HERBICIDES FOR KIWIFRUIT

T.I. COX

Horticultural Research Centre, MAF, Levin

Summary

A large number of herbicides was screened for indications of tolerance by kiwifruit (*Actinidia chinensis*) at the seedling and young plant stages. Soil treatments of alachlor, chlorthal, dinitramine and pendimethalin and foliage applications of carbetamide, dichofop-methyl, dalapon, desmedipham/phenmedipham, ioxynil and metribuzin were promising and all warrant further investigation. Suggestions are made for further testing in field situations.

INTRODUCTION

In the currently prosperous kiwifruit industry expansion is occurring in both existing and new areas of the North Island (Sale 1979). In a year, since publication of the latest official statistics (Anon 1979), the total area in kiwifruit has increased by 50% to 3393 ha (P.R. Sale, pers comm). It has been estimated that at least two-thirds of this area has not reached fruit-bearing maturity and the establishment of new plantations is expected to continue over the next few years.

As yet, suitable herbicides for the crop have not been seriously researched. Worldwide, there is almost no literature on the subject although in central California, where kiwifruit growing is also expanding, some herbicide testing has begun (Fischer and Browne 1977).

In New Zealand, a few herbicides have been adopted on an *ad hoc* basis, by experienced kiwifruit growers in the Bay of Plenty (P.R. Sale, pers comm). A common practice is to use directed applications of paraquat/diquat, beginning in late winter and continuing, as necessary, until the leaf canopy has developed in November. Spot applications of asulam are made to docks and glyphosate is quite often similarly used on a range of perennial weeds.

There has been mixed experience with residual herbicides. Simazine has been used occasionally with no recorded problems but dichlobenil, chlorthiamid, terbacil, bromacil and diuron have all caused damage on free-draining light sandy loam soils, which commonly receive up to 2,000 mm of rainfall per annum. Under heavier soil conditions in the Nelson area a test with terbacil did not result in crop damage.

The screening experiments reported in this paper, which included more than forty candidate chemicals, are a first stage in the systematic development of herbicide treatments for kiwifruit.

METHODS AND MATERIALS

Seed was extracted from cool-stored kiwifruit and pre-germinated on damp pads in petri dishes at 25 °C. Flexible moulded plastic propagating trays, each containing 100 cells 3 cm in diameter, were filled with a peat-less soil mix and one chitted seed sown in each cell. Trays were sub-irrigated on capillary matting on the glasshouse bench. At the two true leaf stage seedlings were potted into 7 cm diameter polystyrene cups each fitted with a cotton wool plug to facilitate sub-irrigation. Routine pesticide applications were made as required, captan to control 'damping-off' and cyhexatin and methomyl against mite and whitefly, respectively. When they reached the six true leaf stage and an average height of 5 cm these plants were used in two experiments.

In Experiment 1 a range of herbicides, as detailed in Table 1, was applied to the soil surface by pipette in 10 ml of solution per pot, care being taken to avoid contact with the plant foliage.

Proc. 33rd N.Z. Weed and Pest Control Conf.

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TABLE 1: Treatments applied to kiwifruit seedlings at six true-leaf stage and their effect after 10 days.

Herbicide	Rates, kg/ha				Mean vigour score 0-10 (full vigour)	
	Applied to soil surface Experiment 1		Applied to foliage Experiment 2		Exp 1	Exp 2
alachlor	1.2,	1.8			9.6	
asulam			1.5			9.6
atrazine	0.8,	1.2	0.8,	1.2	6.4	9.5
aziprotryne			1.2,	1.8		6.6
bentazone			0.8,	1.2		2.5
bromacil	0.8,	1.2			2.5	
carbetamide			2.4,	3.6		6.4
chloroxuron	3.0,	4.5			7.0	
chlorthal	5.0,	7.5			9.9	
chlorthiamid	5.0,	7.5			3.2	
chlormethazole			0.8,	1.2		4.6
cyanazine			0.8,	1.2		8.4
dalapon			2.0,	4.0		3.1
desmedipham/phenmedipham*			0.8,	1.2		3.4
desmetryn			0.2,	0.3		5.1
diclofop-methyl			0.8,	1.2		4.9
dinitramine	0.4,	0.6			9.7	
dinoseb-acetate			0.8,	1.2		1.5
diphenamid	3.0,	4.5			6.2	
diuron	0.8,	1.2			3.4	
ethofumesate			1.2,	1.8		4.7
hexazinone	0.8,	1.2	0.8,	1.2	2.7	2.5
ioxynil			0.4,	0.6		1.6
lenacil	0.8,	1.2			9.4	
linuron	0.8,	1.2	0.9,	0.9	5.8	4.5
metamitron	3.0,	4.5	3.0,	4.5	3.8	6.1
methabenzthiazuron	0.8,	1.2	0.8,	1.2	4.6	5.4
metribuzin	0.4,	0.6	0.4,	0.6	2.1	2.7
oxadiazon	1.2,	1.8			3.0	
pendimethalin	1.0,	1.5			9.8	
prometryn	0.8,	1.2	0.6,	0.9	4.2	5.2
propachlor	3.0,	4.5			7.8	
propyzamide	1.0,	1.5			7.8	
simazine	0.8,	1.2			7.0	
terbacil	0.8,	1.2	0.8,	1.2	2.8	5.0

* as product containing 8.25% each of phenmedipham and desmedipham.

