Research Report

SOME PRELIMINARY INVESTIGATIONS INTO THE SELECTIVITY OF 1-phenyl-4-amino-5-chloro-pyridazone-6 IN SUGAR BEET *

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Summary: Experiments are described in which 1-phenyl-4-amino-5-chloro-pyridazone-6 appeared effective against a range of weeds when used pre-emergence and post-emergence at early stages of weed growth. Efficiency of weed control was markedly inferior when the herbicide was applied at more advanced stages of weed growth. Inconclusive results were obtained from the use of added wetting agent and it is suggested that root absorption may be the most important factor governing the success of this chemical. Despite these encouraging results much more research needs to be done on the activity of this herbicide under different sets of soil and weed conditions.

INTRODUCTION

Fischer (1961) announced the activity of 1-phenyl-4-amino-5-chloro-pyridazone-6 as a herbicide in sugar beet and indicated that it might be of use both as a pre- and post-emergence herbicide. Preliminary greenhouse work by the A.R.C. Unit of Experimental Agronomy confirmed this and pointed to the importance of stage of growth and to the possibility that increased activity might result from the addition of a wetting agent to the formulation.

The field programme was designed to investigate these two points and to confirm, or otherwise, the necessity for a larger and more thorough trial series in 1963.

METHODS AND MATERIALS

Details of the experiments are set out in Table I. 1 and 6 were pot culture experiments, the remainder field trials. A randomised block layout, with three replicates, was used at all sites except 5 at Docking where the results quoted are from unrandomised observation plots added on to another experiment.

The Oxford Precision Sprayer was used to spray all experiments except 1 for which a special pot sprayer with a moving nozzle was used. The results quoted are those from applications made at a volume rate of 50 gal/ac. In experiment 1 each species was grown separately and sprayed when it had reached a defined stage of growth, - cotyledon, 2 leaf and so on. Obviously a range of weeds was encountered in the field work and it was felt to be more important to standardise stages of growth of the crop. Accordingly treatments were applied at the following arbitrary stages of crop growth, regardless of weed development.

* The abbreviation PCA is in current use but is not approved by the B.S.I. or the Weed Society of America.

TABLE I

Experiment No.	Location	Soil Type	Sugar Beet Drilling Date
1.	University Field Station, Oxford	Unsterilized potting compost	*
2.	Broom's Barn (Suffolk)	Clay loam	28.4.62
3.	Sprowston (Norfolk)	Sandy loam	19.3.62
4.	Postwick (Norfolk)	Light sandy loam	20 4.62
5.	Docking (Norfolk)	Loamy sand	22.3.62
6	Broom's Barn (Suffolk)	Unsterilized potting compost	26.6.62

* Sown on 26/2/62, 12/3/62 and 21/3/62, all sowings sprayed on 21/3/62, with artificial watering regime thereafter.

DETAILS OF EXPERIMENTAL CONDITIONS

Spraying Dates			Rainfall (in.) for consecutive weeks following first application								
Pre-emergence	Early Post-emergence	Late Post-emergence	1	2	3	4	5	6	7	8	9
3.5.62	24.5.62	31.5.62	.59	.55	.38	tr.	.62	.21	.99		
28.3.62	4.5.62	14.5.62	.66	.72	.56	.13	nil	.25	.40	.80	.23
-	20.5.62	-	.73	.04	.01	.01	.10				
23.3.62	8.5.62	-	.57	1.05	.09	.98					
26.6.62	12.7.62	19.7.62									

1. Pre-emergence - i.e. as soon as possible after drilling.

2. Early post-emergence - i.e. the advanced cotyledon stage, when all the plants had fully expanded cotyledons but the true leaves on the most advanced plants were less than 0.25 in. long.

3. Late post-emergence - i.e. the 2 - 4 leaf stage, when the first pair of true leaves were well expanded and the second pair not more than 0.5 in. long.

The chemical used was an 80 per cent wettable powder (H.S.119 ex. Boots Pure Drug Co. Ltd.) and the doses are referred to throughout in terms of lb/ac of active ingredient.

Vigour scores and counts were made on twelve 18 in. by 2 in. quadrats per plot just before the crops were singled at about the 6 - 8 leaf stage.

RESULTS

Effect on the crop

In some cases, reduction of the early vigour of the crop was noticed where the top dose of 4 lb/ac had been used pre-emergence or at the early post-emergence stage. This was only serious in pot culture experiment 1, where an application was made, with added wetter, at the cotyledon stage. Where this check occurred in field trials it was rapidly out grown and nowhere resulted in loss of final plant or vigour after singling.

Factors affecting weed control

1. Stage of growth

Figure 1 gives results for crop and weeds for the five experiments in which crop, and not weed development, was taken as a guide to spraying date. The weed counts, which are expressed as a percentage of the controls, represent the total broad-leaved weed population with the exception of Polygonum spp. which, in some trials, were relatively resistant. Figure 1 demonstrates very clearly that results from pre-emergence applications were good to excellent and from early post-emergence applications moderate to good, whilst results from late post-emergence applications were uniformly poor.

The stage of growth of the weeds varied to some extent at each site and from site to site, making it difficult to assess the re-action of individual species to 1-phenyl-4-amino-5-chloro-pyridazone-6 from such a limited number of experiments. However, the weed species encountered in this series are listed below, in order of importance, with an indication of their reaction to 1-phenyl-4-amino-5-chloro-pyridazone-6 at the early times of application. The categories are those used in the "Weed Control Handbook".

S - Susceptible

MS - Moderately susceptible

MR - Moderately resistant

R - Resistant

Polygonum convolvulus	MS to S
Stellaria media	S
Matricaria maritima	S
Chenopodium album	S
Veronica persica	S
Polygonum aviculare	MR to R
Poa annua	S
Sinapis arvensis	MS ##
Senecio vulgaris	S
Anagallis arvensis	S
Spergula arvensis	R ##

These two species were found only in one (post emergence) experiment and were at rather advanced stages of growth.

With the exception of the two species noted above (##) these categories refer to pre-emergence applications or those made up to the 1 - 2 true leaf stage, occasional plants being controlled at later stages.

2. Added wetter

Figure 2 illustrates the results obtained from two field and two pot culture experiments in which the effect of added wetting agent was critically examined. The figures are for Chenopodium album in the first two sets of results and Sinapis arvensis and Brassica alba respectively in the last two sets. The stages of growth of the C. album were closely comparable in the first two experiments and, in the second two, the S. arvensis was at a very similar stage of growth to the B. alba but with more of a rosette habit. These results show a complete range of response to the addition of wetting agent from an eightfold increase of activity to a slight negative response.

3. Conditions following spraying

In experiment 1 sets of sugar beet were sprayed with 1-phenyl-4-amino-5-chloro-pyridazone-6 (with the addition of a wetting agent) and the foliage then washed thoroughly after varying time intervals. The vigour of the seedling beet as shown by the fresh weight per plant expressed as a per cent of controls two weeks after spraying, is shown in Table II.

TABLE II EFFECT OF WASHING ON TOXICITY OF 1-phenyl-4-amino-5-chloro-pyridazone-6 TO BEET

Dose	Time interval between spraying and washing off (hr) ½	1	4	24
2 lb/ac	85	93	70	63
4 "	87	73	70	43

These figures indicate a marked loss of activity due to washing off to simulate rainfall within four hours of application. The only application in the field to be followed by heavy rain was the early post-emergence treatment in experiment 2, where a heavy local shower drenched the field about two hours after spraying. Weed control was of the order of 60 per cent at the top dose so this shower did not appear to have affected activity to a marked degree.

The weekly rainfall figures in Table I indicate that conditions were favourable for the activity of soil herbicides. Seedbeds were generally moist and all applications of 1-phenyl-4-amino-5-chloro-pyridazone-6 were followed by showery weather.

