBP gave very good weed control at 2 and 4 qts. per acre. NIX at the 8lb. rate killed all weeds except a few plants of cotula and *Poa annua*. No weed control was obtained with TCA. *Poa annua* and fat-hen were controlled with IPC and to some extent with sodium cyanate, but other weeds were not suppressed.

B. Post-emergence:

Prolonged inclement weather prevented the application of the post-emergence sprays DNBP, sodium cyanate, and Crag Herbicide 1 before the weed seedlings had reached between 6 and 18in. in height 7 weeks after sowing. At this time even sulphuric acid (10 per cent.) gave little weed control. Some plots were hand-weeded before application of the sprays so that a better assessment of crop tolerance might be made. The tolerance of onions to DNBP when sprayed at the 2 to 3 leaf stage was confirmed. Even at the 4 qts. rate only a slight tip burn was produced. Neither sodium cyanate at 10lb. per acre nor Crag Herbicide 1 at the 4lb. rate harmed the onions.

Small Fruits

(1) **Raspberries:** At the Levin Horticultural Research Station the perennial grasses couch and creeping bent (*Agrostis stolonifera*) are very troublesome weeds in the areas planted in raspberries. TCA at 25, 50, and 100lb. per acre was sprayed around the canes in late September 1952, at which time growth had already commenced. All rates of application produced a severe chlorosis of the raspberry foliage. The fruit which formed on the treated bushes was much reduced in size. Though there was a gradation of toxicity from the 25lb. rate up to the 100lb. rate, so severe was the damage in each case that all the bushes had to be destroyed.

Further trials are being conducted this year with the application of TCA in smaller amounts and at different times. Overseas, 60lb. of TCA applied in the autumn has given good couch control without any effect on the raspberry canes.

(2) **Strawberries:** Crag Herbicide 1 at 2 and 4lb. per acre rates was applied in the spring to a new planting of Auchincruive Climax strawberries. The strawberries displayed no intolerance to this material. Unfortunately no weeds appeared on the control plots and therefore it was not possible to assess the weedicide value of this material or of the TCA which was applied at the same time.

TCA at 10lb. per acre caused a marginal scorch of the strawberry foliage, though they almost completely outgrew this symptom later.

Flowers

Gladioli:

DNOC 2, 3, and 5 qts; IPC 4 and 8lb.; and the sodium salt of MCP, 1.22lb. of acid equivalent per acre, were tested as pre-emergence sprays for the control of weeds in a gladioli crop grown on the Levin Horticultural Research Station. Redshank and spurrey formed the bulk of the weed population. The gladioli were tolerant to all the chemicals at all rates of application. DNOC gave excellent weed control even at the lowest rate and can be recommended with confidence. This herbicide has been used overseas for weed control in this crop.

Where a more resistant type of weed growth is present better results are likely to be obtained from the use of the di-nitro-phenol mixture— butyl form 50 per cent. amyl form 10 per cent.—applied at 1 quart in 15 gals. of dieselene per acre.

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DISCUSSION

Q. Was not the TCA application on raspberries when plants were shooting at the base carried out too late?

A. (Pengelly): Applications at that time produced a harmful effect and are not recommended. Autumn applications are more suitable.

Comment: Work has shown that the di-nitro-phenol mixtures are valuable for weed control on wet soils. With the addition of emulsifying agents nearly 100 per cent. control of spurrey and chickweed was obtained. Also good control was obtained of seedlings of *Poa annua*, toad rush (*Juncus bufonius*), and prairie grass (*Bromus catharticus*) around young shrubs and nursery trees and also in bulb beds.

Comment: The di-nitro-phenols have been listed as poisonous, especially the oil-based forms, and special care is needed when applying these.