THE TOLERANCE OF NEW ZEALAND CROPPING WEEDS TO HERBICIDES

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Summary

The paper deals with the tolerance of weeds that are associated with cropping in New Zealand, to herbicides usually applied to obtain weed control. The results are mainly of the major weeds *Amaranthus hybridus, Chenopodium album, C. pumilio, Coronopus didymus, Polygonum aviculare, P. persicaria, Solanum nigrum, Spergula arvensis* and *Poa annua*. Other less frequent weeds are included where information was available. The herbicides include those of the carbamate, triazine and urea groups as well as derivatives of acetic, butyric, benzoic, and picolinic acids. The data are of the control of weeds by an optimum rate of application of pre- and post-emergent chemical treatments.

INTRODUCTION

DURING the past six years the N.Z. Department of Agriculture has conducted about 400 replicated trials in which chemicals have been used to reduce or eliminate the effect of weed competition among fodder, vegetable and cereal crops. During this period, there have been many papers presented at this conference that have dealt with the use of herbicides for weed control. In some of these papers valuable weed tolerance data have been given, but these refer to specific aspects. Allen (1964) indicates the tolerance of weeds to post-emergent chemicals employed in pea crops while Ward (1963, 1964) deals with weeds found in waste areas where applications of soil sterilants are made. Taylor (1960) in a useful paper, deals specifically with the control of spurrey (*Spergula arvensis*). In this paper an attempt is made to summarize, from all departmental trials, the specific aspect of weed tolerance in general terms, without reference to crop tolerance. A number of chemicals that are not now being used are not included. All rates of materials are expressed in terms of active ingredient per acre.

TOLERANCE TO SOIL-APPLIED HERBICIDES

The control of weeds is dependent upon many factors, and consequently poor weed control may be attributed to weed resistance rather than another factor. Usually with soil-applied chemicals, factors which reduce weed control are low soil moisture with dry weather, excess rainfall causing leaching, poor soil tilth in the seedbed, strong winds that remove sprayed soil particles, poor spray application and breakdown or loss of chemicals through the action of ultra-violet light or temperature. Quick growth of crops to prevent subsequent weed germination, or to provide growth competition, is essential.

Table 1 shows the degree of control usually obtained when applied under conditions of adequate soil moisture. Under dry conditions the control was very much poorer. An increase in rates usually increased control, except with certain resistant weed species. The lettering is according to the following tabulation:

Ex	—	Excellent
VG	—	Very good
G	—	Good
FG	—	Fairly good
F	—	Fair (but unsatisfactory)
S	—	Some
P	—	Poor
Var	—	Variable (Poor-Excellent, under similar conditions)
—	—	No reliable information available
( )	—	Tentative (Insufficient information)

The results of some of the chemicals are only tentative, and confirmation is required from further experiments. For the sake of space, the weed species have been designated by an abbreviation of their botanical name, as follows:

Abbreviation	*Botanical Name*	*Common Name*
AMhy	*Amaranthus hybridus*	redroot
CHal	*Chenopodium album*	fathen
CHpu	*Chenopodium pumilio*	—
COdi	*Coronopus didymus*	twin cress
CRcp	*Crepis capillaris*	hawksbeard
FUmu	*Fumaria muralis*	fumitory
Pan	*Poa annua*	annual poa grass
PLla	*Plantago* spp.	plantains
POol	*Portulaca oleracea*	purslane
POpr	*Polygonum persicaria*	redshank
SEvu	*Senecio vulgaris*	groundsel
SIof	*Sisymbrium officinale*	hedge mustard
SOni	*Solanum nigrum*	nightshade
SPar	*Spergula arvensis*	spurrey, yarr.
STme	*Stellaria media*	chickweed
VEar	*Veronica* spp.	speedwell

In Table 1, the stated control for each of the less common weeds is not as positive as for the common ones, because there were few reports of their presence or absence in trial areas. This table does not indicate differences obtained under dry conditions, such as chloramben controlled redroot better than redshank or spurrey.