DISCUSSION

This paper deals with the results of a restricted series of trials in one year only and it would be unwise to draw sweeping conclusions from such limited experience. This herbicide has, however, shown itself to be capable of giving useful selective weed control, with some indication that it may be as much or more use as a pre-emergence herbicide than when applied post-emergence.

The marked difference between the weed control obtained from early and late post-emergence applications suggests that better results might have been obtained by spraying at a very early stage of weed development, irrespective of crop growth. It could be argued, however, first that it is simpler to tie the time of application to a definite growth stage of the crop and second, that the "advanced cotyledon stage" is probably about the earliest that the beet rows can be seen clearly across the field, a factor of considerable importance for accurate spraying and essential for band spraying.

In some respects, the evidence from this series of trials is confused. In one experiment, there was a marked response to the addition of wetting agent, coupled with a reduction in activity where the chemical was washed off the foliage. This would suggest that in these cases the herbicide was largely absorbed through the foliage. On the other hand, in field experiments and a further pot culture experiment there was little or no effect due to the addition of wetting agent and in at least one case heavy rain within two hours of spraying still allowed a high degree of activity. It could be suggested from these cases that, even for post-emergence use, this chemical may, in some cases, act largely through the soil.

Further work needs to be done to investigate the effect of varying soil conditions on the activity of 1-phenyl-4-amino-5-chloro-pyridazone-6, to obtain more information on the range of weeds controlled, and to determine the margin of crop tolerance at all stages of growth.

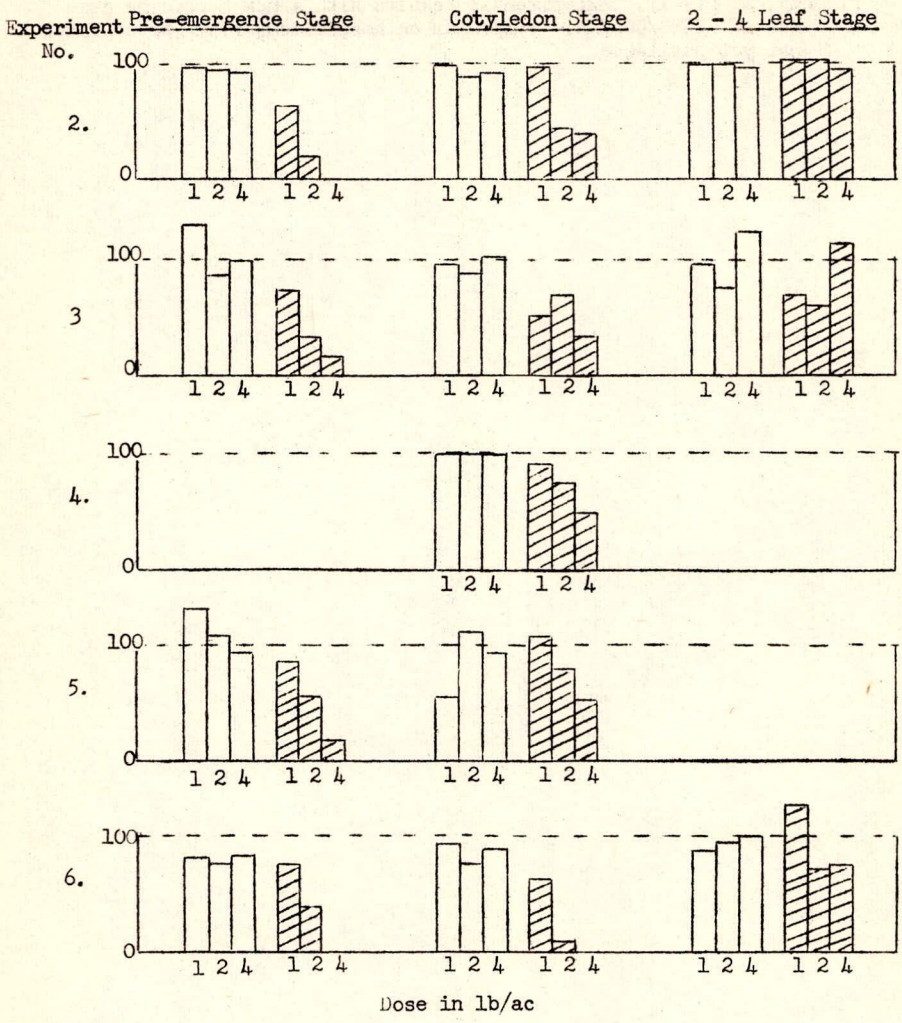
ACKNOWLEDGMENTS

This work was financed by the Sugar Beet Research and Education Committee of the Ministry of Agriculture. Thanks are due to Mr. C. Parker at the University Field Station, Oxford, who carried out one of the experiments and gave helpful advice on the remainder, and to Mr. P. P. Walker for invaluable technical assistance with the field work.

REFERENCE

FISCHER, A. (1961). Experimental results with a new herbicide for beets. EWRC/COLUMA. Symposium on herbicides, 1961 (proceedings not yet published.

FIGURE 1. SELECTIVITY OF PCA FROM APPLICATIONS MADE AT DIFFERENT STAGES OF CROP GROWTH

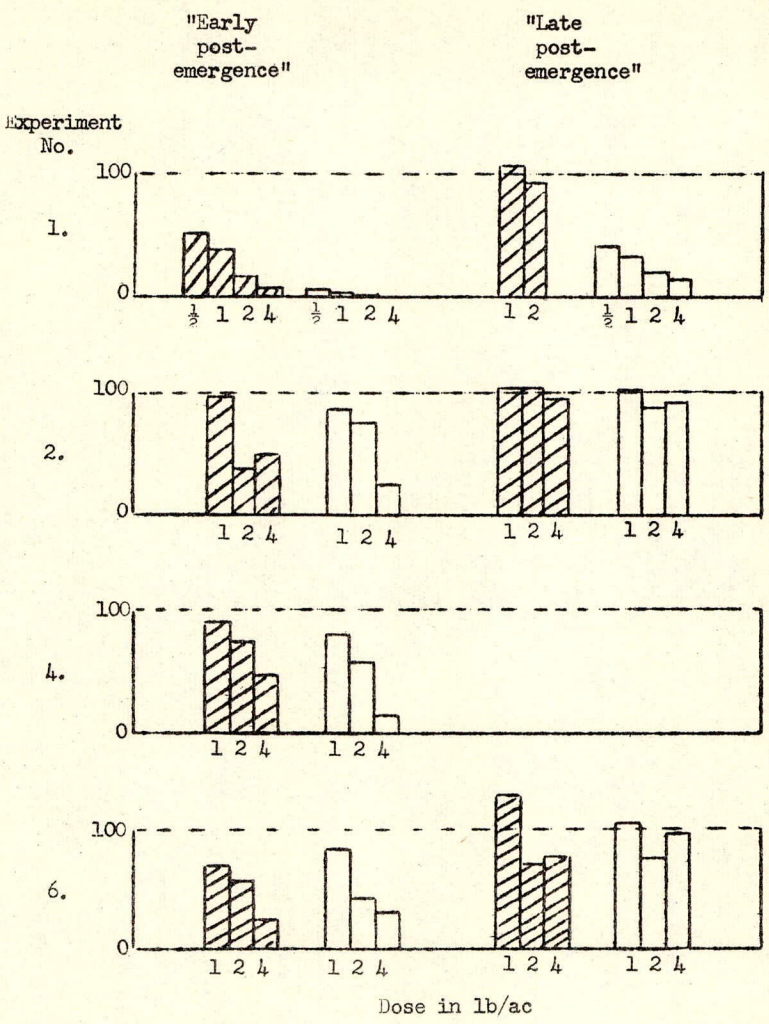


KEY: All results are expressed as per cent of controls

Sugar beet

Broad leaved weeds.