The treatments of Experiment 2, also listed in Table 1, were foliage-applied in a laboratory cabinet. Herbicide solutions were sprayed at 200 kPa pressure and 410 litres/ha equivalent through a fan nozzle (Spraying Systems Teejet no. 730231) mounted on a spray cart which travelled at a constant speed and height above the plants.

In both experiments seven plants were used for each treatment.

In Experiment 3, older plants were used, three per treatment, size graded by replicates. They were grown in black plastic planter bags and selected foliage acting herbicides were applied, by the same technique as Experiment 2, when plants were 12 to

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28 cm tall with up to 12 leaves. In order to improve uniformity of treatment, only the main shoot with three young expanded leaves was sprayed on each plant. The lower, older leaves were shielded from the spray by means of a filter paper collar, 24 cm diameter, slit to the centre and held in place around the plant stem with a paper clip. Treatments are listed in Table 2.

After treatment, plants were returned to the glasshouse bench and the development of treatment effects observed and recorded. Major assessments were made after 7, 10 and 20 days, and for Experiment 3, after 3 months.

TABLE 2: Treatments applied to foliage of young kiwifruit plants in Experiment 3.

Herbicide	Rates, kg/ha	
amitrole T	2.0,	4.0
asulam	1.5	
bromofenoxim	1.6,	2.4
carbaryl/propanil*	5.0,	7.5
carbetamide	2.4,	3.6
dalapon	2.0,	4.0
desmedipham/phenmedipham	0.8,	1.2
diclofop-methyl	1.0,	1.5
glyphosate	1.0,	1.5
ioxynil	0.6,	0.9
metribuzin	0.4,	0.6
oxadiazon	1.4,	2.1

* as product containing 4% carbaryl and 25% propanil.

RESULTS

Experiments 1 and 2

Symptoms developed at different rates. A number of herbicides had a rapid and severe effect on young seedlings, at both rates of application. The results of an assessment of plant vigour made 10 days after treatment are included in Table 1. Mean figures are given for chemicals as the differences caused by dose were generally small.

Soil-applied treatment(S) which resulted in completely dead or moribund plants with only a small amount of green tissue when assessed 10 days after treatment were :— bromacil, chlorthiamid, diuron, hexazinone, metamiltron, metribuzin, oxadiazon and terbacil.

Foliage applied herbicide treatments (F) causing early death of seedlings were :— bentazone, dalapon, desmedipham/phenmedipham, dinoseb acetate, hexazinone, ioxynil and metribuzin.

The effects of the remaining herbicide treatments summarised from the 20 day assessment are as follows :—

alachlor (S)	Seedlings tolerant to 1.8 kg/ha.
asulam (F)	Pale younger leaves.
atrazine (S) (F)	Severe damage, or death, with soil drench. Foliage application resulted in slight scorch at 0.8 kg/ha and slight scorch plus chlorosis at 1.2 kg/ha.
aziprotryne (F)	Chlorotic leaf margins and scorch.
carbetamide (F)	Growing points killed, interveinal reddening.
chloroxuron (S)	Severe damage, or death.
chlorthal (S)	Seedlings tolerant to 7.5 kg/ha.
chlormethazole (F)	Severe damage, or death.
cyanazine (F)	Some chlorosis and scorch, especially at 1.2 kg/ha.
desmetryn (F)	Chlorosis and scorch, severe at 0.3 kg/ha.
diclofop-methyl (F)	Stunting with new growth of side shoots.

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dinitramine (S)	Seedlings tolerant to 0.6 kg/ha.
diphenamid (S)	Scorch and leaf distortion, especially at 4.5 kg/ha.
ethofumesate (F)	Growing points killed, interveinal reddening.
lenacil (S)	Veinal chlorosis and some scorch.
linuron (S) (F)	Severe damage, or death.
methabenzthiazuron (S) (F)	Severe damage, or death.
pendimethalin (S)	Seedlings tolerant to 1.5 kg/ha.
prometryn (S) (F)	Severe damage, or death.
propachlor (S)	Irregular effect, some healthy but several plants killed.
propyzamide (S)	Some leaf distortion and stunting.
simazine (S)	Irregular effect, some healthy but several plants killed.
terbacil (F)	Severe damage or death.

