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EVALUATION OF HERBICIDES FOR POTATOES IN SOUTHERN QUEENSLAND

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SUMMARY

Herbicides to supplement inter-row cultivation of potatoes were evaluated in the Lockyer Valley, southern Queensland, during 1977.

Metribuzin gave full season control of weeds which escaped cultivation. However, neither this herbicide nor any other treatment, including hand weeding, increased yield over cultivation.

The potato crop was not adversely affected by pre-emergence application of trifluralin, chlorthal-dimethyl, alachlor, linuron, prometryn and dinoseb and early post-emergence application of paraquat, bentazone and metribuzin.

I. INTRODUCTION

The potato industry in southern Queensland produces about 130 000 t annually from 6 500 ha of crop, mainly grown in the Lockyer Valley, a fertile flood plain. There are two crops a year, a spring crop planted between June and August and an autumn crop planted about February. The growing season is approximately four months and irrigation using a variety of sprinkler systems is almost universal.

About 70% of the annual rainfall of 777 mm is received in the period October to March. Spring crops are generally grown early enough to be harvested before the wet season and planting of autumn crops may be deferred if rainfall is excessive. The avoidance of very wet growing conditions results in relatively low weed population density and inter-row cultivation once or twice normally provides acceptable weed control. Growers are not concerned if crops become overgrown with weeds late in the season since this helps to remove excess moisture from the heavy-textured soil. Slashers are used to chop up weed growth immediately before harvest.

Until about 1975 herbicides were rarely used apart from occasional treatment of recently emerged crops with paraquat to control seedling weeds. After 1975 growers began using residual herbicides, initially linuron and more recently metribuzin, with reduced dependence on cultivation. The main reason for this trend was the increasing use of fixed irrigation systems in early-planted spring crops to mitigate frost damage. The irrigation pipes are assembled after an early cultivation and then left undisturbed for the remainder of the season. Recognition that cultivation under unfavourable conditions may encourage the development of clods which reduce the efficiency of mechanical harvesters may have contributed to this trend.

Anticipating further increased use of herbicides in potatoes, we decided to evaluate a range of potential treatments under local conditions. The treatments were to be supplementary to cultivation carried out within 3 weeks of crop emergence. The herbicides selected for evaluation are either registered for weed control in potatoes in Queensland or have some potential for this purpose.

II. METHODS

General

Two experiments were conducted, one in autumn and one in spring 1977 at Gatton Research Station (latitude 27°33′S, longitude 152°20′E) on a representative Lockyer Valley alluvial clay loam soil. Sebago, the cultivar most commonly grown in southern Queensland, was planted in these experiments. Crop culture including planting method, fertilizers, irrigation, inter-row cultivation and crop protection followed recommended local practice. The implement used for inter-row cultivation was a 'Lilliston' rolling cultivator adjusted to form a hill over the crop rows. Plots were four rows 86 cm apart and 9 m long, the middle two rows being harvested for yield determination and the experimental designs were randomized blocks with three replicates.

Table 1 lists the herbicides evaluated, experiment management data are summerized in table 2, and the rates (as active ingredients) appear with the results in tables 3 and 5. The herbicide treatments were applied by means of an 'Oxford Precision Sprayer' operated by compressed air and delivering a liquid volume of 440 l ha^{-1} at a pressure of 206 kPa. Herbicide rates and timing of application in relation to crop development and management were based on recommended practice.

Weed growth was rated visually at crop maturity on a linear scale of 1 to 10, with 1 representing negligible weed development and 10 representing 100% ground cover. At harvest the crop was dug mechanically and the tubers collected by hand. The tubers were then sorted into standard commercial grades, total weight and number of tubers for each grade being recorded.

Experiment 1 (autumn)

Cultivation was carried out a few days before crop emergence to control weed growth which followed rain shortly after planting. Cultivation of the growing crop was delayed by further rains so that the metribuzin treatments (stage 5) which should have followed cultivation were applied before this operation.

Towards the end of the season some of the potato plants were visibly affected by potato leaf roll virus which may have contributed to the variable yields which were recorded.