FIGURE 2. THE EFFECT OF ADDED WETTING AGENT ON THE RESULTS OBTAINED FROM POST-EMERGENCE APPLICATIONS OF PCA



KEY: All figures are expressed as per cent of controls

▨ without wetter ☐ with added wetter

Research Report

PRELIMINARY RESULTS WITH 1-PHENYL-4-AMINO-5-CHLOROPYRIDAZONE-6 FOR THE CONTROL OF ANNUAL WEEDS IN SUGAR BEET

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Summary: A programme of ten field trials carried out in 1962 demonstrated the herbicidal activity of 1-phenyl-4-amino-5-chloropyridazone-6 and indicated some of the factors associated with the post-emergence use of this compound for the control of weeds in sugar beet. There are indications from supporting greenhouse studies that soil incorporation treatment before weed emergence is worthy of further attention.

INTRODUCTION

At the European Weed Research Council/Columa Symposium on Herbicides in Paris, December 1961, Fischer[1] reported the promising selective herbicidal properties of 1-phenyl-4-amino-5-chloropyridazone-6 (PCA)* in sugar and fodder beet. Fischer showed that application at doses between 1 and 3 kg active ingredient/ha. (= 0.9 - 2.7 lb/ac) both pre- and post-sugar beet emergence could give satisfactory control of a range of common annual weeds of sugar beet without appreciable effect on the crop. Fischer (1961) reported that under conditions of high air temperature and humidity, occasional curling and slight necrosis of the cotyledons had been observed but that after a period of 2-4 weeks there was usually no indication of damage remaining. Fischer also reported that pre-emergence weed control could be improved by the addition of a small amount of OMU without particularly increasing the risk of damage to the beet. Arrangements were made to carry out a preliminary evaluation of PCA under British conditions in 1962. For this programme formulations of PCA and PCA/OMU were made available by courtesy of Messrs. BASF, Ludwigshafen.

METHODS AND MATERIALS

Ten trial sites were selected with the assistance of the British Sugar Corporation. Fields were chosen where high population of common annual weeds were to be expected. Soil types varied from light sand to clay loam. Treatments as indicated below were arranged in three blocks. Plot size was 1/120 acre. Applications were made overall by boom type sprayer at 20 gal/ac. No soil incorporation was carried out.

Details of the experimental products are as follows:-

'HS 119': A wettable powder containing 50 per cent of technical 1-phenyl-4-amino-5-chloropyridazone-6 (PCA)

'HS 92' : A wettable powder containing 64 per cent technical 1-phenyl-4-amino-5-chloropyridazone-6 (PCA) and 16 per cent technical N-cyclo octyl-N'-dimethylurea (OMU).

Treatments included:-

* This abbreviation is in common use but it is not approved by the B.S.I. or the Weed Society of America.

'HB 119' at doses equivalent to 1.25 to 2.75 lb/ac (by 0.25 lb steps).

'HS 92' at doses equivalent to 1 to 2.8 lb total /ac.

Mixed OMU/BIPC product ø

Not all treatments were applied at each site

Emphasis was placed on investigating the factors determining selectivity. To this end applications were made at as many stages of early crop and weed growth as possible from time of drilling onwards.

All trials were carried out within the period April 28th - May 18th. Records of soil and air temperatures at the time of application were made at each site and are given with the results. In no cases were conditions in any way extreme. In all trials, soil tilth was good and there was always adequate soil moisture to allow germination and to sustain growth of crop and weeds. In no case was spraying followed by heavy rain nor did soil conditions become wet subsequent to application.

Assessment of beet and weed population was made on a number of occasions during the season by both quantitative and qualitative methods. A ring marking technique was employed to distinguish between plants at different growth stages when they were sprayed.

RESULTS

Details of trial results are given in table I. Application of PCA made before beet emergence was without effect on the beet, irrespective of dose. Application of PCA at doses of 1.5 lb/ac and upwards after beet emergence up to the development of the first pair of true leaves, caused appreciable initial injury in the form of cotyledon curling and necrosis. This injury increased with increasing dose rate and at high rates sometimes caused mortality. Except where this occurred, recovery of the beet was often of a surprisingly high order considering the initial injury. Application made when the first pair of true leaves was well formed was followed either by no injury or by slight injury with substantial recovery.

Application of PCA before weed emergence gave unsatisfactory weed control irrespective of rate. Application of PCA after emergence and up to the initial appearance of the first true leaf or pair of leaves, gave good control of most of the annual weed species present at a dose of 1.75 lb/ac. Some minor differences in weed susceptibility were observed, Galium aparine being one of the least susceptible and Polygonum convolvulus one of the most susceptible of the species occurring in the trial series described. With applications made subsequent to the initial appearance of the first true leaf or leaves, degree and speed of control decreased with increasing maturity. By the time the first leaf or pair of leaves was fully developed, both aspects of control were unsatisfactory even at the highest dose used.

The same type of response of beet and weeds occurred on all soils. Degree of weed control and crop injury varied but with the limited number of trials no correlation between activity and soil type can be made.

ø 'Alipur'

As can be seen in Site 1, the only trial where application was made before beet and weed emergence PCA/OMU had no more effect on the beet or weeds than PCA alone. Where PCA/OMU was applied after beet emergence, during the stage of maximum susceptibility to PCA, the injury to beet was much greater with PCA/OMU, as was to be expected. As shewn in the table, variations in soil temperature were relatively slight and there are no indications of effect of temperature on activity of PCA.

DISCUSSION

From these trials it is clear that the ideal situation for the use of PCA is when all weeds emerge more or less simultaneously and can be sprayed at the cotyledon stage either (a) before sugar beet emergence or (b) after development of the first pair of true leaves of the beet. This result differs from those of Fischer who finds that the susceptible stage of the beet ends with the first appearance of the first true leaves.

As it so happened, in the trials reported, the most resistant stage of weed growth usually coincided with the most susceptible stage of the beet and vice versa. Usually, the effect on the beet was not apparent after singling. Exceptions to this occurred where high rates were used and/or spraying was carried out at the more susceptible stages of beet growth. Obviously, at other sites and in different seasons, more favourable association of weed and beet growth stages would often occur. In farming practice, it often occurs that heavy infestations of weed emerge before the beet. In such situations the use of PCA at 1.75 lb/ac would appear to have much promise when sprayed at the cotyledon stage of the weeds. There are also occasions where weeds emerge appreciably later than the crop and here again PCA could be valuable if used when the weeds were at the cotyledon stage and the first pair of leaves of the beet were well formed.

In the two cases in the trials reported, where PCA was applied before weed emergence, results were unsatisfactory, Fischer (1962) on the other hand finds that good control of weeds often occurs with pre-emergence treatment. This discrepancy between Fischer's and the results reported here could be due to a number of factors and is worthy of further investigation. In this connection it is interesting to note that in supporting greenhouse experiments good control of weeds followed soil incorporated treatments that were made before weed emergence. Furthermore, sugar beet was found to possess a useful tolerance to PCA when it was sown in treated soil. It would be valuable to attempt to confirm these results in the field and this is planned for 1963. The use of PCA in this way could greatly increase the scope of an extremely interesting and promising compound.

REFERENCES

FISCHER A. (1961) E.W.R.C./Columa Symposium on herbicides, Paris (Proceedings not published)

FISCHER A. (1962) Private communication, November 1962

TABLE I

List of weeds occurring in the trial series (In the table the botanical names have generally been abbreviated)

Stellaria media	Chickweed
Polygonum persicaria	Reshank
Polygonum convolvulus	B. Bindweed
Polygonum aviculare	Knotgrass
Veronica spp.	Speedwells
Chenopdium album	Fat Hen
Matricaria spp.	Mayweed
Urtica urens	Annual nettle
Chrysanthmum segetum	Corn Marigold
Galium aparine	Cleavers
Sinapis arvensis	Charlock

Key * Effect varies with dose. Ø Alipur.