Other Species

Bidens pilosus (beggar's ticks): Very good control by ureas and methylmercapto triazines at 1 lb, but not with chlorpropham.

Matricaria chamomilla (chamomile): Possibly resistant to prometryne and linuron.

Sonchus oleraceus (sow thistle): Similar to other members of the Compositae family, which are usually tolerant to carbamates.

Capsella bursa-pastoris (shepherd's purse): Similar to hedge mustard of the same family (Cruciferae), except that chlorpropham has given poor control.

Datura stramonium (thorn apple) and *Nicandra physaloides* (apple of Peru) show a similar tolerance to chloramben, triazines and ureas as nightshade, which is of the same family, Solanaceae.

Erodium cicutarium (storksbill): Dinoseb excellent, diphenamid very good, prometryne good control, but possibly tolerant to the ureas.

Polygonum aviculare (wireweed) and *P. convolvulus* (cornbind) appear more tolerant than redshank, especially with chloramben and the triazines. The Polygonaceae are somewhat tolerant to the ureas.

Panicum capillare (witchgrass), an annual summer grass, is just as susceptible as the annual winter grass *Poa annua.*

TOLERANCE TO FOLIAGE-APPLIED HERBICIDES

As with pre-emergent chemicals, certain factors hinder satisfactory weed control being obtained. Hot dry weather for some time prior to spraying toughens the leaf surface and makes it more difficult for penetration to take place. Rainfall soon after spraying can remove spray particles. Control is assisted if the crop makes quick growth to overtop any weeds that remain either stunted or unchecked.

Chemicals Used in Brassicas

Table 2 shows the measure of control from 3 herbicides used mainly for weed control in brassica crops. The stage of growth of the weeds refers to the size up to which the stated control was obtained. For convenience in the table, SMCA is an abbreviation for the sodium salt of chloroacetic acid.

TABLE 2: DEGREE OF POST-EMERGENT WEED CONTROL IN BRASSICAS

Weeds	*Size (in.)*	*Leaves*	*Control SMCA 10.2 lb*	*Control Nitrofen 2 lb*	*Desmetryne 4 oz Ht. (in.)*	*Desmetryne 4 oz Control*
C. pumilio	½–2	—	FG	VG	—	—
Fathen	½–2	2–6	VP	G+	1–10	VG
Fumitory	—	1–2	P	Ex	1–10	Ex
Nightshade	1–4	2–8	FG	VG	1–6	Var
Redroot	1–4	2–6	VG	G	1–10	P
Redshank	1–5	2–6	VG	G	1–10	F
Shepherd's purse	1–2	2–4	S	S	1–4	P
Spurrey	½–2	2–4	Var	FG+	1–10	VG+
Twin cress	½–3 diam.		F	P	2–4	P
Wireweed	1–4	3–5	VP	G+	3	S

Nitrofen: The 2 lb rate gave excellent control of speedwell, annual nettle (*Urtica urens*) and cornbind in the 2- to 4-leaf stage, but chickweed, catchfly (*Silene gallica*) and penny cress (*Thlaspi arvensis*) were resistant. For the first 6 weeds listed in Table 2, the maximum height at which very good control was obtained was 2 in. Spurrey was more tolerant and, to obtain equivalent control, needed to be no larger than 1 in. at the 2- to 3-leaf stage. Wireweed should be less than the 2- to 3-leaf stage.

Sodium chloroacetate (*SMCA*): Although it has largely been replaced by nitrofen which has a greater weed control spectrum,

