PRE- AND EARLY POST-EMERGENCE WEED CONTROL IN ONIONS

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Summary. Six residual herbicides and programmes involving mixtures were evaluated for early season weed control and onion crop tolerance on a brown granular clay loam soil at Pukekohe.

The most promising weed control coupled with adequate crop safety was obtained with chlorthal-dimethyl pre-emergence followed by propachlor at the crop loop stage. Chlorthal-dimethyl at normal and twice normal rates showed excellent crop safety but failed to give adequate control of some problem weeds. Chlorpropham as an early post-emergence spray (onion loop stage) improved the overall weed control following pre-emergence chlorthal-dimethyl but crop damage can occur when heavy rain follows chlorpropham application.

The weed control spectrum with pre-emergence propachlor was limited and it also caused crop thinning at twice normal rates. Chloridazon/chlorbufam applied at the onion flag stage provided excellent weed control but caused crop thinning in lighter patches of soil.

INTRODUCTION

Onion production has more than doubled in the Pukekohe region of New Zealand over the last 5 years to an estimated 1600 ha in 1980. This represents over 70 percent of the national area and all of the recent increase has been for export (Wood 1980).

The early weed control period from crop emergence to the onion two true leaf stage is difficult because of limited crop tolerance to existing herbicides. Throughout New Zealand the use of a diquat/paraquat mixture 7 to 18 days after drilling and a few days before the onions emerge, is the first essential step for effective weed control. The most common early season residual treatment in Pukekohe has been the use of a chloridazon/chlorbufam mixture plus a non-ionic wetting agent applied at the onion flag stage, but there is a risk of crop thinning and yield reduction especially on lighter soils. Other residual herbicides which have been effective include chlorthal-dimethyl, propachlor, chlorpropham and mixtures of these (Cox 1968; Wilson 1971). Toth *et al.* (1973) and Roberts *et al.* (1976) reported favourably on pre-emergence mixtures of chlorthal-dimethyl plus propachlor, while McLean (1977) rated ethofumesate as worthy of consideration.

The research reported here was to evaluate alternatives aimed at improving crop safety without sacrificing weed control efficiency.

MATERIALS AND METHODS

Trials 1 to 4 were sown in 1977 and 1978 and involved herbicide applications up to the crop flag stage (onion hook). Herbicide combinations

aimed at improving the weed control spectrum were studied in Trial 5 (1979).

All trials were sown in the period early July to early September (Table 1). In Trials 1 to 4 the herbicides were applied at normal recommended rates and at twice normal rates to check crop tolerance (Tables 2 and 4). In Trial 5 supplementary irrigation was also included to simulate a heavy leaching rainfall after chlorpropham was applied post-emergence at two rates and at two growth stages (Table 4).

The soil type was Patumahoe clay loam (66% clay, 27% silt, 7% sand) with a trial site mean pH 6.6 and organic carbon levels between 2.5 and 3.1%. The cultivar Pukekohe Longkeeper was sown with Stanhay precision seeder at a rate of 3.3 kg ha^{-1} and at a depth of 15 mm. Trials had four or six replicates using plots of 5 by 1.5 m, each containing five rows spaced 25 cm apart.

The pre-crop emergence treatments were applied between 6 and 13 days after drilling, followed by a diquat/paraquat mixture 0.5 kg ha^{-1} applied overall a few days before onion emergence (10 to 15 days after drilling). Post-emergence onion loop stage treatments were applied approximately 4 weeks after sowing, while the flag stage applications were between 5 and 7 weeks after sowing. Treatments were applied in 400 L ha^{-1} water at 200 kPa pressure using a modified Oxford precision sprayer.

Weed population counts in the unsprayed control plots 8 to 10 weeks after drilling were made to determine species present in the trial sites. Weed cover ratings expressed as a percentage of the unsprayed controls were recorded after the counts and just prior to overall handweeding. Treatment effects on the onion plant stand were recorded 3 months after sowing from plant counts in the three central rows by 4.4 m in each plot. A crop vigour rating was also recorded at 3 months in Trial 5. The onions matured approximately 6 months

Table 1. Weed species and their densities on untreated plots of each trial.