Site	Date of Spraying	Air Temp.	Soil Temp.	Treatment in lb/ac
1. Bradmore, Notts. sandy loam (a)	Stage 1, 28 April	9°C	8°C	PCA 1.25, 1.5 1.75, 2.0 2.25, 2.5 2.75
				PCA/OMU 2.0 2.4. 2.8
				OMU/BIPC Ø
	Stage 11, 9 May	15°C	13°C	PCA 1.25, 1.5 1.75, 2.0 2.25, 2.5 2.75
				PCA/OMU 1.2 1.4, 2.0 2.8
	Stage 111,18 May	15°C	12°C	PCA 1.25, 1.5 2.0, 2.25 2.5, 2.75

TABLE OF RESULTS

Assessment Scale:

	Crop	Weed
0.	No injury	No control.
1.	Slight injury, no mortality	Poor control, up to 20 per cent.
2.	Slight to moderate injury, up to 15 per cent mortality.	Fair control, up to 40 per cent.
3.	Moderate injury, up to 25 per cent mortality.	Fairly good control, up to 60 per cent
4.	Severe injury, up to 50 per cent mortality.	Good control, up to 80 per cent.
5.	Very sever injury, over 50 per cent mortality.	Very good control to complete control.

Crop stage	Crop Injury Rating	Weed Stage	Weed Control Rating	
Unemerged	(0)	S. media, P.aviculare, Veronica spp., P. convolvulus, C. album — unemerged	(0)	
Unemerged	(0)	as above	(0)	
Unemerged	(0)	as above	(2)	
Unemerged to just emerged	(1-3)* after singling vigour = unspr.	S.media, V. spp., P.aviculare, P.convolvulus, C. album — Unemerged to cotyledon Unem.to 1st lf. un-emerged	Unem.: (0) (0) (0) (2) (0)	Em.to 1st lf: (2-4)* (2-4)* (2-4)*
Unemerged to just emerged	(2-4)* after singling vigour = unspr.	as above	as above	
1st pair leaves just showing	(0)	S.media 1 pr. leaves; V. spp. 2 pr. leaves; C. album 1 pr.lvs.fully expanded; P. convolvulus 1-2 lvs.; P. aviculare. N.B. No weed was predominant at this site	(0)	

TABLE 1 (cont'd)

Site	Date of Spraying	Air Temp.	Soil Temp.	Treatment in lb/ac
2.Bradmore, Notts sandy loam (b)	Stage 1, 28 April	9°C	8°C	PCA 1.75 2.0
				PCA/OMU 1.4
	Stage 11, 9 May	16°C	14°C	PCA 1.5, 1.75 2.0
3.Screveton, Notts clay loam	2 May	13°C	9°C	PCA 1.75, 2.0 2.25, 2.5
				PCA/OMU 2.4
			N.B.	Assessment after singling

Crop Stage	Crop Injury Rating	Weed Stage		Weed control Rating
Cotyledon	(3) after singling vigour = unspr.	*Matricaria* spp. *S. media* *P. aviculare* *C. album* *P. convolvulus*	Cotyledon	(4) negligible dose response
Cotyledon	(4) after singling vigour = unspr.	as above		(4)
1st leaf	(1)	*Matricaria* spp. *S. media* *P. aviculare* *C. album* *P. convolvulus*	1st leaf or pair of leaves cotyledon to 1st lf.	(1) (3)
		N.B. No weed was predominant at this site		
1st pr. leaves just showing	(2-4)*	*P. aviculare*	cotyledon to 2-3 leaves	(0-1)*
as above	(4)	as above		(0-1)

invalidated by uneven growth of crop

TABLE 1 (cont'd)

Site	Date of spraying	Air Temp.	Soil Temp.	Treatment in lb/ac
4. Hougham, Lincs. (a) Loamy sand	4 May	12°C	10°C	PCA 1.5, 1.75 2.0
5. Hougham, Lincs. (b) Light sand	4 May	12°C	10°C	PCA 1.75
				PCA/OMU 2.8
6. Hougham, Lincs., (c) medium loam	4 May	12°C	10°C	PCA 1.5, 1.75 2.0

Crop Stage	Crop Injury Rating	Weed Stage	Weed Control Rating
1st pr.leaves just showing	(2-4)* After singling: 1.5 = unsprayed 1.75 - v.slight reduction in vigour 2.0 - moderate reduction in vigour	*P. convolvulus* 1st leaf just showing) *P. aviculare* 1st leaf expanding) *U. urens* 1st pair lvs. expanding)	(2-3)*
		C. segetum)1-2 pairs) *S. media*) leaves)	(1-2)*
		N.B. No weed was predominant at this site	
cotyledon	(4) After singling: slight reduction in vigour	*P. persicaria*) Cotyledon) *P. aviculare*)) *P. convolvulus*)1st leaf or) *S. media*)pair of lvs) *Veronica* spp.)showing)	(4)
		N.B. *P. persicaria* predominant	
cotyledon	(5) After singling: severe reduction in vigour	as above	as above
cotyledon	(2-3)* After singling: no apparent reduction in vigour	*P. persicaria*) *P. convolvulus*) Cotyledon) *C. album*) *U. urens*) Cotyledon to) 1st pr, leaves) *C. segetum*) 1st pr.) *S. media*) leaves) *S.arvensis*)1st leaf or) *P.aviculare*)pair leaves)	(4)
		N.B. *P. persicaria* predominant at this site	

TABLE 1 (cont'd)

Site	Date of Spraying	Air Temp.	Soil Temp.	Treatment in lb/ac
7, Edwinstowe, Notts. Light sand	Stage 1,. 1 May	17°C	16°C	PCA 1.25, 1.5 1.75, 2.0 2.25, 2.5
				PCA/OMU 1.0 1.4, 2.0 2.8
	Stage 11. 14 May	14°C	10°C	PCA 2.0, 2.5 2.75
8. Mereside Hunts., medium loam	8 May	20°C	15.5°C	PCA 1.25, 1.5 1.75, 2.0

Weed response in this trial dependent on stage rather than species

Crop Stage	Crop Injury Rating	Weed Stage		Weed Control Rating
early cotyledon	(2-4)* Prior to harvest 0-50 per cent thinnings.* Est.yield depression 0-20 per cent*	S.arvensis	1st leaf just showing	
		S.media Matricaria spp. P.persicaria P.convolvulus	cotyledon	(2-5)*
early cotyledon	(4-5)* PCA/OMU Prior to harvest 50-80 per cent thinning.* Est. yield depression 30-60 per cent	as above		(3-5)*
1st pr. leaves	(1-2)* Prior to harvest stand and vigour = unsprayed.	S.arvensis S.media	3-4 prs. leaves	(0)
		Matricaria spp.	1-2 prs. leaves	
		P.persicaria P.convolvulus	1st leaf	(1-2)* (2-3)*

N.B: S.arvensis predominant at this site.

				(i)	(ii)
cotyledon to first pr.leaves	(3)	P.convolvulus	)	(4-5)	(3)
		S.media	)Cotyledon(i)	(3)	(1)
	(2)	G.aparine	)to fully	(2)	(0)
		P.aviculare	)expanded	(3)	(1)
	(Dependent on stage not dose)	Veronica spp.	)1st leaf	(3)	(1)
		C.album	)or pair	(3)	(1)
		U.urens	) (ii)	(2)	(0)
		Matricaria spp.	)	(3)	(0)
		P.persicaria	)	(4)	(1)

N.B. P.convolvulus, S.media & Veronica spp. predominant.