The weed population remaining at crop maturity consisted mainly of bell-vine (*Ipomoea plebeia*) and sowthistle (*Sonchus oleraceus*). There were few grass weeds.

Shortly after harvest the area was sown with a cover crop of oats and lucerne. Plot boundaries were marked to enable any residual herbicide activity to be recorded.

TABLE 1

HERBICIDES USED IN THE EXPERIMENTS

Common Name	Chemical Name	Trade Name
alachlor	2–chloro-2',6'-diethyl-N-(methoxymethyl)-acetanilide	Lasso
bentazone	3–isopropyl-1H-2,1,3-benzothiadiazin-4-one-2,2-dioxide	Basagran
chlorthal-dimethyl	dimethyl 2,3,5,6-tetra-chloroterephthalate	Dacthal W75
dinoseb	2–(1-methylpropyl)-4,6-dinitrophenol	DNBP 20
linuron	N–(3,4-dichlorophenyl)-N'-methoxy-N'-methylurea	Linuron 50
metribuzin	4–amino-6-*tert*-butyl-3-methylthio-1,2,4-triazin-5-one	Sencor 70 (autumn). Lexone 70 (spring)
paraquat	1,1'–dimethyl-4,4'-dipyridylium-2A	Gramoxone
prometryn	2,4–bis (isopropylamino)-6-methylthio-1,3,5-triazine	Gesagard 50
trifluralin	4–trifluoromethyl-2,6-dinitro- NN- dipropylaniline	Treflan
chlorthal–dimethyl 550 g l^{-1} + linuron 75 g l^{-1}		Shamrox WP

TABLE 2

EXPERIMENT MANAGEMENT DATA

General Management	Experiment 1					Experiment 2			
	Date			Days after Planting		Date		Days after Planting	
Planting	14 Feb. 77			..		28 Jun. 77		..	
First emergence of crop	4 Mar. 77			18		1 Aug. 77		34	
Cultivation	1 Mar. 77 and 22 Mar. 77			14 and 35		12 Aug. 77		45	
Hand weeding	25 Feb. 77 and 14 Mar. 77			11 and 28		16 Aug. 77		49	
Harvest	30 May 77			105		26 Oct. 77		120	
First rotational planting	3 June 77			109		14 Nov. 77		139	
Second rotational planting	..			..		7 Dec. 77		162	
Herbicide Applications	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stages 1 & 2**	**Stage 3**	**Stage 5**	**Stage 6**
Application date	15 Feb. 77	15 Feb. 77	24 Feb. 77	8 Mar. 77	14 Mar. 77	4 July 77	11 July 77	16 Aug. 77	29 Aug. 77
Days after planting	1	1	1	22	24	6	13	49	62
Days after emergence	..	..	..	4	10	..	..	15	28
Soil temperature 10 cm (°C)	27·5	30·5	32·0	24·5	24·0	11·5	19·0	17·0	15·5

Identification of herbicide application stages.

Stage 1 Early post-planting pre-emergence, incorporated (garden rake)
Stage 2 Early post-planting pre-emergence
Stage 3 Late post-planting pre-emergence
Stage 4 Crop 25% emerged
Stage 5 Crop 15 cm high
Stage 6 Tuber initiation