	Weed density (no. m^{-2})				
	Trial and Sowing Date				
	1 Aug 12 1977	2 Sept 9 1977	3 July 4 1978	4 Aug 1 1978	5 Aug 29 1978
Lesser swinecress (*Coronopus didymus*)	97	809	226	22	3
Black berry nightshade (*Solanum nigrum*)	19	36	12	241	56
Creeping speedwell (*Veronica persica*)	39	65	24	62	5
Wireweed (*Polygonum aviculare*)	10	110	33	53	1
White clover (*Trifolium repens*)	27	17	67	1	
Fumitory (*Fumaria* spp.)	17	76	3	1	
Fat hen (*Chenopodium album* agg)	3	27	2	21	1
Scarlet pimpernel (*Anagallis arvensis*)	31	3	239		
Smooth hawksbeard (*Crepis capillaris*)	8	19	7		
Powell's amaranth (*Amaranthus powelli*)		1		23	16
Broadleaf dock (*Rumex obtusifolius*)	3	40	1		1
Redshank (*Polygonum persicaria*)	8	7	1	10	1
Annual poa (*Poa annua*)	1	11		1	1
Shepherd's purse (*Capsella bursa-pastoris*)	2			11	2
Barnyard grass (*Echinochloa crus-galli*)		29		5	1

after sowing and the trials were harvested in March after field curing. Total bulb yield was recorded from a 4 m^2 plot area.

RESULTS

Weed control. The spectrum of weeds in the unsprayed treatments of each trial is shown in Table 1. Lesser swinecress was the most common species followed by black berry nightshade, creeping speedwell and wireweed.

At normal application rates in Trials 1 to 4 chloridazon/chlorbufam applied at the onion flag stage was the most effective treatment (Table 2). The next most effective treatment was chlorthal-dimethyl applied pre-emergence plus chlorpropham applied post-emergence at the loop stage. Only marginally less effective was propachlor applied pre-emergence followed by chlorpropham applied at the loop stage.

Table 2. Onion plants density three months after sowing and weed cover rating as a percentage of the unsprayed control 8 to 10 weeks after drilling.

Treatment	Rate (kg ha^{-1}) pre-	post-	Onion plants (no. m^{-2}) Trials 1	2	3	4	Weed cover rating (%) [2] Trials 2	3	4
chloridazon/chlorbufam	1.5		48	31	46	52	28	24	12
	3		38	16	31	49	2	10	9
	1.5	2[1]	49	32	41	51	2	4	1
		3[1]	45	38	57	48	32	7	1
chlormethazole	1		46	23	49	42	30	11	15
	2		28	9	31	17	12	3	4
chlorthal-dimethyl	8		47	35	56	54	75	37	8
	16		46	27	55	56	63	36	6
chlorthal-dimethyl + chlorpropham	8	0.8			51	56		14	1
ethofumesate	1.5		42	29			15		
	3		30	9			1		
propachlor	5		46	31	46	55	41	39	38
	10		42	20	49	54	11	26	36
propachlor + chlorpropham	5+0.8		36	22	30	53	21	16	21
	5	0.8			46	53		13	14
	5	1.6			49	53		5	3
unsprayed control			57	32	55	53	100	100	100
	CV%		31.3	34.2	14.0	8.3	Results not analysed. No recording for Trial 1.		
	LSD 5%		12.4	8.5	6.4	4.1			

[1] Treatments applied at the onion flag stage together with a non-ionic wetting agent at 1.4 L ha^{-1}. Other post-emergence treatments applied at the onion loop stage.

[2] Expressed as a percentage of the unsprayed control.

Propachlor alone gave inadequate weed control in all four trials especially of black berry nightshade and wireweed. Only partial control of lesser swinecress, Powell's amaranth, fat hen and shepherd's purse was obtained. Chlorthal-dimethyl gave poor control in two trials primarily due to ineffective control of lesser swinecress (Table 2).

In Trial 5, excellent weed control was obtained when chlorthal-dimethyl applied pre-emergence was supplemented with propachlor applied at the onion loop stage (Table 4). A similar level of weed control was achieved with chlorthal-dimethyl applied pre-emergence followed by chlorpropham applied at the loop stage. Good weed control was also achieved with chlorthal-dimethyl applied pre-emergence followed by chloridazon/chlorbufam applied at the flag stage (Table 4).

Crop tolerance. Depression in the onion plant stand (Table 2) was in most cases followed by a yield depression (Table 3). In Trial 2 poor plant establishment and final yields (Tables 2 and 3) resulted from late sowing September 9.

Table 3. Effect of herbicide treatments on onion bulb yields in Trials 1 to 4.