TABLE 1 (cont'd)

Site	Date of Spraying	Air Temp.	Soil Temp.	Treatment in lb/ac
9. Tydd St.Giles, Camb., medium loam	Stage 1, 26 April	16°C	15°C	OMU/BIPC ø
	Stage 11, 11 May	15°C	13°C	PCA 1.25, 1.5 1.75, 2.0 2.25, 2.5 PCA/OMU 1.4, 1.6, 1.8
	Stage 111,17 May	16°C	15°C	PCA 1.25, 1.5 1.75, 2.0 2.25, 2.5

Crop stage	Crop Injury Rating	Weed Stage	Weed Control Rating
immediately after drilling	(1)	P.convolvulus) P.persicaria) unemerged G.aparine)	(3)
early cotyledon	(1-3)*	P.convolvulus) cotyledon	(4)
		P.persicaria) 1st leaf	(3)
		G.aparine) 1st whorl leaves	(2)
early cotyledon	(3-4)*	as above	as above
N.B. Crop response initially slow, damage progressively increased until shortly before singling. After singling = unsprayed.			
late cotyledon	(0-2)*	P.convolvulus) 3 leaves	(3)
		P.Persicaria) 2-3 leaves	(2)
		G.aparine) 2 whorls of leaves	(1)
		Subsequent to spraying there was a further emergence of weeds, all were unaffected.	

TABLE 1 (cont'd)

Site	Date of Spraying	Air Temp.	Soil Temp.	Treatment in lb/ac
10. Bury St.Edmunds, Suffolk. light loam	Stage 1, 13 April	9.5°C	10°C	CMU/BIPC Ø
	Stage 11, 7 May	18°C	17°C	PCA 1.5, 1.75 2.0, 2.25 2.5
				PCA/CMU 1.4
	Stage 111, 14 May	13°C	12°C	PCA 1.5, 1.75 2.0, 2.25 2.5
				PCA/CMU 1.4

Crop Stage	Crop Injury Rating	Weed Stage	Weed Control Rating
immediately after drilling	(3)	C.album) unemerged	(3)
		other species) as below) unemerged	(4)
late cotyledon to early first pair leaves	(1-4)*	C.album) cotyledon to)	
		S.arvensis) first pair)	
		Veronica spp.) leaves)	
		S.media) cotyledon to 2-3 pairs leaves)	
as above	(4-5)	Matricaria spp.) 1st pair leaves)	(3-5)
		P.convolvulus) cotyledon to 1 leaf)	
		P.aviculare) 1st leaf)	
1-2 pairs leaves	(1-3)*	C.album) 1-2 prs.leaves)	
		S.arvensis) 2-3 prs.leaves)	
		Veronica spp.) 1-2 prs.leaves)	
		Matricaria spp.) 2-3 prs.leaves)	(2)
		P.aviculare) 1-3 leaves)	
		S.media) small plants)	
		P.convolvulus) 1-2 leaves	(3)
		°/ Dose response overshadowed by effect of stage.	
as above	(3-4)	as above	as above

Presentation by Mr. G.W. Cussans of the two preceding papers.

The experiments reported have dealt, to some extent, with stage of application and in evaluating the results, it is very important to consider the relationship of crop and weed growth.

With regard to crop tolerance of PCA, it has appeared from these experiments that applications made before the emergence of the crop or after the appearance of the first pair of true leaves were generally quite safe at doses greater than those likely to be used in practice. Sugar beet, however, does appear to pass through a stage between emergence and the appearance of the first true leaves, during which applications of PCA have given rise to distortion of the cotyledons and to loss of plant in severe cases. Where damage has occurred in trials it has been very rapidly outgrown, although Lush and his colleagues report one case where visual differences were still apparent just before harvest. Dr. Fischer and Mr. Beinhauer have produced harvest results from a number of experiments in which there has been a slight tendency for plots treated with PCA to outyield control plots.

In the experiments reported by myself and by Fischer and Beinhauer weed control has been quite satisfactory from applications made before weed emergence although Lush and his colleagues report poor weed control in the experiment in which they applied pre-emergence treatments.

In all these experiments the most important factor controlling weed control by post-emergence applications has been stage of growth, very briefly the smaller weeds are more effectively controlled and efficiency falls off very rapidly after weeds reach the 2 true leaf stage. Control of more advanced weeds tends to be slow and poor although in some cases useful suppression of weed competition may be achieved. Both papers include a list of weeds controlled in these experiments - indicating a wide range of weeds including Chenopodium album and members of the Brassica family.

My own paper deals, to some extent, with the question of adding wetting agent to the formulation, without drawing any firm conclusions. In fact the effect of added wetter has varied from an eight fold increase in activity to no effect at all. In this connection Fischer and Beinhauer report that they have developed an improved formulation and that, in trials, this has given better selectivity, particularly at more advanced stages of weed growth.

PCA obviously acts through the soil in the case of pre-emergence applications and the suggestion has been made that soil activity could be important, in some cases, even for post-emergence use. No obvious correlations were noted in any of these trials, between activity of PCA and any of the factors known to influence the activity of soil herbicides, but such factors could conceivably be a cause of anomolous results. In this connection, Lush and his colleagues report selectivity from applications of PCA made before drilling and worked into the seedbed - an interesting suggestion, which obviously must be followed up in subsequent trial work.

If it is possible to summarise all this work in a short statement it would be fair to say that PCA is an extremely interesting and potentially a highly selective herbicide, not the least interesting feature being that application can be made at three stages in the cycle of the crop;

1. Before drilling or between drilling and emergence of the crop.

2. After the sugar beet has developed its first pair of true leaves, provided that the weeds are not so large as to show appreciable resistance.

3. After singling - to suppress late germination of weeds.

Research Summary

FIELD TRIALS WITH 1-PHENYL-4-AMINO-5-CHLORO-PYRIDAZONE-6 A SELECTIVE WEEDKILLER FOR SUGAR BEET CULTURE

by

Jean Lhoste, Herve D'Ille, Antoine Casanova, Laboratoire Des Pesticides, Procida, France, et Louis-Andre Durgeat Institut Technique Francais de la Betterave.

The authors are conducting an experimental programme with selective weedkillers in sugar beet culture. This summary reports the results obtained with 1-phenyl-4-amino-5-chloro-pyridazone-6 (PCA*), a new herbicide lately mentioned by Fischer. This compound has been used singly or as a combined spray with cyclo-octyl-dimethylurea (CMU).

EXPERIMENTAL METHOD.

Treatments were carried out with a logarithmic field plot sprayer developed by van der Weij. Each experimental plot was 2m wide and 30m long. There were two or four replicates of each treatment. A Control plot was positioned between each pair of treated plots. Spraying was carried out at different times between the date of sowing and the date of thinning the crop.

In order to assess the efficiency of the weedkiller, beet seedlings and weeds were weighed and counted at the time of thinning out, i.e. about 50 days after sowing. For this purpose, sugar beet and weeds were collected from areas of 0.6 m^2. These areas corresponded with the dose ranges shown in Table 1.

*This abbreviation is in current usage but is not approved by the B.S.I. or the Weed Society of America.

TABLE I - DOSE OF ACTIVE INGREDIENT SPRAYED ON QUADRATS FROM WHICH SUGAR BEET AND WEEDS WERE COLLECTED.

Dose Category	Distance from end of logarithmic plot	Dose of chemical sprayed in kg/ha		
		PCA	PCA	CMU
I	0.5 - 1.0 m	4.71 - 4.62	3.77 - 3.70 + 0.94 - 0.92	
II	15.0 - 15.5 m	2.58 - 2.52	2.07 - 2.02 + 0.51 - 0.50	
III	21.0 - 21.5 m	1.92 - 1.87	1.54 - 1.50 + 2.38 - 0.37	
IV	29.5 - 30.0 m	1.24 - 1.20	0.99 - 0.96 + 0.25 - 0.24	

RESULTS

1) Sugar beet

After treatment with PCA, no phytotoxicity was observed on beet seedlings except during the stage of "opened cotyledons". On the contrary, the mixture PCA + CMU was phytotoxic when applied post emergence. Because

of this effect, the combined PCA + CMU spray must be applied at least 3 or 4 days prior to germination of the beet.

2) Weeds

Treatments with PCA proved fairly efficient against:-

Chenopodium album L.	Fumaria officinalis L.
Sinapis arvensis L.	Polygonum persicaria L.
Polygonum aviculare L.	Polygonum convolvulus L.
Stellaria media Will	Veronica sp.
Anagallis arvensis L.	