TABLE 1: WEED CONTROL BY PRE-EMERGENT CHEMICALS

Chemical	(*lb a.i.*)	Common Weeds							
		AMhy	*CHal*	*CHpu*	*COdi*	*POpr*	*SOni*	*SPar*	*Pan*
Chloramben	4	Ex	VG	Ex	VG	G	F	VG	VG
*CDAA-T	8	Ex	VG	(Ex)	(G)	VG	(P)	G	Ex
Chlorpropham	4	F	G	(P)	P	VG	VG	VG+	VG
*CDEC	8	VG	P	VG	P	FG	VG	FG	VG
*EPTC	8	Ex	Ex	P	—	Ex	Ex	P	Ex
*PEBC	8	Ex	S	S	—	G	P	G	Ex
*Propham/endothal	8	F	F	—	—	Ex	F	G	F
Omu/BiPC	2	G	VG	(F)	(G)	VG	VG+	VG	P
Linuron	1	G	VG	(VG)	G	Var	G	G	G
*Monolinuron	1	—	Ex	—	(Ex)	G	F	G	—
*Chloroxuron	2	F	G	P	G	P	F	F	F
Ametryne	1	FG	FG	Ex	—	Var	F	VG	G
Prometryne	1	G	F	Ex	VG	G	G	VG	VG
Propazine	2	VG	FG	—	VG	Ex	Ex	Ex	P
*Atrazine	2	P	Ex	Ex	Ex	Ex	Var	Ex	Ex
Simazine	2	Ex	Ex	Ex	Ex	VG	Ex	Ex	Ex
*DCPA	8	P	G	—	P	P	FG	VG	VG
*Dichlobenil	2	F	—	F	VG	F	Ex	FG	G
*Dinoseb	6	F	Ex	VG	—	Var	Ex	VG	—
*Diphenamid	8	S	VG	—	—	P	P	G	Ex
*PCA	6	FG	VG	—	Ex	VG	Ex	VG	P
TCA	18	G+	G	—	S	VG	(P)	S	Ex
Trifluralin	8	G	VG	(G)	P	G	P	VG	VG

LESS COMMON WEEDS

Chemical	*(lb a.i.)*	*CRcp*	*FUmu*	*PLla*	*POol*	*SEvu*	*SIof*	*STme*	*VEar*
Chloramben	4	VG	(P)	P	(VG)	(G)	VG	(S)	(G)
*CDAA-T	8	(F)	—	(P)	P	—	P	—	Ex
Chlorpropham	4	P	(G)	(G)	G	(P)	(Ex)	VG	(G)
*CDEC	8	P	—	—	(P)	—	P	—	—
*EPTC	8	(P)	Ex	—	—	—	—	VG	VG
*PEBC	8	G	—	—	(P)	—	—	—	—
*Propham/endothal	8	(FG)	—	—	—	—	—	—	—
Omu/BiPC	2	Ex	—	—	—	—	—	Var	Var
Linuron	1	(F)	P	P	—	P	—	—	P
*Monolinuron	1	—	—	—	—	—	—	—	Ex
*Chloroxuron	2	P	—	P	P	—	—	—	—
Ametryne	1	—	F	—	FG	VG	S	(P)	(P)
Prometryne	1	—	(P)	Var	(FG)	(F)	Ex	(S)	P
Propazine	2	Ex	Ex	Ex	Ex	FG	—	(Ex)	Ex
*Atrazine	2	—	Ex	—	VG	Ex	Ex	Ex	Ex
Simazine	2	Ex	F	—	(G)	Ex	Ex	Ex	VG
*DCPA	8	S	—	G	(VG)	(P)	P	Ex	—
*Dichlobenil	2	—	—	—	(FG)	—	G	—	—
*Dinoseb	6	—	—	—	—	—	—	—	—
*Diphenamid	8	P	—	F	(VG)	—	Ex	—	(Ex)
*PCA	6	—	—	—	—	—	—	—	—
TCA	18	—	—	—	—	VG	—	—	P
Trifluralin	8	F	—	G	(VG)	G	(FG)	(Ex)	—

* The results from these chemicals are mostly tentative.

sodium chloroacetate can be used effectively on the major weeds up to 10 or 12 in. high. Fathen is resistant even at high rates. High temperatures appear necessary for adequate control of spurrey.

Chemicals in Other Crops

Table 3 includes 4 chemicals normally employed in vegetable and fodder crops. The results for monolinuron are only tentative and need confirmation from further trials.

