NEW DEVELOPMENTS IN CEREAL BROADLEAF WEED CONTROL

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Summary

Four new herbicides, dicamba, picloram, prometryne and ioxynil, have been evaluated for selective broadleaf weed control in cereals in New Zealand. When used alone, none has proved sufficiently active against all common annual and perennial broadleaf weeds when applied at acceptable rates. Their weed control spectrum has in all cases been broadened when applied in mixture with phenoxyacetic compounds. MCPA is the preferred phenoxyacetic component. Dicamba/MCPA appears the most versatile mixture when applied at 1.5 to 2 oz and 8 to 12 oz active ingredient per acre, respectively. Picloram at 0.5 to 1 oz a.i. per acre appears promising but wheat tolerance requires investigation. Prometryne at 4 oz a.i. per acre has shown the greatest activity against spurrey (*Spergula arvensis*) and fumitory (*Fumaria* spp.). Ioxynil appears worthy of further evaluation.

INTRODUCTION

For many years, weedkillers formulated from either MCPA or amine salts of 2,4-D have been employed almost exclusively for selective broadleaf weed control in cereals. Although satisfactory for the control of many weeds, these herbicides have given only marginal and often inadequate control of the *Polygonum* spp., cornbind (*P. convolvulus*), redshank (*P. persicaria*), and wireweed (*P. aviculare*). In addition, such weeds as fumitory (*Fumaria* spp.) and spurrey (*Spergula arvensis*) have not been satisfactorily controlled.

Under present farming systems, cereal cropping has tended to become concentrated in restricted localities on soils of medium to high fertility — soils which favour the growth of crop and weeds alike. The combination of favourable environment and only partly effective herbicides has resulted in a steady increase in phenoxyacetic tolerant weeds in the major cereal-cropping localities. Although the present situation has not yet reached a crisis, there is an obvious need for a more effective herbicide treatment.

Although cereal herbicide usage in New Zealand is not great (probably only some 100,000 acres are treated annually), the weed problem is rather complex and successful herbicides must be quite versatile. In the first place, weed mono-cultures are rare. Almost invariably, mixed populations of annual weeds are present and all too frequently perennial weeds such as Californian thistle (*Cirsium arvense*) and docks (*Rumex* spp.) are also present in considerable numbers. In addition, cereal crops are sown over a wide period from late autumn until late spring. This variable further accentuates the difficulty of timing herbicide applications to coincide with maximum weed susceptibility and adequate crop tolerance.

TABLE 1: WEED SUSCEPTIBILITY AND CROP TOLERANCE TO FOUR NEW SELECTIVE CEREAL HERBICIDES

		Dicamba 4 oz	Picloram 1.5 oz	Prometryne* 4 oz	Ioxynil* 4 oz
Black nightshade (<i>Solanum nigrum</i>)	Sd	S	S	S	S
	Yp	S	S	S	S
Californian thistle (<i>Cirsium arvense</i>)	root regrowths	S	S	R	R
Chickweed (<i>Stellaria media</i>)	Sd	S	MS	S	S
	Yp	MS	MR	MS	MS
Cleavers (<i>Galium aparine</i>)	Sd	MS	S	—	MS
	Yp	MR	S	—	MR
Cornbind (<i>Polygonum convolvulus</i>)	Sd	S	S	MS	S
	Yp	S	S	MR	MS
Docks (<i>Rumex</i> spp.)	seedlings	S	S	MR	MS
	regrowths	MS	MS	R	MR
Fathen (<i>Chenopodium album</i>)	Sd	S	S	S	S
	Yp	S	S	S	MS
Fumitory (<i>Fumaria</i> spp.)	Sd	MR	R	S	R
	Yp	R	R	S	R
Hedge mustard (<i>Sisymbrium officinale</i>)	Sd	MS	R	S	S
	Yp	MR	R	S	MS
Mayweeds (<i>Matricaria</i> spp. and <i>Anthemis cotula</i>)	Sd	MS	MS	MR	S
	Yp	MS	MS	MR	MS

Ideally, a cereal herbicide should be effective against all common annual and perennial weeds, should give control of established as well as recently emerged weeds, and exhibit satisfactory crop tolerance for the maximum period.

EXPERIMENTAL

A number of new selective herbicides have recently become available for evaluation in New Zealand. These include dicamba, picloram, prometryne and ioxynil. Unfortunately, preliminary trials early showed that no herbicide so far evaluated would provide acceptable and economic control of all broadleaf cereal weeds when used alone. Further, inadequate crop tolerance and the possibility of undesirable residues could restrict the commercial usefulness of dicamba and picloram alone at rates required for satisfactory weed control.

Details of probable weed susceptibility and crop tolerance based on both New Zealand and overseas results are shown in Table 1. All rates are in ounces of active ingredient per acre.