At the 3 - 4 leaf stage, weeds were getting more resistant to PCA.

Examples of the results obtained with PCA alone and with the PCA + CMU mixture are shown in Tables II and III.

TABLE II - EXPERIMENT WITH PCA IN COURDIMANCHE: PERCENTAGE REDUCTION IN THE TOTAL BULK OF WEED MATERIAL IN THE TREATED PLOT, COMPARED WITH THE ADJACENT CONTROL PLOT

Dose Category	Delay between time of sowing and date of spraying.											
	1 day	5 days	13 days	20 days	23 days	26 days	29 days	33 days	33 days	39 days	42 days	46 days
I	95	98	98	94	95	91	96	90	92	82	78	78
II	92	83	82	90	85	79	90	82	89	81	3	37
III	95	95	84	86	82	72	95	84	86	67	70	58
IV	94	93	90	88	70	75	82	94	91	86	84	59

TABLE III - EXPERIMENT WITH PCA + OMU IN CHARS: PERCENTAGE REDUCTION IN THE TOTAL BULK OF WEED MATERIAL IN THE TREATED PLOT, COMPARED WITH THE ADJACENT CONTROL PLOT.

Dose Category	Delay between time of sowing and date of spraying.					
	7 days	11 days	18 days	26 days	32 days	39 days
I	95	97	99	97	76	66
II	80	80	96	80	56	61
III	69	66	91	54	68	31
IV	79	74	89	71	38	59

CONCLUSIONS.

Though it is difficult to determine exactly the optimum dose, we are of the opinion that a minimum of 2.5 kg of PCA or 1.6 kg of PCA + 0.4 kg OMU per ha might be recommended.

PCA may be applied during a rather long period in the development of the beet, limited by the dryness of the soil, and the rapidity in growth of the weeds.

As regards the combined spray of PCA + OMU, only pre-emergence treatments have proved really efficient.

A full account of this work will be published in "WEED RESEARCH"

Discussion on three preceding papers

Mr. J.D. Fryer I would like to comment on a slide shown by Dr. Fischer. If I understood it rightly, as the dose increased the weed control appeared worse. This seems unusual. Has he any comment on this?

Mr. G.W. Cussans This is really in Dr. Fischer's province and I do not know whether these results were statistically significant. I forgot to mention that the work on formulations had led to an improved formulation and they believe that the dose can be reduced. I have had a more rational dose response in my own trials; on the other hand I consider that the stage is more important than the dose.

Mr. E. Leafe With regard to the comment about Dr. Fischer's table, Mr. Fryer may have been interpreting the weed control results upside down; there was a dose response in the way you would expect from the weed control point of view.

Mr. F. Sherwood Could either of the speakers tell us something about the effect of PCA on weeds which had not germinated at the time of application of the PCA?

Mr. G.W. Cussans I thought I had dealt with this point. I did find that pre-emergence treatment was slightly superior to that in the early weed stages. The more general impression however seems to be that the cotyledon stage applications are more successful. The pre-emergence applications I dealt with were pre-weed or pre-beet. Mr. Lush and his colleagues did not get good pre-weed control. He may like to comment on this. It may be due to one of the many factors we have already discussed.

Mr. G.B. Lush We had little experience with PCA pre-emergence but, where we did, the results were not satisfactory and we do not know why there is this difference. Soil temperatures might be relevant.

Dr. W.E. Ripper Endothal/Propham mixtures are not generally successful in controlling fat hen. The success shown with PCA would be of practical importance to every sugar beet grower. Is this compound compatible with the systemic insecticides which would be applied at about the same time post-crop emergence?

Chairman No reply. Once again Dr. Ripper has floored them.

SESSION 10

Chairman: Professor G.E. Blackman, F.R.S.

Part 1 NEW HERBICIDES

Research Summary

THE CONTROL OF WEEDS IN AGRICULTURAL KALE

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Kale (Brassica oleracea var. acephala) is commonly grown as a green crop for winter feed on the stock farms of the United Kingdom. A number of chemicals for weed control in kale have been available for some time, but these, sulphuric acid, sodium monochloracetate and potassium cyanate, are not entirely satisfactory and have not gained widespread acceptance by the farming community. As the first step in a new approach to kale, information was obtained through the National Agricultural Advisory Service that Chenopodium album (fat hen), Polydonum persicaria and P. lapathifolium (redshank) and Sinapis arvensis, Raphanus raphanistrum and Brassica spp. (charlock) are the most serious weed problems.

Experiments in 1961

In this first year of the investigation, field screening experiments were carried out on clean and weedy kale, in which 26 experimental chemicals were applied to the soil or to foliage according to their mode of action: the choice of those chemicals being made in consultation with Dr. Holly and Mr. Parker, of the Weed Research Organisation and the A.R.C. Unit of Experimental Agronomy, respectively.

During the course of these experiments it was observed that a selective control of C. album in kale was being achieved by foliar applications of three methylmercapto triazines* :-

ametryne ... 2-methylmercapto-4-ethylamino-6-isopropylamino-1,3,5-triazine
simetryne ... 2-methylmercapto-4,6-bis(ethylamino)-1,3,5-triazine
'G 34360' ... 2-methylmercapto-4-methylamino-6-isopropylamino-1,3,5-triazine

As these results had been obtained by logarithmic applications further experiments were started on late sown kale in which finite plots were sprayed with an Oxford Precision Sprayer. In a typical experiment the three chemicals were applied at three doses in 50 gal water/ac to C. album 7-8 in. high growing in marrowstem kale at the 3-4 leaf stage on 16.8.61. Effectiveness of weed control is shown in Table 1.

* These chemicals were supplied by Fisons Pest Control Ltd. Desmetryne has been proposed as the common name 'G 34360'.

TABLE I NUMBER OF LIVE PLANTS OF CHENOPODIUM ALBUM PER SQUARE YD ON 6.9.61 (21 DAYS AFTER SPRAYING)

Dose - oz/ac	3.2	6.4	9.6
ametryne	5	0	0
simetryne	28	1	0
'G 34360'	13	0	0
Unweeded Control	152		

Owing to the dense weed population on the control plots accurate counts of the kale population were not made. Counts on the sprayed plots indicated that only the highest dose of ametryne had caused any mortality. On 1.11.61 the plots were harvested and the yields of clean kale obtained are shown in Table 11.

TABLE II YIELDS OF GREEN KALE IN TONS/AC ON 1.11.61.(10 WEEKS AFTER SPRAYING)

Dose - oz/ac	3.2	6.4	9.6
ametryne	7.4	8.5	5.2
simetryne	7.4	7.2	7.4
'G 34360'	7.9	9.4	7.7
Unweeded Control	0.6		

This and other experiments conveyed the impression that 'G 34360' was the most promising of the three herbicides because of its greater margin of selectivity between C. album and kale. In the early winter of 1961 the results were disclosed, in confidence, to Fisons Pest Control Ltd. and their co-operation in developing the chemicals was obtained. In the spring of 1962 the National Agricultural Advisory Service was approached, and agreed to test the chemicals at as many sites as possible in 1962.

Experiments in 1962

The 1962 programme was an agreed one between the Weed Research Organisation, Fisons Pest Control Ltd. and the National Agricultural Advisory Service. The Weed Organisation continued with experiments on kale at Begbroke to test the direct reaction of the crop in the absence of weeds, account being taken of such factors as stage of growth at the time of spraying, volume rate, variety and sowing density: work on the weed control aspect being done on ordinary farm crops near Oxford. Yield results are not yet available but a considerable amount of intermediate information has been collected. The overall picture obtained from the Organisation's work is summarised in the following points:-

1. All three chemicals have caused more than 90 per cent kill of actively growing C. album at 4 oz/ac, though 5-6 oz/ac may be required if the plants are well advanced in bud or if growth is slow due to drought.

2. 'G 34360' is appreciably less toxic to kale than are ametryne or simetryne, and it should have a sufficient margin of selectivity between C. album and kale to justify commercial use.