TABLE 3: DEGREE OF POST-EMERGENT WEED CONTROL IN VEGETABLE CROPS

Weeds	*Prometryne 1 lb*	*Linuron 1 lb*	*Mono-linuron 1.5 lb*	*PCA 6 lb*
Cornbind	VG	—	—	G
Fathen	VG+	VG+	(Ex)	VG
Fumitory	Ex	P	—	—
Nightshade	—	VG+	(S)	Ex
Redroot	VG+	VG+	(VG)	G
Redshank	VG+	G+	(Ex)	Ex
Shepherd's purse	P	Ex	—	—
Speedwell	Ex	Ex	(Ex)	—
Spurrey	VG+	Ex	—	G
Twin cress	Ex	Ex	(Ex)	VG
Wireweed	F	P	—	P
Max. size for VG control:	2–3 in. 4–6 leaf	4–6 in.	—	2 in. 2–4 leaf

Prometryne: Very good on fathen with 6 to 8 leaves up to 4 in. high. Spurrey was not as susceptible over 2 in.

Linuron: Only fair on redshank larger than 2 in. high. Good control of barnyard grass (*Echinochloa crusgalli*) when up to 12 in. high, but atrazine at 3 lb was excellent.

Some "Hormone-type" Chemicals

These are mainly used in cereals, though the potassium salt of picloram has been used in combination with nitrofen in brassicas. Table 4 shows the weed control obtained from some of these chemicals. The potassium salt of MCPA, sodium salt of MCPB and the amine salt of dicamba are included with picloram.

The size of the weeds refers only to picloram and dicamba. The size of weeds normally treated with MCPA and MCPB was generally 1 to 4 leaf, 1 to 4 in. high.

There have been insufficient detailed results to determine accurately the susceptibility of weed species to dichlorprop, mecoprop, bromoxynil, and ioxynil.

DISCUSSION

This paper has attempted to show, where information was available, what weed control is likely to be obtained from the use of any one chemical at some particular stage of weed growth, without giving the results as percentage control. This may have caused emphasis to be placed on slight differences which were in fact not significant. In a number of trials it was observed that

TABLE 4: DEGREE OF POST-EMERGENT WEED CONTROL BY HORMONES

Weeds	*MCPA 1 lb*	*MCPB 1 lb*	*Size (in.)*	*Picloram 2 oz*	*Dicamba 4 oz*
Cornbind	FG	P	6	G	Ex
Fathen	VG	Ex	1–10	Ex	FG
Nightshade	VG	VG	4–6	Ex	F
Redroot	VG	VG	1–10	Ex	FG
Redshank	S	P	1–10	VG	G
Shepherd's purse	FG	FG	1–2	VG	—
Sow thistle	G	G	1–2	FG	P
Spurrey	P	P	1–2	G	FG
Tares (*Vicia* spp.)	VG	S	1–2	VG+	Ex
Wireweed	FG	G	1–2	VG	F

an early application of a herbicide to weeds in the cotyledon stage gave an excellent kill. In some trials this early kill was not recorded, and, followed by a re-germiantion of the dominant weed, the control was given later as poor. Sometimes the fact that smaller weeds were smothered or sheltered by larger weeds at the time of application could have resulted in a record of poor control, whereas in fact the sprayed material did not reach them.

The recent work of Roberts (1965) on the tolerance of germinating dicotyledons to various concentrations of chlorpropham, confirms the field observations presented in this paper. The weed species that required 0.02 to 0.08 ppm of chlorpropham to cause a 50% inhibition of root elongation are classed in this paper as those with which 4 lb gives very good control. Concentrations from 0.2 to 0.9 ppm equal the species with which good control is obtained (except nightshade which is very good), and 1 to 10 ppm refer to poorly controlled species (except hedge mustard which is tentatively excellent).

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REFERENCES

Allen, F. C., 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*: 200–8.
Roberts, H. A., 1965: *Weed Res.*, 5 (1): 61–7.
Taylor, R. L., 1960: *Proc. 13th N.Z. Weed Control Conf.*: 39–46.
Ward, R. K., 1963: *Proc. 16th N.Z. Weed Control Conf.*: 137–8.
———— 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*: 215–21.