Experiment 3

The following observations, made 7 days and 3 months after application to the plant foliage, summarise the overall effect of treatments.

amitrole T	Bleaching and necrosis of interveinal leaf areas and growing points leading to severe damage.
asulam	Little effect initially, but chlorosis developed with premature leaf fall and distorted new growth.
bromofenoxim	Rapid initial leaf necrosis and bleaching of leaf margins, and growing points. Long term recovery possible.
carbaryl/propanil	Rapid leaf necrosis leading to senescence and death of plant.
carbetamide	Downward leaf cupping and leaf tip necrosis with eventual recovery.
dalapon	Initial discolouration and slight cupping of leaves, some distortion of new growth. Long term recovery possible.
desmedipham/phenmedipham	Some leaf chlorosis and marginal necrosis but plants recovered.
diclofop methyl	Slight leaf distortion initially but rapid recovery.
glyphosate	Collapse of foliage leading to leaf-fall, distorted new growth and, usually, death.
ioxynil	Initial general leaf necrosis but plants recovered well.
metribuzin	Chlorosis and necrosis of expanded leaves, growing points remained healthy and plants recovered.
oxadiazon	Rapid leaf necrosis followed by distorted, stunted new growth. Severe damage.

DISCUSSION

Experiments 1 and 2 gave basic information on the physiological tolerance of kiwifruit to a wide range of herbicides. A number of chemicals, both soil-applied and foliage-applied, can be excluded from further discussion as a result of their definite and drastic early effects, as listed in the text. Others were slower acting but eventually resulted in severe damage or death. The remainder can be considered in more detail as potentially useful in field situations.

Soil-applied alachlor caused no damage at 1.8 kg/ha. The related propachlor gave inconsistent results, possibly due to experimental error and should be examined again. Most of the triazine herbicides caused unacceptable damage but the relatively slight effect of foliar applications of atrazine, up to 1.2 kg/ha, is interesting. The only other triazines considered possible as foliage treatments, aziprotryne and cyanazine, were more damaging than atrazine. Soil applied simazine produced an irregular effect but lack of damage is quite likely to be a result of lack of movement to the rooting zone rather than true tolerance.

Both dinitramine 0.6 kg/ha and pendimethalin 1.5 kg/ha were well tolerated when applied as soil drench treatments. The only other soil-applied herbicides worth considering are chlorthal, lenacil and propyzamide. Chlorthal at 7.5 kg/ha was

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apparently quite safe. Lenacil caused some leaf scorch and chlorosis. Propyzamide caused some leaf distortion and stunting.

Foliage-applied asulam, a particularly slow-acting herbicide, caused little more than leaf chlorosis in Experiment 2, but had more drastic effects over the longer time-span of Experiment 3. Carbetamide and ethofumesate, also foliage-applied, both caused a reddening of the leaves and death of the developing growing points. However, regrowth could occur in older plants as discussed below in relation to carbetamide.

Initially, in Experiment 3, severe damage was caused by amitrole T, bromofenoxim, carbaryl/propanil, ioxynil, metribuzin and oxadiazon but after 3 months it was considered that good recovery had occurred from ioxynil and metribuzin treatments and was likely with bromofenoxim. On the other hand the slower effect of glyphosate finally proved lethal to the plants concerned. The remaining treatments caused intermediate effects. Diclofop-methyl was almost harmless and plants recovered from damage caused by carbetamide, dalapon and desmedipham/phenmedipham.

As would be expected, some differences in sensitivity to particular herbicides were observed as a result of treating plants of different ages. Experiments 1 and 2 were severe tests of immediate, inherent sensitivity of kiwifruit to particular herbicides. The finding that several foliage-applied herbicides caused a less severe effect in the longer-term Experiment 3 suggests that, in practice, with suitable directed spraying techniques, these herbicides might still be used safely. On the other hand, the increasing severity of slow acting herbicides cannot be determined in short term screening trials like Experiments 1 and 2.

These initial screening trials point to several herbicides which may ultimately be of value in kiwifruit production and they should now be evaluated in the field. In particular, soil treatments of alachlor, chlorthal, dinitramine and pendimethalin are promising. Although few foliage treatments were tolerated by seedling kiwifruit, good recovery occurred from initial damage when several treatments, namely carbetamide, diclofop-methyl, dalapon, desmedipham/phenmedipham, ioxynil and metribuzin were applied to larger plants. These herbicides would be worth testing under field conditions both as overall and directed sprays.

In concurrent work at Pukekohe with older plants, Wilson (1980) has also selected alachlor as a promising herbicide for kiwifruit.

ACKNOWLEDGEMENTS

Thanks are given to Gillian Rains and Robyn Kerr for assistance with this work.

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ERRATA

Due to an error in calculation, rates of herbicides applied to the soil in Experiment 1, Table 1, page 84, were actually ten times greater than those quoted. Relevant statements made in results and discussion sections of the text must be amended accordingly.