3. The phytotoxic symptoms develop in 7-14 days, according to whether growing conditions are fast or slow. C.album shows chlorosis of the leaves, death of the growing point and finally death of the stem. Kale show some chlorosis on the leaves, but subsequent leaf emergence is normal.

4. The optimum time to spray is when the kale plants have 3-4 true leaves expanded. Earlier spraying may cause injury; later spraying carries no dangers for the kale but the C. album may be too well grown for easy control.

5. Volume rate in the range of 15-50 gal/ac does not appear critical.

6. No differences in varietal response have been observed in a preliminary study of four marrowstem, three thousand head and one dwarf variety of kale.

7. The control of C. album by these chemicals can lead to very substantial increases in yield of kale.

8. The activity of the chemicals is not confined to C. album. Polygonum persicaria and P. lapathifolium (redshank), Urtica urens (annual nettle), Stellaria media (chickweed), Senecio vulgaris (groundsel), Sinapis arvensis (charlock), Fumaria officinalis (fumitory), and Lamium amplexicaule (deadnettle) are all affected, but the experience to date is not sufficient to justify drawing conclusions.

9. The three chemicals are known to have soil as well as foliar activity, but preliminary indications are that at 4 oz/ac soil action is not a significant factor.

As 'G 34360' is a chemical of low mammalian toxicity which should not represent undue hazard to man or beast, its commercial development as a foliar spray might well provide a control of C. album in kale which is sorely needed.

It is intended to publish a full paper on the subject in "Weed Research".

Acknowledgments

The authors wish to thank T. Woodward and A. Lock, of the Weed Research Organisation, for their part in the field programme. Thanks are also due to the many N.A.A.S. officers and farmers who helped in providing experimental sites, and to Dr. Woodford and the staff of the Weed Research Organisation for their interest and support.

Research Summary

SELECTIVE CONTROL OF CHENOPODIUM ALBUM IN KALE WITH METHYLMERCAPTO TRIAZINES

C. Baker, H. M. Holmes and R. K. Pfeiffer
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INTRODUCTION

The discovery by Elliott & Cox in 1961 of the potential value of three methylmercapto triazines for the selective control of Chenopodium album in kale led to extensive investigations of this subject by the authors in 1962.

Two of these triazines were studied, namely:

a) Simetryne: 2-methylmercapto-4,6-bis(ethylamino)-s-triazine

b) 'G 34360':* 2-methylmercapto-4-methylamino-6-isopropylamino-s-triazine

EXPERIMENTAL METHODS

The work proceeded in two stages:-

I. Greenhouse work during the winter of 1961-62 in which a range of triazines were compared. In these experiments, Elliott's results were confirmed and aspects such as development stage, crop density and the formulation of the chemicals were studied.

II. Field investigations in 1962, when there were two series of experiments:-

a) small plot investigations at Chesterford Park on factors likely to influence the crop safety of the candidate triazines (type of kale, development stage, plant density, the effect of rain and soil moisture, formulations).

b) a series of fifty field experiments which were distributed over the main kale-growing areas of England and Wales, to study the reliability of the proposed treatments and to determine the optimum dose. Each of these trials consisted of a logarithmic strip of each of the two herbicides and a small replicated yield trial with two rates of each chemical.

RESULTS AND CONCLUSIONS

1) Comparison of the two triazines

In the majority of the experiments, 'G 34360' showed slightly but significantly better selectivity than simetryne. The two triazines did not always show a difference in crop toxicity though in some experiments, both in

* Desmetryne has been proposed as the common name for 'G 34360'

the field and in the greenhouse, simetryne was found to be significantly more toxic to the kale than 'G 34360'. There was, however, a marked tendency for 'G 34360' to give a better control of C. album. Out of 51 field experiments, higher activity on C. album was shown by 'G 34360' in 39 trials and by simetryne in 7 trials; in the remaining 5 trials there was no observable difference. On average, 4 oz/ac of 'G 34360' gave 82 per cent reduction of C. album; the same rate of simetryne gave 72 per cent control.

2) Dose

Both the minimum effective dose and the maximum dose tolerated were found to vary considerably, mainly according to growing conditions. Thus higher rates were tolerated in general on kale grown under drought conditions in the eastern counties as compared with kale grown under moist, warm conditions in the west. The same relationship was indicated on C. album. A systematic field study on the variation in crop sensitivity in relation to soil moisture showed a significant increase in sensitivity in irrigated kale over a crop grown under drought conditions on the same field. An analysis of all data available led to the conclusion that 4 oz/ac of either triazine could be regarded as acceptable under moist conditions and 6 oz/ac under conditions of low rainfall and atmospheric humidity. At these rates a high degree of control of C. album has been obtained.

Under growing conditions which caused the kale to be particularly sensitive, the 4 oz dose caused scorch and a check to growth. However, recovery was remarkably rapid and complete and in experiments on clean crops no difference between treated and untreated kale could be detected two months after spraying, provided that initial crop vigour and plant density were adequate. Recovery was not always complete on late-sown crops because of the shorter growing period.

Even under unfavourable conditions, any adverse treatment effect on crops infested with C. album is unlikely to be of any importance in comparison with the increase in growth resulting from weed control.

3) Spray volume

Volume rates from 10 to 80 gal/ac were compared. The differences found were small and irregular.

4) Crop development stage

Greenhouse and field data showed kale to be sensitive to the triazines at the recommended dose when treated at the cotyledon stage and up to the three leaf stage. Treatments can only be recommended from this stage onwards.

5) Seedrate and plant density

Crop sensitivity was found to increase with reduced plant density. This is thought to be partly due to the shielding effect in dense populations.

6) Relative tolerance of kale, turnips and swedes

Swedes and turnips were found to be highly sensitive to both herbicides and no reliable selective control of C. album can be obtained in these crops.

7) Reaction of different types of kale

No differences were found in the sensitivity of marrow-stem and thousand-head kale.

8) Toxicology and residues

Both compounds are of low mammalian and avian toxicity, and appear to present no hazards in use:-

Compound		Acute oral LD 50 (mg ai/kg)		
		Rat	Mouse	Bird
Simetryne:	technical	905	535	-
	50 per cent wettable powder	1080	-	-
	25 per cent wettable powder	1830	-	500 (pheasant)
'G 34360'	technical	595	1290	-
	25 per cent wettable powder	650	-	250 (hen)

Residues of the chemicals in kale harvested from four sites 12 weeks after treatment at 8 oz/ac were determined, using a gas-liquid chromatography technique capable of detecting 0.1 ppm. No residues of either simetryne or 'G 34360' were detectable in the treated crops. The proposed commercial introduction of 'G 34360' has been submitted under the Notification Scheme.

Research Report

THE CONTROL OF WEEDS IN KALE AND OTHER BRASSICAE WITH CERTAIN METHYLMERCAPTO TRIAZINES

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Summary: Sixteen experiments using three methylmercapto triazines for weed control in kale and allied crops were planned with the help of the Weed Research Organisation and laid down by the N.A.A.S. in 1962. Ametryne, simetryne and 'G 34360' were each applied at three doses to crops in the early stages of growth. This report covers the effects of the herbicides on the crops and weeds up to the time of the first assessment (about 3 weeks after spraying). The results of the second assessment (about 6 weeks after spraying) were available for only three centres at the time when this paper was prepared, and therefore no separate data is presented. Sampling for yield estimations will, where possible, be carried out before the crops are utilised.

INTRODUCTION

In 1961, ametryne, simetryne and 2-methylmercapto-4-methylamino-6-isopropylamino-s-triazine ('G 34360') at low doses proved to be the most promising of a considerable number of herbicides investigated by the Weed Research Organisation for selective weed control in kale and were tested further by the N.A.A.S. under commercial farming conditions in 1962. This report is a preliminary account of the results obtained.