TABLE 3

WEED RATINGS AND TUBER YIELDS

Herbicide	Rate (kg ha^{-1})	Application Stage	Experiment 1		Experiment 2			Tuber Yield† (t ha^{-1})
			Broad-leaved Weed Rating*	Tuber Yield† (t ha^{-1})	Weed Ratings*			
					Sowthistle	Potato Weed	Barnyard Grass	
trifluralin	0·84	1	2·67	18·34	2·00	2·00	1·00	13·53
chlorthal-dimethyl	7·5	2	2·33	13·44	1·33	1·67	1·33	12·62
chlorthal-dimethyl + linuron ..	6·6 + 0·9	2	3·00	17·92	1·67	1·67	1·67	12·06
alachlor	2·25	3	3·00	16·73	1·33	1·67	2·00	13·77
alachlor	4·5	3	2·33	14·64	1·33	1·67	1·33	12·38
linuron	1·0	3	3·00	16·21	2·00	2·00	2·33	13·14
linuron	2·0	3	3·00	15·12	1·67	1·33	2·67	13·47
prometryn	1·0	3	2·67	15·11	1·33	2·00	2·33	13·71
prometryn	2·0	3	2·00	17·46	1·00	2·33	1·33	14·80
dinoseb	2·2	3	4·00	13·37				
paraquat	0·8	4	2·33	15·14				
metribuzin	0·18	5	1·67	17·03	1·00	1·00	2·67	12·60
metribuzin	0·35	5	1·33	13·86	1·00	1·00	1·33	13·32
metribuzin	0·7	5	1·00	14·54	1·00	1·00	1·00	13·86
metribuzin	1·4	5	1·00	16·00	1·00	1·00	1·00	13·11
bentazone	0·96	5			2·00	2·00	2·33	12·63
bentazone	0·96	6			1·00	1·67	4·67	11·37
Hand weed control			2·33	16·29	2·00	2·33	3·00	12·98
Untreated control			4·00	16·00	2·33	2·33	2·17	13·71
L.S.D. 5%								
From untreated control			1·47	N.S.	0·52	0·61	1·00	N.S.
Other comparisons			1·70		0·60	0·71	1·16	

* Weed ratings: 1 = nil or few, 10 = complete cover.

† Tubers weighing over 85 g.

Experiment 2 (spring)

Few weeds developed and only one cultivation was necessary. The population at crop maturity consisted of potato weed (*Galinsoga parviflora*), sowthistle and barnyard grass (*Echinochloa* sp.).

Numbers of potato plants in the pre-emergence herbicide treatments and the untreated control were recorded to show whether any treatment had affected emergence.

Three weeks after harvest half of each plot was sown with separate rows of sorghum, soybean, sunflower and lucerne. Three weeks later the other half of each plot was sown with sorghum, soybean, sunflower and pumpkin. The lucerne was destroyed by aphids but plant numbers of the other crops were recorded to assess residual herbicide activity (table 5).

III. RESULTS AND DISCUSSION

Table 3 gives the yield of marketable tubers and weed ratings. The experiments showed no yield advantage following removal of weeds either by herbicides or hand weeding. This result may be compared with the findings of Hawton (1977) in northern Queensland where the yield from weed-free cultivation was significantly higher than from normal cultivation in an experiment conducted in the summer season 1972–73. However in a similar experiment the following summer the difference between the two treatments was not significant.

No herbicide treatment significantly reduced tuber yield. However, the non-significant yield reduction following application of bentazone at tuber initiation should not be disregarded and this herbicide requires more thorough testing on potatoes before it can be recommended. No pre-emergence treatment affected plant population (table 4).

Metribuzin gave the most complete weed control in experiment 1, although it was not significantly different from the hand weeded control. Chlorthal-dimethyl, paraquat and the higher rates of alachlor and prometryn were also similar to the hand weeded control but the performance of the remaining herbicide treatments was not significantly different from the untreated control.

TABLE 4

EFFECT OF PRE-EMERGENCE HERBICIDES ON POTATO POPULATION, EXPERIMENT 2

Treatment		Number of Potato Plants 29 Days after First Emergence (thousands ha^{-1})
Herbicide	Rate (kg ha^{-1})	
trifluralin	0·84	36·4
chlorthal-dimethyl	7·5	35·3
chlorthal-dimethyl + linuron	6·6 + 0·9	34·7
alachlor	2·25	38·3
alachlor	4·5	36·4
linuron	1·0	34·9
linuron	2·0	36·2
prometryn	1·0	36·8
prometryn	2·0	35·3
Untreated control		39·5
No significant differences		