Examination of Table 1 will show that both dicamba and picloram are deficient in their control of cruciferous weeds, fumitory and spurrey. Wireweed is doubtfully controlled. Picloram gives marginal control of chickweed. Prometryne and ioxynil are ineffective against Californian thistle and regrowth docks and ioxynil fails to control fumitory. Established wireweed appears tolerant to these contact-type herbicides. Spurrey and fumitory are susceptible only to prometryne.

In an endeavour to overcome the inadequacies of the individual compounds, trials began in 1962 evaluating mixtures. Because of their versatility and relative cheapness, the phenoxyacetic herbicides were an obvious choice as the base for such mixtures to which other compounds could be added to increase the weed control spectrum. Although amine salts of 2,4-D appeared the most logical choice because of their greater herbicidal activity, trial evidence tends to favour MCPA. In admixture with other compounds, evidence of less activity against weeds has not been obvious and improved crop tolerance over 2,4-D, particularly at the 5-leaf stage, has made it the preferred material.

A series of screening trials served to isolate likely candidate mixtures. These were evaluated in the 1964-65 season in fully replicated field trials from which yield data could be obtained. Unfortunately, an unfavourable season in Canterbury so reduced yields that harvesting was not attempted. Yield data were therefore confined to two spring-sown wheat crops in the Wanganui and Marton districts.

RESULTS

Details of the yield trials are shown in Tables 2 and 3.

In both trials, a late attack of stem and leaf rust probably reduced yields. In Trial A, cornbind control was acceptable from all treatments except the prometryne/2,4-D mixture. In Trial B, all treatments except MCPA gave satisfactory control of annual weeds. MCPA failed to control redshank. Californian thistle was not well controlled by any treatment because of the large numbers of shoots which emerged after the treatments were applied. Mixtures containing ioxynil and prometryne gave only marginal control of already emerged Californian thistle.

In the Canterbury trials, dry hardened growth conditions prevailed. Ioxynil and prometryne failed to give acceptable control of cornbind when applied at 4 oz in mixture with either MCPA or

TABLE 2: TRIAL A, WANGANUI

Wheat: Variety — Gamenya. Sown — September 10, 1964.
 Treated — November 5, 1964. Stage of growth — 3–4 tillers.
 Weeds: Mainly cornbind from 4–10 leaf, trace redshank, *Anthemis cotula*.

Treatment (oz)	Yield bu/acre 1st Quality			% Seconds	Cornbind Seed (lb/acre)
Dicamba 1/MCPA 6	54.1	a	A	5.0	5
Dicamba 2/MCPA 12	53.7	a	A	5.0	11
2,4-D (amine) 13	53.1	a	AB	5.0	4
Dicamba 2/2,4-D 12	52.2	a	AB	6.0	5
Dicamba 1/2,4-D 6	52.1	a	AB	6.2	10
Picloram 0.75/MCPA 6	50.8	ab	AB	5.5	4
Ioxynil 4/2,4-D 6	50.7	ab	AB	6.8	10
Ioxynil 4/MCPA 6	50.6	ab	AB	6.3	3
Prometryne 4/2,4-D 6	44.8	bc	BC	5.2	48
Control (untreated)	44.8	bc	BC	6.8	218
C.V.	7.6%				

TABLE 3: TRIAL B, MARTON

Wheat: Variety — Gamenya. Sown — October 4, 1964.
 Treated — November 12, 1964. Stage of growth — Fully tillered.
 Weeds: Wild turnip 3–6 leaf; fathen 4–8 leaf; black nightshade 2–4 leaf;
 redshank 2–4 leaf; Californian thistle 2 to 6 in. high.

Treatment (oz)	Yield bu/acre 1st Quality			% Seconds
Ioxynil 4/2,4-D 6	54.3	a	A	6.9
Ioxynil 4/MCPA 6	53.8	ab	AB	7.9
MCPA 15	50.8	abc	ABC	7.5
Control (untreated)	49.5	bcd	ABC	7.5
2,4-D (amine) 18	48.5	cd	ABC	7.1
Dicamba 2/MCPA 12	48.1	cd	ABC	7.4
Dicamba 1/2,4-D 6	47.6	cd	BC	7.0
Dicamba 2/2,4-D 12	46.2	cd	C	8.1
Picloram 0.75/MCPA 6	45.7	d	C	6.9
Dicamba 1/MCPA 6	45.3	d	C	12.9
Prometryne 4/2,4-D 6	44.6	d	C	10.8
C.V.	6.1%			

2,4-D at 6 to 8 oz. Ioxynil alone at 8 oz also failed to control cornbind. Dicamba at 2 oz and picloram at 0.75 oz gave adequate cornbind control when applied in mixture with phenoxyacetates at 12 oz but dicamba gave marginal control at half this dosage. An amine salt of 2,4-D gave acceptable cornbind control at 16 oz.