MATERIALS AND METHODS

The herbicides, which are relatively insoluble, were used as wettable powders. No difficulties in obtaining adequate dispersal were reported at volume rates of 30-40 gal/ac through the hand sprayers used but some centres had trouble from excessive foaming, especially at the high dose of 'G 34360'. It is unlikely that this would be important under commercial spraying conditions.

The experiments were carried out on fourteen crops of kale (seven Marrow Stem; four Thousand Headed and three of mixed Marrow Stem and Thousand Headed); one of kale interspersed with a few rows of swedes; and one crop of rape. The standard design, which was followed at 15 centres, provided for the application of each material at doses of 2, 4 and 6 oz/ac at the 2-5 true leaf stage of the crop. Assessments of the density of each of the main weeds present and of the total weed infestation were made by quadrat counts at the time of spraying. These were repeated approximately 3 to 6 weeks later at some centres, but the records are not complete at others. All the trials were, however, scored on each occasion for general cleanliness and crop damage. Yields will, where possible, be taken before the crop is used. At Pangbourne, only the 4 oz dose of ametryne was applied, but more detailed records were taken.

Randomised block layouts were used throughout. At 15 centres there were three replications of plots of about 1/100th acre, with one unweeded and one hand weeded control in each block. At Pangbourne there were 4 replications of 1/200th acre plots, with unweeded control plots in each block. Field details for each centre are given in Table I. - see page 773.

The weed density figures are quoted where available, in Tables I and IV mainly as a guide to the level of infestation against which the performance of the herbicides must be judged. An estimation of the percentage reduction in the total weed population and in the numbers of the main species present can be derived for centres where data is available. This information cannot, however, be related directly to the weed control scores which provide the only common factor for comparisons covering all the trials, and which have accordingly been used in the tables. Since the scores are not related to any fixed scale of response, little uniformity of assessment can be expected, and the figures should be treated with caution. The fact that the scores for some weeds on the control plots tend to be low should also be noted. It is presumed that in these cases the observer has also taken into account the reduced vigour of the weed growing in competition with the crop.

The scores of the unweeded controls have been used in all comparisons because of the considerable variation in the time at which hand-weeding was carried out in relation to the date of spraying. The scores for crop damage are more straightforward, but again these cannot be related to any scale showing the degree of damage.

RESULTS

Crop

The two types of crop damage reported were an initial leaf scorch, accompanied in severe cases by a holing of the leaves and the death of young plants, and later a mottled chlorosis, developing first in the younger growth. The degree of damage varied from centre to centre, and in some instances no scorching was seen. Scorch symptoms were recorded at Truro, Holsworthy, Lapford, Broadmayne, Stourton, Ilminster, Pangbourne, Westoning and Penrith. This scorch was worst at the four and six ounce application rates, when it was often accompanied by the death of younger plants. At Truro, Holsworthy, Lapford and Ilminster, 'G 34360' was noted to have been less harmful than ametryne and simetryne. Chlorosis was seen at all centres, but the symptoms had disappeared or nearly disappeared by the time of the first assessment at Lapford, Hertford, Lancaster, Dewsbury and Penrith. At nine of the other centres, treated plots were shorter and less vigorous than the unweeded controls, and the chlorosis was occasionally more persistent. At Thulston and Penrith where the crops were sown early and developed slowly under dry and relatively cold conditions, the controls compared unfavourably with the treated plots because of excessive weed competition. At Thulston, this effect was apparent at three weeks, whilst at Penrith it developed in the twentyseven days between the first and second assessments when the mean score for vigour on the unweeded controls was 2.3 compared with a mean of 7.9 for all treated plots. At Broadmayne an apparently similar trend was noted at the first assessment.

A summary of the results is given in Table II - See page 782/3. The increased effect from the 4 and 6 oz/ac doses and the tendency for 'G 34360' to be less damaging should be noted.

Plant population counts are available only from the Pangbourne centre, where crop damage was relatively severe, and are shown in Table III.

TABLE III. EFFECTS ON DENSITY OF KALE

	Dose oz/ac	Plants per sq yd
ametryne	4	8.0
simetryne	2	12.1
	4	11.8
	6	11.6
'G 34360'	2	13.4
	4	12.3
	6	8.8
Control		18.6

The crop at this centre showed greater variation than usual in stage of growth. The distribution was as follows: 2 true leaf - 35 per cent; 3 true leaf - 40 per cent; 4 true leaf - 21 per cent; 6 true leaf - 4 per cent.

The swedes at Stourton suffered heavier initial damage than the kale but subsequently made a good recovery. The one rape crop at Truro showed relatively heavy initial damage.

Weeds

Scorch damage developing shortly after the treatment of susceptible weeds was reported at some centres but not at others. In all trials chlorosis developed in the younger tissues, spreading downwards until the plant died or began to recover.

The mean scores for general cleanliness given in Table II follow the same pattern as that recorded for crop damage, in that weed control becomes progressively better with increasing dose, but 'G 34360' is rather less effective at 2 and 4 oz/ac than ametryne and simetryne.

Detailed records were obtained for up to five main weeds at each centre, the frequency with which the various species occurred being as follows:-

Chenopodium album 15 centres; Stellaria media 11 centres; Polygonum persicaria 6 centres; Matricaria maritima var. inodora and Capsella bursa-pastoris 4 centres each; Urtica urens and Spergula arvensis 3 centres each; Fumaria officinalis 2 centres; Sinapis arvensis and Veronica spp. 1 centre each.

A few records are unreliable, mainly because the weed to which they refer was unevenly distributed over the trial area. A summary of the remaining scores at the first assessment is given in Table IV. - see pages 784, 785, 786, 787.

All the materials gave a good control of Chenopodium album at each of 12 centres out of a total of 13 for which full records are available. Results tended to improve with increasing rates of application, but the 2 oz/ac and 4 oz/ac doses were usually satisfactory. At these doses, ametryne and simetryne were rather better than 'G 34360'. At Holsworthy, immediate re-infestation in a slow growing crop spoilt the effect of the treatments, and indicated that, at the low doses used, none of the herbicides has any residual action.

Atriplex patula did not occur as a major weed at any centre but behaved similarly to Chenopodium album at Oernant.

Species which were killed as easily as Chenopodium album were Stellaria media and Veronica spp. The 2 oz/ac dose of each of the materials appeared to be adequate against these weeds.

Polygonum persicaria and Spergula arvensis were rather more resistant than Chenopodium album. P. persicaria was generally killed or severely checked by the 6 oz/ac doses of each material but the effect of the lower applications, particularly of 'G 34360' was not consistent. A measure of control was, however, obtained at each of the 4 centres recorded in detail. At Holsworthy, where the results were least satisfactory, seedlings were killed and the remaining plants prevented from growing above the kale, as happened on the control plots.

Spergula arvensis was most effectively dealt with by the 6 oz/ac application of ametryne and simetryne. Two of the centres reported, however, that surviving plants were later quickly smothered by the crop.

Urtica urens appears also to have needed a high dose at Oernant but infestations which occurred on part of the plot area at Broadmayne and Westoning were more easily controlled.

Fumaria officinalis was easily controlled at Castle Combe but the treatments were less effective against a thinner population of more mature plants at Oernant. Capsella bursa-pastoria was controlled to some extent by 4 and 6 oz/ac of ametryne and simetryne at each of 3 centres.

The control of Matricaria maritima var. inodora was on the whole, poor, although the mean figures tend to show that the weed may have received some check, particularly at the high doses. Sinapis arvensis was reported as resistant at two centres where the weed appeared in small numbers, and it is not known whether the apparent success of the 4 and 6 oz/ac doses of 'G 34360' at the one trial for which scores are available could be generally repeated.

Weeds which occurred at some centres and were resistant to treatment included Cirsium arvense, Ranunculus repens, Viola tricolor, Galium aparine, Plantago major and P. lanceolata, Taraxacum officinale, Polygonum aviculare, Rumex spp. and Potentilla anserina. Grass weeds were not affected by these herbicides.