TABLE 5

EFFECT OF HERBICIDE RESIDUES ON THE SURVIVAL OF ROTATIONAL CROPS, EXPERIMENT 2

Treatment		Plant Numbers 6 Weeks after Sowing (plants m^{-2})						
Herbicide	Rate (kg ha^{-1})	Sown 3 Weeks after Harvest			Sown 6 Weeks after Harvest			
		Sorghum	Sunflower	Pumpkin	Sorghum	Sunflower	Pumpkin	Soybean
trifluralin	0·84	9·3	7·8	1·0	7·8	2·9	0·5	2·9
chlorthal-dimethyl	7·5	4·4	9·3	1·5	5·8	10·7	1·0	5·4
chlorthal-dimethyl + linuron ..	6·6 + 0·9	11·7	8·8	2·9	5·4	10·2	2·4	2·9
alachlor	2·25	1·5	2·9	2·4	6·8	3·9	1·0	2·0
alachlor	4·5	6·3	6·8	5·4	2·4	3·9	1·5	2·4
linuron	1·0	5·4	6·8	1·5	9·3	10·2	2·9	5·4
linuron	2·0	14·6	8·3	2·0	4·9	10·2	1·5	3·9
prometryn	1·0	5·8	4·9	2·4	8·3	7·8	1·5	2·0
prometryn	2·0	5·8	11·7	1·5	6·8	2·4	2·9	2·4
metribuzin	0·18	6·8	7·8	3·4	10·2	6·3	2·4	9·7
metribuzin	0·35	2·9	6·3	2·4	4·9	7·8	2·4	6·3
metribuzin	0·7	12·7	5·4	0	7·3	6·8	0·5	6·3
metribuzin	1·4	1·5	2·4	0	7·3	1·5	1·0	6·3
bentazone	0·96	4·4	2·9	2·0	6·3	7·3	1·5	2·4
bentazone	0·96	5·4	6·8	1·5	4·9	7·8	2·4	3·9
Control*		6·5	8·8	2·4	5·5	5·4	1·8	5·0
L.S.D. 5%								
From control		5·3	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Other comparisons		6·5						

* Mean of untreated and hand weeded controls

In experiment 2 metribuzin gave significantly better control of sowthistle and potato weed than the hand weeded control. With the other herbicides the sowthistle results followed a similar trend to experiment 1 but only linuron at 2 kg ha^{-1} gave effective control of potato weed. Trifluralin, chlorthal-dimethyl, chlorthal-dimethyl plus linuron, the high rates of alachlor and prometryn and metribuzin at 0·35 kg ha^{-1} and above were the only treatments to give significantly better grass control than hand weeding. The similarity of the hand weeded and untreated control weed ratings implies that the weeds developed after hand weeding.

The relatively poor performance of linuron in experiment 1 compared with experiment 2 may be explained by the difference in soil temperature at time of application (table 2). Hawton (1977) suggested that pre-emergence linuron treatments gave better weed control in winter than in summer because of rapid breakdown of the chemical at high soil temperatures.

The emergence of oats and lucerne sown after harvest in experiment 1 was variable and the lucerne seedlings were severely attacked by aphids. No systematic rating was attempted although it was observed that only metribuzin at 1·4 kg ha^{-1} had caused any obvious stand loss. In experiment 2 soil crusting caused variable emergence of the rotational crops. Significant differences in survival were recorded only for sorghum sown 3 weeks after harvest, but no herbicide reduced plant numbers significantly below control. There was no survival of pumpkins sown 3 weeks after harvest following application of metribuzin at 0·7 and 1·4 kg ha^{-1}.

It is concluded that it should not be necessary to supplement cultivation with herbicides in potato crops in southern Queensland. If heavy weed growth is expected metribuzin applied shortly after crop emergence at 0·35 kg ha^{-1} should control broad leaved weeds for the remainder of the season and 0·7 kg ha^{-1} should control grasses as well. This conclusion confirms existing recommendations. There is a risk of damage to pumpkin crops if they are grown immediately after potatoes treated with metribuzin, and harvest of weed-free potato crops might be delayed without weed growth to transpire excess soil moisture.

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REFERENCES

HAWTON, D. (1977).—Weed control in potatoes on the Atherton Tableland, Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* 17:832-836.

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