Widespread farmer evaluation over the past two seasons of a mixture of 1½ to 2 oz dicamba in mixture with 9 to 12 oz 2,4-D has confirmed experimental findings.

DISCUSSION

Mixtures of dicamba and phenoxyacetic herbicides have given acceptable weed control under a wide range of conditions when

TABLE 4: PROBABLE WEED SUSCEPTIBILITY TO FOUR NEW SELECTIVE CEREAL HERBICIDE MIXTURES

		Dicamba		Picloram		Prometryne		Toxynil	
		2 oz/MCPA 12 oz		0.75 oz/MCPA 12 oz		4 oz/MCPA 12 oz		4 oz/MCPA 12 oz	
Black nightshade (<i>Solanum nigrum</i>)	Sd	S		S		S		S	
Californian thistle (<i>Cirsium arvense</i>)	Yp	S		S		S		S	
Chickweed (<i>Stellaria media</i>)	root regrowths	S		S		S		S	
Cleavers (<i>Galium aparine</i>)	Sd	MS		MS		MS		MS	
Cornbind (<i>Polygonum convolvulus</i>)	Yp	MS		MS		MS		MS	
Docks (<i>Rumex</i> spp.)	Yp	—		—		—		—	
Fathen (<i>Chenopodium album</i>)	Sd	S		S		S		S	
Fumitory (<i>Fumaria</i> spp.)	root regrowths	MS		MS		MS		MS	
Hedge mustard (<i>Sisymbrium officinale</i>)	Sd	S		S		S		S	
Mayweeds (<i>Matricaria</i> spp. and <i>Anthemis cotula</i>)	Yp	MS		MS		MS		MS	
Redroot (<i>Amaranthus</i> spp.)	Sd	MR		MR		MR		MR	
Redshank (<i>Polygonum persicaria</i>)	Yp	S		S		S		S	
Shepherd's purse (<i>Capsella bursa-pastoris</i>)	Sd	MS		MS		MS		MS	
Spurrey (<i>Spergula arvensis</i>)	Yp	S		S		S		S	
Annual and biennial thistles	Sd	MS		MS		MS		MS	
Wild turnip (<i>Brassica campestris</i>)	Yp	—		—		—		—	
Wireweed (<i>Polygonum aviculare</i>)	Sd	S		S		S		S	
	Yp	MS		MS		MS		MS	
		MR		MR		MR		MR	

applied at a rate of 1½ to 2 oz dicamba and 9 to 12 oz phenoxyacetic acid. There has been no evidence of crop yield suppression. Fumitory and wireweed are not well controlled by this mixture.

Picloram at 0.75 oz in mixture with MCPA at 6 oz has proved slightly more active than dicamba/MCPA at 2 oz and 12 oz, respectively, but fumitory, wireweed and chickweed have not been adequately controlled. Crop tolerance has yet to be fully established.

Prometryne at 4 oz in mixture with phenoxyacetic herbicides at 6 to 8 oz has unexpectedly proved phytotoxic to wheat as evidenced by marked tip-burn. This may be simply a formulation problem. Marginal weed control of many weed species has been obtained. Prometryne has shown outstanding activity against spurrey and fumitory.

Ioxynil at 4 oz in mixture with phenoxyacetics has given acceptable weed control only under succulent growth conditions. Resprout perennial weeds (*e.g.*, Californian thistle) have been controlled only by the phenoxyacetic component. Fumitory and wireweed are not adequately controlled by ioxynil mixtures and spurrey control is marginal. No evidence of crop yield suppression has been obtained.

From data obtained both here and overseas, probable weed susceptibilities to various mixtures have been calculated. These are shown in Table 4. The mixtures selected are estimated to be the most acceptable on cost-efficiency for New Zealand conditions.

CONCLUSIONS

No simple mixture of two herbicides adequately controls all problem broadleaf weeds common to New Zealand cereal crops. Cost precludes the use of more sophisticated formulations for general use.

A mixture which applies 1½ to 2 oz dicamba and 9 to 12 oz MCPA appears to be the most versatile for local conditions. Of the significant weeds, only fumitory and wireweed appear insufficiently controlled.

Picloram is worthy of further evaluation at rates between 0.5 and 0.75 oz in mixture with MCPA at 6 to 10 oz. In particular, cereal tolerance requires further investigation.

Despite evidence of phytotoxicity, prometryne should be further evaluated for spurrey and fumitory control. The addition of MCPA will be necessary in many instances for broad-spectrum weed control.

A clear place has not yet been established for ioxynil on present results. Lack of general activity under dry conditions and against certain common weeds precludes its acceptance as a complete cereal herbicide. In mixture with phenoxyacetics, ioxynil and its analogue bromoxynil are worthy of further evaluation.

The ideal cereal herbicide has yet to be developed. Dicamba in combination with MCPA offers significant improvements over presently used phenoxyacetic compounds but does not fulfil all the requirements of a truly universal herbicide.

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