Treatment	Rate (kg ha^{-1})		Bulb yield (t ha^{-1})			
	pre-emergence	post-emergence	Trial 1	2	3	4
chloridazon/chlorbufam	1.5		52.2	30.3	68.8	83.6
	3		44.7	16.2	54.1	80.3
	1.5	2[1]	41.4	31.1	63.2	80.0
		3[1]	42.0	27.5	73.7	69.9
chlormethazole	1		42.5	26.7	70.6	78.9
	2		31.1	12.6	50.8	48.1
chlorthal-dimethyl	8		50.3	30.5	71.8	84.4
	16		43.5	27.7	77.0	88.1
chlorthal-dimethyl + chlorpropham	8	0.8			69.5	87.3
ethofumesate	1.5		40.0	24.6	discontinued	
	3		17.8	4.9	due to damage	
propachlor	5		45.5	32.8	72.9	78.6
	10		40.9	15.8	71.0	77.7
propachlor + chlorpropham	5+0.8		34.5	22.3	47.2	81.3
	5	0.8			68.1	86.6
	5	2.6			70.3	82.1
unsprayed control			53.7	32.5	76.7	85.2
	CV%		27.9	35.2	12.7	7.4
	LSD 5%		10.6	8.5	9.2	5.7

[1] Treatments applied at the onion flag stage together with a non-ionic wetting agent at 1.4 L ha^{-1}. Other post-emergence treatments applied at the onion loop stage.

Chlorthal-dimethyl was the safest herbicide and at twice the normal rate no crop establishment or yield reductions were recorded (Tables 2 and 3). Both ethofumesate and chlormethazole caused major yield reductions at twice

normal rates while propachlor and chloridazon/chlorbufam applied pre-emergence also resulted in some yield reductions at high application rates. Chlorpropham applied post-emergence in Trial 5 caused significant suppression of onion vigour in most treatments (Table 4) especially when twice the normal rate was followed by supplementary irrigation. However, final bulb yields were not significantly reduced.

Table 4. Effect of herbicide treatments in Trial 5.

Treatment and rate (kg ha^{-1})				Weed rating (%)	Onion plants (no. m^{-2})	Crop vigour (%)	Bulb yield (t ha^{-1})
pre-emergence		post-emergence					
chlorthal-dimethyl	8		0.8 (lp)	20	64	73	56.4
	8		1.6 (lp)	15	62	80	58.2
	8	chlorpropham	1.6 (lp)[2]	25	53	55	52.2
	8		1.6 (fg)[2]	15	63	78	63.7
	8		(fg)[2]	53	63	98	60.8
-		chlorpropham	1.6 (lp)[2]	43	61	70	60.8
-			1.6 (fg)[2]	35	64	85	59.4
propachlor	5	chlorpropham	0.8 (lp)	48	64	73	56.4
	5		1.6 (lp)[2]	45	58	60	53.9
chlorthal-dimethyl	8	propachlor	5 (lp)	18	64	65	57.2
chlorthal-dimethyl +propachlor	8			25	61	68	59.5
	5						
chlorthal-dimethyl	8	chloridazon/ chlorbufam[3]	1.5 (fg)	18	64	88	59.5
unsprayed control				100	64	100	57.6
CV%				29.8	4.3	13.1	7.5
LSD 5%				14.5	3.7	11.1	5.3

[1] (lp) = Loop stage and (fg) = flag stage post-emergence applications.

[2] 28 mm of extra water applied by hand to simulate heavy leaching rain soon after application.

[3] A non-ionic wetting agent was added at 1.4 L ha^{-1} to chloridazon/chlorbufam.

DISCUSSION

While chlorthal-dimethyl was the safest treatment, control of weeds was limited especially of lesser swinecress, shepherd's purse and fumitory.

Weed control was greatly improved when chlorthal-dimethyl applied pre-emergence was supplemented by either propachlor or chlorpropham applied at the loop stage to emerging weeds. Both post-emergence herbicides markedly suppressed subsequent weed growth development, particularly of lesser swinecress and fumitory. In later trial work propachlor applied post-emergence had been rated higher for weed control than chlorpropham applied post-emergence.

Although not obvious from the trial results, district experience with chloridazon/chlorbufam has shown that application at the flag stage is safer than pre-emergence application, but the risk of thinning and yield reduction still exists especially on light soils. In the one site with low soil organic carbon levels of 2.6% (Trial 4, Table 2) significant crop thinning and yield reduction was noted.

In Trial 5 (Table 4) promising weed control was also achieved with the programme of chlorthal-dimethyl followed by chloridazon/chlorbufam applied at the flag stage at a low rate (1.5 kg ha^{-1}). Although only recorded in one trial this programme warrants further study, and it would also be desirable to have the better treatments included in evaluations over a wider range of soil types.

Results of this trial work demonstrated the need for a programme of two early season residual herbicide applications. The best combination was chlorthal-dimethyl applied pre-emergence and chosen for crop safety followed by propachlor at an early post-emergence stage to kill those weeds not controlled by chlorthal-dimethyl.

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